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WATER INSTITUTIONS AND SECTOR PERFORMANCE: A QUANTITATIVE ANALYSIS WITH CROSS-COUNTRY DATA

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WATER CHALLENGE: AN INSTITUTIONAL DIAGNOSIS

As the world ushers into the new millennium, water scarcity—both in its quantitative and qualitative manifestations—is emerging as a major development challenge for many countries. While water quantity is a key problem in countries racing towards their physical limits to fresh water expansion, water quality is a major concern in countries with an expanding industrial sector, commercialized agriculture, and urban settlements. Since pollution-induced water quality deterioration reduces the utility of the existing water resources, water scarcity also emerges even in countries with no apparent limits for fresh water expansion. Besides, given the serious economic, ecological, and welfare consequences of floods in many countries, water crisis is also to be viewed in a much broader sense than as a mere scarcity issue.

Although countries differ in terms of the nature and severity of their water problems, one aspect common to most countries is that water scarcity—whether quantitative, qualitative, or both—originates more from use inefficiency and poor management than from the physical limits for supply augmentation. This, in fact, is the crux of water crisis and it is such diagnosis that raises the hope that the problem is solvable through better water use and management. But, the task is not that easy as it involves radical changes in the way water resources are developed, allocated, and managed at present. How to design, initiate, and sustain these changes and tackle the water challenge on a durable basis, that too, within the economic, ecological, and political constraints, is the heart of the ongoing water debate both at the national and international arenas. As an introduction and as a backdrop to subsequent discussion, it is necessary to understand water crisis in all its dimensions as well as to show the institutional underpinnings of water challenge especially from a global perspective.

1.1. Physical Dimension

Water crisis is usually viewed in terms of an increasing imbalance between water supply and demand. However, it is much more than a simple hydrological or physical phenomenon as it also has its origin in the currently pervasive gaps in the economic and institutional dimensions of water resource development, use, and management.

Water is certainly the most abundant and ubiquitous resource on earth. But, not all of which can be of use as 97.5 percent of global water is too salty to support human consumption and crop production. Even the rest of the fresh water, estimated at 35 million cubic kilometer (million cukm)/year[1], cannot be fully accessed as most of which is locked either in the ice cover of Arctic and Antarctic regions or in deep underground

[1] One cukm is equal to one billion cubic meter (bcum).

aquifers. Thus, the physically accessible fresh water potential amounts to only 90,000 cukm/year, representing just 0.26 percent of global fresh water reserves (Shiklomanov, 1993:13). More than two-third of even this potential evaporates back into the atmosphere. Although this portion, known as green water, is not accessible for direct human use, it does provide, however, indirect but indispensable ecological benefits by sustaining both the life-supporting functions of ecosystems as well as the livelihood needs of people relying on rainfed agriculture.

Even the rest of the fresh water potential, known as blue water, cannot be fully utilized due to economic, technological, and environmental limitations, spatial and temporal mismatch between fresh water availability and demand, and pollution-induced quality deterioration. The spatial distribution is a grave problem as water resources are not available in the place or at the time of their need. For instance, Brazil with just a small fraction of global population share one-fifth of global fresh water resources whereas India and China sharing more than a third of world population have only one tenth of global fresh water resources (Shiklomanov, 1993:13). As a result, of the estimated blue water potential of about 40,000 cukm, only about 12,500 cukm can be accessed under the present economic and technical conditions [Food and Agriculture Organisation (FAO), 1996:3]. The issue is going to be still more complicated as the extent of future utilization of even the accessible blue water is also threatened by climatic change-induced variations in the level and spatial pattern of global temperature and precipitation.[2]

While it is true that desalinization and water recycling can increase water supply, these options are not only costly but also become relevant only in few contexts. As a result, the supply augmentation capabilities of these options are extremely limited. Although desalinization capacity has increased tremendously during the fast few decades to reach 18 million cubic meter (million cum)/day at present, it is confined to a handful of countries in the Middle East and few coastal cities in the US (Gleick, 1998:30-31). Considering its present capacity as well as future expansion, the total supply from desalinization is no more than a fraction of total global water demand.[3] Similar is also the case with water reuse and recycling. Water reuse is not more than 2 percent of total water demand even in the countries of the Arabian Peninsula witnessing the most severe scarcity of fresh water (see Abdulrazzak, 1995:230). Although there are serious concerns over its ecological and health consequences, the use of treated wastewater for irrigation purpose is substantial and growing in countries like Israel, Mexico, and Chile, and Tunisia.

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[2] The spatial variations in global precipitation and temperature are expected to cause considerable shift in the regional pattern of agriculture and accentuate the already serious spatial mismatch between water supply and demand. Warming in the winter is predicted to be greater in the northern latitudes than towards the equator. Precipitation is expected to fall consistently throughout the year in high latitudes and in the tropics but may increase as much as 10-20 percent in certain zones such as 35-50°N (Gleick, 1993:107).

[3] However, in the context of the seven countries in the Arabian Peninsula, the supply from desalinization is substantial representing about a tenth of their current total water demand (see Abdulrazzak, 1995:232).

Improvement in water use efficiency is indeed a promising avenue for supply augmentation in view of the extensiveness of water losses and resource underutilization at present. Since this option helps to realize the hidden resource potential within the existing supply limits, it augments supply even in the absence of new water development projects and also preempts the ecological consequences ranging from waterlogging and salinity to aquifer depletion. For instance, a 10 percent improvement in water use efficiency, for instance, can add 2 million hectare (mha) of additional irrigation in Pakistan and 14 mha of additional irrigation in India (Postal, 1993:60; Saleth, 1996:234). In a condition where investment constraints and environmental issues are limiting irrigation expansion in developing countries, the option of improving irrigation efficiency is very important.[4] The adoption of modern irrigation technologies can improve water use efficiency up to 95 percent and could lead to water savings of over 50 percent (Postal, 1999:187). While these technologies have a tremendous potential for water saving, they cover only a limited area and confine to just a handful of countries.

The total area covered by modern irrigation technologies is estimated to be only about 1.6 mha representing just a fraction of a percentage of global irrigated area at present. Three fifth of this area is accounted by five countries: US, Spain, Australia, Israel, and South Africa (Postal, 1993:60-61). There is also a substantial scope for water saving in the urban sector both by reducing water loss and improving water use efficiency. For instance, water saving through retrofitting of traditional residential water appliances such as toilets can release substantial water for further redistribution. In California, for instance, the retrofitting of toilets can alone lead to a 25 percent saving in indoor water use (Gleick, 1998:22). But, the retrofitting program is not only costly but also requires cooperation from water users. Neither the required level of additional investment nor the extent of public cooperation can be obtained without changing at first the incentive environment through policy changes.

As against the binding limits for supply augmentation, the water demand is increasing due to a fast growing global population and expanding scale of global economic activities. Between 1950 and now, the global population has more than doubled to reach six billion and it is expected to double again to reach 12 billion by 2100. Urbanization, the major consequence of population growth and economic expansion, leads to serious pressures both on the quantitative and qualitative dimensions of water resources. Urban population, estimated to be 43 percent of global population at present, is expected to rise to 61 percent by 2025 implying an urban population of about 5 billion by then. The water-related consequences of urbanization are going to be particularly serious in the already heavily populated developing countries. The growth of urban settlements not only magnifies the task of providing water supply and sanitation services but also increases the health and environmental risks of water pollution from industrial effluent and urban sewerage. As many developing countries are concentrating their

[4] For instance, the additional irrigation development possible in the developing countries during 1995-2020 is predicted to be only 37 mha implying an annual growth rate of just 0.7 percent as compared to the rate of 1.7 percent observed during 1982-93 (Rosegrant and Ringler, 1999:12).

limited resources on the immediate task of providing water supply, they are unable to invest enough resources either in sanitation program or in sewerage treatment. For instance, in the Latin American region, over 90 percent of urban wastewater is collected and discharged directly into the water systems (Nash, 1993:32). In addition to urban sewerage, farm chemicals from commercialized agriculture and toxic effluents from energy-intensive industries also tend to aggravate water scarcity from its qualitative dimension.

Apart from the quantitative and qualitative pressures on its physical dimension, water demand is also growing due to the broadening perspective of water and its ecological, ethical, and cultural roles. Water is needed not only for meeting human needs but also for meeting the needs of the water-based ecosystems that form part of the global life-supporting system. As a result, the minimum in-stream flow requirement that is now mandatory in many countries also forms an increasing component of water demand. Similar is also the need for reserving water for supporting surviving indigenous communities and their traditional cultures (Donahue and Johnston, 1998). In view of the human rights implications of meeting basic water needs and the equity aspects of empowering vulnerable groups including women, water demand also assumes now an ethical and social dimension.

In any case, the demand for water is growing much faster than supply augmentation in many countries. The demand growth is particularly serious in the over populated but water scarce regions of developing countries where water is the defining line between poverty and prosperity. With population growth and economic expansion, the scale of global economic activity has also increased several folds. . For instance, irrigation that accounts for over a three-fourth of total water use has expanded from 50 to 250 mha during 1900-2000 and is expected to reach 296 mha by 2020. The expansion in irrigation, drinking, and industrial needs during 1990-00 has resulted in a dramatic increase in global fresh water withdrawals from 500 to about 4000 cukm/year (Gleick, 1998:6-7)[5].

Although current withdrawal represents no more than 5 percent of the physically accessible global fresh water resources, it is close to a third of the economically accessible blue water resources of the planet. However, Postal, et al. (1996) predict that global water withdrawal is already close to 54 percent of the accessible blue water and can be as high as 70 percent of the same by 2025. This prediction is certainly not off the mark. Given current population and its projection for 2100, and an annual per capita allowance of 200 cum for household needs and 800 cum for irrigation (Falkenmark, 1999:360)[6], the total global human water requirement can be as high as 6 billion cubic

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[5] There are, in fact, many estimates available on total global water withdrawal by 2000. These estimates vary from 3940 to 6826 km3/year depending upon the experts and the year of estimation (Gleick, 1998:Table 1.1:14).

[6] The per capita demand can be still higher in areas with poor rainfall as the irrigation allowance of 800 cum/person/year assumes that only 50 percent of the total irrigation needed for food production comes

meter (bcum) at present and 12 bcum by 2100. This means that global water demand, which represents 50 percent of the accessible blue water at present, can be very close to the ultimate water barrier towards the end of this century. But, in a scenario where the withdrawal of 30 to 60 percent of the accessible fresh water resources is considered as the practical limit for supply augmentation (Falkenmark and Lindh, 1993), it is not farfetched to see many countries to reach their supply limits just within next couple of decades.

The telltale symptoms of water scarcity are already evident in 80 countries with 40 percent of global population and 18 of them, mostly in the Middle East, are actually drawing either close to or over their renewable water supply limits (Falkenmark and Lindh, 1993:80; Gleick, 1993:105-106). Already, 55 countries in Africa and Asia are not in a position even to meet the basic water needs of their growing population. As a result, about 2.2 billion people do not have access to clean water and 2.7 billion people do not have access to sanitation services (Gleick, 1998:40). The increasing water scarcity is also a major threat to irrigated agriculture especially in developing countries of Africa and Asia with a major share of global population and a predominant dependence on agriculture. Often, the social and economic costs of water scarcity also spill into the social and political arenas causing severe water conflicts both among users, regions, and countries (Gleick, 1993; Beaumont, 1994; Frederiksen, 1998; Postal, 1999).[7]

Besides the socio-economic consequences of its quantitative dimension, water scarcity is also having far serious effects on its qualitative dimension. Pollution-induced quality deterioration not only reduces the benefits of available supply but also leads to pernicious environmental and health hazards. As a result of water pollution and poor sanitation services, more than 2 billion people remain exposed to malaria risk in about 100 countries (Nash, 1993:27). More than 250 million new cases of waterborne diseases are reported every year leading to an annual death of 5 to 10 million people (Gleick, 1998:39). On the other side of the spectrum, water related natural disasters like floods and famines also take a heavy toll of human life both directly as well as indirectly through

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from man-made irrigation while the rest comes from soil moisture from precipitation (Falkenmark, 1999:360). Besides, in view of the heavy evaporation demand and percolation losses, the amount of water (in the form of soil moisture) needed to produce the annual per capita diet can be as high as 2000 cum. This is particularly so in countries such as India and China both of which have a major share in global irrigated area and population (FAO, 1996:5).

[7] Some of these conflicts even have the potential to become full-fledged water wars as a large part of the surface flow in several countries originates from outside their borders. For instance, in the case of 19 countries, the proportion of surface water originating beyond their borders ranges from 21 percent (Israel) to about 97 percent (Turkmenistan and Egypt). What is notable the most is the fact that the share of global population that will face the predicament of water conflict in these hotspots is projected to increase from 44 to 75 percent by 2025 (Postal, 1999:138-140).

diseases.[8] Apart from the human costs, there are also economic losses from crop and property damages.[9]

1.2. Economic Dimension

While one can imagine how threatening are the long-term ecological consequences of water crisis to global life-supporting systems and hence, to the very survival of the human species, the immediate economic consequences of water crisis can be easily reckoned given the key role of water in socio-economic development. Water resources support 40 percent of global food production through irrigation and 20 percent of global fish yield through aquaculture (FAO, 1996:2). Water resources also help in generating 640,000 megawatt of power constituting 20 percent of global power supply (Gleick, 1998:70). The direct economic contributions of water resources can be still higher at the regional level. For instance, irrigation contributes to 70 percent of food production in China and 50 percent of the same in India (FAO, 1996:5). Similarly, the role of hydropower in total power need is far higher than the world average in many countries. For instance, in 63 countries, hydropower accounts for more than 50 percent of total power production and in 23 of them, it accounts for over 90 percent of total power supply (Gleick, 1998:71).

The water sector in general and its irrigation segment in particular are going to face a much heavier pressure in the near future in view of the growing food demand of an expanding population especially in the developing countries of Asia and Africa. For instance, the food demand of the developing countries that was at 1,021 million tons in 1993 is expected to jump to 1,634 million tons by 2020 with up to 80 percent of the additional supply depends critically on irrigation (Rosegrant and Ringler, 1999). Similarly, in view of the physical limits, production constraints, technical difficulties, and pollution proneness of fossil energy, the demand for the cheaper, technically flexible, and environmentally clean hydropower is also increasing in all countries. This will add pressure on the water resources of the countries with the technical potential for hydropower generation and infrastructural capabilities for power trade.[10]

Water resources development has served well its historical function of supporting a world with an increasing population and an expanding scale of economic activities. But, there are evidences for the fact that the positive relationship between water resources and economic development is now getting disturbed not just in developing countries but even in developed countries. The negative consequences such as the ecological and

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[8] Although there are many recent cases for the human costs of such disasters, the most serious cases include the death of 0.9 to 1.2 million people in 1887 and 1.0 to 3.7 million people in 1931 (Wijkman and Timberlake, 1984; McDonald and Kay, 1988).

[9] For instance, the annual economic loss due to floods in China alone is estimated to be as high as $5 billion (Qishun and Xiao, 1995).

[10] There is a considerable scope for regional power trade. For a European case study of the economic and technical potential for such trade, see von der Fehr and Sandsbraten (1997).

social disturbances in project areas, salinity in irrigated regions, aquifer depletion in arid zones, and pollution-induced water quality and health damages in urban centers raise the social costs whereas inefficient use and mismanagement reduce the social benefits from additional supply. As a result, the net economic and welfare contributions of water resources tend to decline over time and across countries. Some indirect evidences for this fact are provided by Orloci, Szesztay and Varkonyi (1985) who evaluate the relationship between per capita Gross Domestic Product and per capita water use based on cross-section data pertaining to 50 countries over three points of time (1965, 1980, and 2000). Despite the conceptual difficulties with the variables and the crude nature of the analysis, the result suggests clearly that the positive association observed between the two variables is getting weaker over time. The weakening trend suggests the simple fact that water use declines with economic development due to a shift from extensive to intensive use pattern facilitated by water scarcity and technology. But, the positive trend still suggests the reality that water continues to remain as a major constraint for economic development especially among countries in the lower income range.

There are also more specific cases that provide much stronger evidence for the declining net contributions of water resource development. For instance, in India with a current irrigated potential close to 90 mha, about a tenth of this potential remains unutilized and close to a sixth of the actually irrigated area is afflicted with waterlogging and soil salinity (Saleth, 1996:20). While underutilized capacity leads to an opportunity costs covering not only the output forgone but also the interest on investment, waterlogging and salinity lead both to a short-term productivity decline as well as to a long-term loss of scarce and productive land resources. The underutilization of water resources developed with costly investment and the production loss from waterlogging and soil salinity are far more serious when considered especially from a global perspective. For instance, while the total storage capacity of all reservoirs in the world is estimated to be about 6,000 cukm, the actual amount of water stored in these reservoirs is far lower than the capacity in view of problems such as siltation, catchment deterioration, and flow irregularities (FAO, 1996:8). On the other side of the spectrum, the area affected by irrigation-induced salinity is estimated between 20 to 47 mha and yield loss from these areas is estimated to be about 30 percent (Postal, 1999:93; Rosegrant and Ringler, 1999:11).

When the total output is less than its optimum due to the combined effects of capacity underutilization and productivity loss from salinity, the cost of creating additional irrigation potential is also becoming prohibitive in many countries. The capital cost of new irrigation capacity, which is already high in many parts of the world, is increasing at a faster rate due to environmental and resettlement costs as well as delay-induced cost escalation. The estimated capital cost of adding a hectare of irrigation varies from \$1500-4000 in China and India to \$6000-10,000 in Brazil and Mexico. In parts of Africa, it can be as high as \$10,000-20,000 (Postal, 1993:57 and 1999:62). Under this condition where the output contributions of irrigated area are declining and the environmental and financial costs are increasing, it is no wonder why the net economic and welfare contributions of water development projects tend to decline over time.

Similar instances for the declining economic and welfare contributions of water resources can also be found in other sectors. In the context of urban sector, for instance, adding more water to existing supplies can contribute more to costs than benefits in view of the pervasiveness of water loss, lower water rates, and poor cost recovery. In this context, Mexico City provides the best case for the worst situation facing the urban water sector of many developing countries. The magnitude of water losses in Mexico City is estimated to be high enough to supply the gross water need of a whole city of the size of Rome (World Resources Institute, 1990). It is rather ironic that such a magnitude of water loss occurs in a city that pumps its water from a 200-km distance and a 2-km altitude. Unfortunately, as in most other urban centers of the developing countries, cost recovery in Mexico City is as low as 20 percent. It is, therefore, no surprise that the cost of supporting this city is said to exceed its contributions in terms of goods and services (Falkenmark and Lindh, 1993:86).

It is clear that the declining trend in the net economic contributions of water resources occurs due to inefficient use, poor management, declining water productivity, and increasing environmental and financial costs. It is also an outcome of the fact that the linear relationship that existed initially between water resources and economic development has now to incorporate the circularity of multifarious effects that emerge in the process of interaction among society, water, and ecosystem (Falkenmark, 1999; Varis, 1999). In view of the broader perspective of the linkages between water, society, and environment, the economic dimension of current water crisis incorporates not only the strict economic aspects but also the economically relevant ecological and social aspects. While the declining net economic contributions of water sector is understandable in view of an increasing weight attached to current and future ecological and social costs, it is rather difficult to reconcile with the negative financial contributions of the water sector in many countries. The negative financial trend, an obvious outcome of lower water charges and poor cost recovery, risks the efficient maintenance of existing water infrastructure as well as the potential for additional investments in future water development projects. Declining water sector investment and deteriorating physical health of water infrastructure are now casting a shadow on the very existence and sustainability of water sector itself. In view of the close linkages among the financial status, physical health, service quality, and economic performance of the water sector, the overall process of economic development itself depends critically on water sector performance. The key issue in the economic dimension of water challenge is, therefore, how to improve the financial and economic sustainability of the water sector and enhance and sustain, thereby, its indispensable contributions to socio-economic development.

1.3. Policy Dimension

The problems facing the water sector are a clear indication that the water sector is no longer in the era of plenty but entering now into the era of scarcity, both at the local and global levels. In contrast to the prediction of economic theory that resource use efficiency tend to improve with scarcity, water use tend to be more and more inefficient in the very face of an increasing water scarcity. Why is this so? The answer lies in water sector policies including the approach on which they are based and the framework within which they are formulated and implemented. The basic approach and the institutional framework that dominated the surplus era continue with little change even in the scarcity era. The emphasis on engineering solution, the treatment of water as a free good, and bureaucratic allocation and management are all now inconsistent with the requirements and challenges of the new era. Therefore, it is how to resolve the conflicts between past policies and the emerging realities that is the central issue on the policy dimension of water challenge.

Water crisis is an outcome of the growing imbalance between water needs (as determined by population growth and economic development) and supply augmentation capabilities (as determined by economic policies, managerial framework, and technological conditions). Policy has a key role both in managing water needs as well as in enhancing the supply augmentation and management capabilities. For instance, policy changes that can capture and reflect the increasing value of water can justify options ranging from desalinization to inter-regional water transfer either directly or indirectly through the import of water-intensive commodities. However, economic justification for these costly options can occur only when the efficient use of the already available water resources raise the economic and social value of water. A higher value and hence, the price of water, can both justify as well as pay for the costly supply augmentation options. This argument can also be extended to other situations where there is scope for fresh water development but involves higher environmental and social costs. In this case, a higher value of water obtained from an efficient use of existing supply can be used to finance ecological restoration and resettlement programs. Through appropriate policies, therefore, it is possible to integrate supply augmentation with demand management so that an efficient allocation and use of the already developed resources can both justify and pay for the development of additional supplies. To what extent can these policies succeed in this respect depends, however, on two critical aspects, that is, economic approach and allocation framework. Unfortunately, it is the absence or limitations of policies with such an economic approach and institutional underpinning to support an allocation framework that is responsible for the present predicament of water sector in most countries.

A retrospective review of the approaches and policies that are followed hitherto can show how inconsistent are they with the emerging resource realities, socio-economic concerns, and development ethos. While an efficient and durable solution to water scarcity requires an economic approach, decentralized management, market-based allocation and full-cost pricing, the water policies in most countries are characterized by the predominance of an engineering approach, centralized management, bureaucratic allocation, and subsidized provision. Instead of the urgent need for an allocation-oriented paradigm for water resource development and management, the supply-oriented paradigm continues to be the basis for water resource development and management in many countries.

While it is easy to criticize the supply-oriented approach from hindsight advantage, it is rather unfair to underestimate its historical role in supporting a world with an increasing population and an expanding scale of economic activity. The massive amount of water resources developed through large schemes did help the emerging countries of Africa and Asia to support their expanding agriculture and urban settlements. It did help to eliminate the major food crisis of the 1950s and 1960s and provide environmentally clean energy to support industrial development and higher quality of life. But, the emerging resource realities and development concerns as well as a century-long accumulation of the negative effects of water development projects and their mismanagement tend to reduce the relevance of the supply-side approach.

The conceptual basis, assumptions, and policy implications of the supply-oriented paradigm have become now not only obsolete but also incompatible with the present concerns. With an increasing premium attached to the ecological, social, and cultural aspects of water, the narrow and isolated perspective of water underlying the supply-oriented paradigm is inconsistent with the objectives of sustainable water resource management. In view of the critical linkages that water sector has with the rest of the economy, it is no longer appropriate to view water problems as an issue only within the strict confines of water sector. Similarly, when the scarcity value of water is increasing, it is inappropriate to insulate the water economy from the influence of market forces through the politically rooted system of public provision and subsidized water charges. While the water sector is gradually, but steadily, emerging out of the grip of political and other myopic considerations, it has not yet reached the stage where economic and sustainability considerations can alone guide water sector decisions. Thus, the ability of most countries to face the twin-challenge of supply augmentation with the least ecological and social costs, and the development of institutional frameworks for an efficient and equitable use of both existing and future supplies is critically predicated on the speed with which policy reforms are undertaken to create a new governance structure needed for water allocation and management.

The situation surrounding current water crisis is not all that bleak in view of a few positive trends on the policy dimension. Since there is a growing recognition that water crisis is mainly an outcome of inappropriate policies and mismanagement, there is now hope that the water problems can be addressed with appropriate national and international policies. There is also a remarkable degree of consensus as to the general approach towards and the key components of water sector reforms. While the approach has its roots in an allocation paradigm that can both ensure efficient management of existing resources and justify future addition through water development, the reform agenda includes the key institutional issues related to the legal, policy, and administrative aspects of water resources development and management. Many countries have already undertaken significant reforms in their water sector and many more are going to undertake such reforms soon (Saleth and Dinar, 2000).

1.4. INSTITUTIONAL DIMENSION

The crisis in the water sector has also made apparent the inherent limitations of existing institutions in dealing effectively with the new set of problems that are related more to resource allocation and management than to resource development. The multifarious economic and political consequences of water scarcity including the widespread occurrence of inter-regional and inter-sectoral water conflicts have heightened the need for creating flexible but effective water allocation and management mechanisms. The traditional perspective of water as a free good has to be replaced with a perspective of water as an economic and social good. This means that water pricing, project selection, and other related policies have to be changed to reflect such a new perspective. Allocation and conflict resolution mechanisms have to be created, strengthened, or updated both in the legal and policy spheres. Water users, who were customers or clients in the surplus era of water development, have now become important players in the scarcity era of water sector. The water administration and water sector decision process have to accommodate now an increasing role of user organizations, non-governmental agencies, and women, environmental, and other self-help groups as well as to explore the ways in which emerging water and information technologies can be gainfully utilized. Thus, as countries move from a state of plenty to a state of scarcity, water institutions that define the rules of water development, allocation, and utilization, have to be concurrently reoriented to reflect the changing supply-demand and quantity-quality realities.

The public goods character of water and the scale issues in its exploitation necessitated and justified its public ownership and state involvement in its development and distribution. This arrangement did work well in the surplus era. But, as water scarcity becomes economically binding and the magnitude of water-related subsidies including the administrative overhead costs becomes fiscally constraining, the social costs of such a state-dominated institutional arrangement are now beginning to surpass the corresponding social benefits. As a result, the current trend is towards an alternative system that can allow private decision-making in water resources development, allocation, and management. For the alternative system to function in an effective way, legal changes are needed to facilitate a private and transferable water rights system capable of assuring full legal, physical, and tenure certainty of water rights (Ciriacy-Wantrup, 1956; Milliman, 1959; Dales, 1968). With such a water rights system, economic conditions could create the necessary incentives for water exchanges both within and across sectors and such exchanges will enhance efficient water use.[11]

While private water rights system is crucial for individual incentive for efficient water use, some of the physical features of water also create interdependence and conflicts among water rights holders. Although such conflicts can be resolved through courts, there are also considerable incentive for collective action among users both to

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[11] In many cases, in addition to the quantity specification, water quality needs also to be specified as part of the water rights so as to avoid quality-related externalities (Howe, Schurmeier, and Shaw, 1986).

minimize and resolve conflicts at lower costs as well as to internalize the long-term effects of their short-term actions (Ostrom and Ostrom, 1972). This means that the private water rights system has to be accompanied not only by complementary organizations for collective action but also by mechanisms to coordinate private institutional arrangements with public or government management institutions. Thus, contrary to the general perception, the private water rights systems, collective action institutions, and state management organizations are not alternative institutional options but complementary institutional components of a new governance structure for water sector. The creation of the kind of allocation-centered institutional mechanisms and governance structures needed to deal with water scarcity on a continuing basis is not an isolated task. It warrants a rather radical change in the whole gamut of institutional arrangements that govern various facets of water sector like water resource development, allocation, utilization, and management. As will be shown below, the change entails concurrent reforms in the legal, policy, and administrative spheres of the water sector.

While water pricing policies and market mechanisms are the key components of the framework needed for operationalizing the allocation-oriented approach to water scarcity problems, they themselves require a set of other supportive arrangements. For instance, the allocative role of water prices requires them to be based on the scarcity value or the opportunity cost of water. Since, the administratively determined water prices for various uses observed in most countries are based on average rather than the marginal cost of supply, they reflect neither the supply cost nor the scarcity value (Dinar and Subramanian, 1997). To be realistic, the introduction of marginal cost pricing in irrigated agriculture requires volumetric water pricing. But, volumetric water policy, in turn requires prior institutional and technical changes to support volumetric water allocation. These changes include the introduction of water rights system, the development of water user associations, and the modification of project design and distribution networks.[12] These institutional and technical changes can influence water prices both by providing an implementation framework as well as by encouraging the emergence of direct allocation mechanisms such as water markets. Besides the legal system of water rights and the physical structure for water measuring and conveyance, the efficient operation of water markets depends also on the organizational mechanisms for enforcement and conflict resolution (Easter, Rosegrant, and Dinar, 1999).

Institutional reform of the magnitude required at present is obviously a daunting challenge in most countries with outdated and poorly functioning water institutions. The main issue is whether there are incentives and compulsions powerful enough to induce countries to undertake the reform task of such a proportion, especially given the political risk and investment needs. One of the key premises in institutional economics literature is that institutional change occurs only when its transaction costs are less than the

[12] Although the introduction of volumetric water supply does not require the water rights system, the volumetric water distribution policy will be more effective in achieving its efficiency and equity objectives with the water rights system than otherwise.

corresponding opportunity costs.[13] With an increasing water scarcity and its economic, ecological, and political costs, the opportunity costs of the prevailing institutional inadequacy within the water sector are indeed tremendous and increasing fast to exceed the corresponding transaction costs. While this is a necessary condition for water sector reform, it is not sufficient so long as the political economy constraints remain a powerful obstacle for initiating any substantive institutional reform. Fortunately, in addition to the positive influence of the progress in water and information technologies as well as the pressures from donor agencies and international commitments of countries, there are a few powerful factors that enhance the prospects for water sector reforms in most countries.

Although institutions evolve with the changing conditions and social needs, often, this natural process of institutional evolution is obstructed by the rent-seeking behavior of the politically powerful groups (North, 1990:7-8). As a result, sub-optimal institutions persist by resisting changes. But, with an increasing water scarcity and growing macro economic problems, these rents are now declining to create conditions where these groups themselves are now open to change.[14] Moreover, the emergence of middle class—a product of economic development and education—has also reduced the political dominance of few groups and improved the political balance necessary for group-neutral reforms. It is this changed political milieu that explains the declining domination of engineering approach and irrigation sector, and the increasing importance of economic and environmental concerns and non-irrigation sectors. With the emergence and political influence of pro-reform constituencies, there is now a political urge for institutional reform.

The economic gains likely to be realized from allocation-oriented institutional change are not only substantial but also increasing with every increase in water scarcity. Since the magnitude of net benefits from institutional changes in water sector is a direct function of the degree of water scarcity, the economic incentives for institutional change increases with every increase in the level of water scarcity as induced by factors like population growth, economic development, and climate change. The increasing water scarcity also magnifies both the real and economic costs of inappropriate water sector policies (e.g., treating water as an 'open access' resource and subsidized water provision) which can be approximated by the gap between the scarcity value of water and the prevailing water charges.

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[13] In the particular context of water institutions, transaction costs cover both the real and monetary costs of instituting the regulatory, monitoring, and enforcement mechanisms needed for water resource development, allocation, and management. Similarly, the opportunity costs cover both the real and economic value of opportunities foregone or the net social loss in preserving the 'status quo'.

[14] For instance, the institution of subsidized and bureaucratic provision of water that is held for long in view of its benefits to the politically powerful farm groups is now facing a tremendous pressure for change. This is because the financial and performance crisis engendered by this arrangement now threatens the very benefits that these groups used to receive from the public water systems.

Apart from water scarcity that creates an endogenous pressure for change, the opportunity cost of institutional change within the water sector is also strongly influenced by some factors that originate outside the strict confines of the water sector. These factors, which are often underestimated, include the macro economic adjustment policies as well as the socio-political liberalization and reconstruction programs (Dinar 2000:6-10). Macro economic reform magnifies the fiscal implications of the opportunity costs of institutional change. In contrast, the socio-political reform attempts (e.g., in Chile during the 1970s, Spain during the 1980s, China since the 1980s, and South Africa since the 1990s) reduces the transaction costs directly because the institutional changes in water sector form part of a system-wide reform.[15] The opportunity cost of institutional change is also being magnified further by water-related natural disasters such as droughts (e.g., California), floods (e.g., China), and soil salinity (e.g., Australia). This means that the original opportunity costs of a crisis-ridden water sector, though remain a potent force for change, also get an additional support as well as context to gain the much needed political economy thrust both to prompt and to sustain the process of institutional change.

1.5. Why this Study?

Although institutional reforms within water sector are urgent, they need not be undertaken at one go. They can be spaced within a well-planned time frame. For instance, the cost of transacting institutional reform in a given political economy context can be minimized and the usual inertia associated with the stupendous nature of the reform task can be overcome through a gradual but sequential reform strategy. Since such a strategy continuously builds on the synergy generated by undertaking selected reforms in key institutional components, subsequent reforms become easier to transact both politically and institutionally. Similarly, with an increasing integration of world economic system under the ongoing process of globalization, countries have begun to realize that learning from each other's experience is an important means for improving their mutual performance in various spheres including water management. In this context, cross-country flow of knowledge and experience in the realm of water sector reforms are very valuable both for creating the demonstration effect as well as for providing key inputs for institutional design and implementation strategies.

While cross-country experience can minimize the costs and risks involved in experimenting with institutions, insights into the components, prioritization, and sequencing of institutional reforms can be useful for identifying the technically feasible and politically acceptable format and design of reform strategies. Thus, well-conceived policy research could itself be a powerful instrument in promoting institutional changes within the water sector. Unfortunately, the extant literature has a major gap on this important area of institutional research. It is this fact that provides both the motivation

[15] This means that there are significant scale economies in institutional change. Such scale economies can be exploited to minimize the overall transaction costs with a proper design and timing of institutional initiatives within water sector.

and justification for the present study that aims to review and document the recent institutional changes in global water sector as well as to quantitatively evaluate the process of institution-performance interaction within water sector from a cross-country perspective.

Country-specific studies dealing with either water institutions or water sector performance in isolation are common whereas studies evaluating them with a cross-country perspective are rather rare or dated. Although country-specific approaches are useful, the "best practice" cases identified through a cross-country exercise is particularly relevant for providing motivation for institutional changes. Documentation and analytical evaluation of cross-country experience in the context of water sector and its institutional arrangements are valuable, at least, on two counts. The knowledge base created from cross-country experience allows countries to learn and adapt from mutual experience with minimal transaction cost and uncertainty as well as enables international funding agencies to develop and perfect both their national and global level institutional initiatives for improving water sector performance.

The identification of a strategy for water institutional reform with minimum transaction cost and maximum political acceptability requires much sharper understanding of both the analytical and operational linkages among various components of water institutions as well as the ultimate impact of such institutional inter-linkages on the overall water sector performance. Current knowledge does enable one to trace this causative chain of change including its nature and direction. But, current information can allow neither a precise quantification of the true transaction and opportunity costs of institutional change nor a rigorous evaluation of the two components of institution-performance interaction, i.e., institutional inter-linkages and institution-performance linkages. From the viewpoint of both institutional theory and water sector policy, it is important to evaluate the nature and strength of both the institutional inter-linkages as well as the institution-performance linkages within the water sector. Such an evaluation, if performed especially within an analytical framework amenable for both qualitative and quantitative considerations, can provide immense policy insights into the relative significance of various institutional components in terms of the nature and magnitude of their institutional inter-linkages and performance effects. This sort of functional analysis of institutional components evaluated within a quantitative framework and carried out within an appropriate empirical context can provide critical inputs for the policy task of designing effective water institutions as well as identifying politically the most acceptable sequence of institutional change relevant for different contexts.

The literature also presents a similar gap both on the nature and mechanics of institution-performance interaction especially in the water sector context. The theoretical literature elaborating the additional gains possible from institutional changes—both in the general and in the water sector contexts—are vast and growing. The literature in a general institutional context covers the seminal works of Olson (1971), Bromley (1989), Ostrom (1990), and North (1990). The same in the water institution context include the important works of Fox (1976), Frederikson (1992), Le Moigne, et al., (1994), and

Picciotto (1995), Saleth (1996), Hearne and Easter (1997), Saleth and Dinar (1999a, 1999b, and 2000), and Challen (2000). Unfortunately, with the notable exception of Saleth and Dinar (1999b), the existing literature on the subject—both theoretical and empirical—provides little guidance as their focus is either too narrow to consider water institutions as a whole or too descriptive and anecdotal to provide any quantitative evaluation.[16]

The limitation of the existing literature is understandable for two reasons. First, most studies have either ignored or underestimated the strategic roles of the critical linkages evident among institutional components (e.g., the linkages between property rights system and conflict resolution capabilities or the extent of water technology and information application and enforcement/monitoring capabilities of water administration). And, secondly, the inherent difficulties in quantifying institutional issues have discouraged the attempt for a quantitative evaluation of water institution of their performance impacts. Besides, quantitative evaluation of institutional issues present immense empirical difficulties not only because of their non-quantitative nature but also because of the non-availability of the right kind of data. While the analytical challenges and empirical difficulties are too real to discount, the strategic value of a quantitative institutional inquiry within the water sector provides the urge to venture into this uncharted course of policy research. The present study aims to make a modest beginning in this critical but least explored area of institutional research in the water sector.

1.6. Approach, Scope, and Objectives

As it is clear from the rationale and context of our study outlined above, the objectives of this enquiry are twofold. The first is to document and evaluate the very features of the water sector, existing institutional arrangements, and recent institutional initiatives in various countries within a comparative context. And second is to analytically demonstrate and empirically evaluate the process of institution-performance interaction using both observed, anecdotal, and perception-based information from an international survey of water experts designed and conducted specifically for this study.

Before specifying the objectives and approach, it is instructive to specify the scope and focus. Since water institution falls in a domain intersected by economics, law, and public policy and is also strongly influenced by factors like resource endowment, demography, and science and technology, the basic approach here is inherently inter-disciplinary in orientation and analytical in character. While water sector covers all its sub-sectors, the institutional change covers changes in water law, water policy, and water administration. Water sector and water institution are approached from a national level perspective with a view to capture their essential and policy-wise relevant characteristics

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[16] While Saleth and Dinar (1999b) is the only study that attempts a quantitative evaluation of the institution-performance interaction in the context of water sector, there are a number of studies that evaluate the interaction in various other contexts. They are reviewed as well as contrasted with the present approach in chapter 2.

and features. While such a macro perspective involves an obvious sacrifice of micro details, such an approach is taken deliberately to sharpen the focus on the main thrust of this study, i.e., institutional inter-linkages and institution-performance linkages.

Since the process of institution-performance interaction within water sector is influenced by a variety of factors like historical forces, political arrangements, demographic condition, resource endowment, and economic development, the critical roles of these exogenous factors are also to be included within our evaluation framework. The role of these factors will be evaluated based on a cross–country comparative review of major water sector challenges and recent institutional responses. The cross-country review of water sector and water institution goes far beyond simple documentation and comparative analysis in the sample countries as it organized within a stage-based perception of institutional change and performed within an institutional transaction cost framework. Although both the nature and direction of the institutional changes observed among countries vary by country-specific economic, political, and resource realities, there are clearly identifiable trends and patterns. To unravel these trends and patterns of change at the international level, this study aims to address the following questions: What are the nature and direction of these changes? Which are the key factors that motivate these institutional changes? How adequate are these changes for addressing both the existing and emerging water sector challenges? Is it possible to use cross-country experience for deriving a workable agenda for institutional changes especially among countries that are at the threshold of water sector reform? The answers to these and related questions can help in understanding the water sector challenges and in delineating the contours of ongoing institutional responses at the global level.

In the context of the quantitative evaluation of the institutional inter-linkages and institution-performance linkages within the water sector, the approach underlying the analytical framework and evaluation methodology can be briefly explained in terms of the following four inter-related steps. First, the concepts of water sector, water institution, and water sector performance are defined to set the broad contour of analysis. Second, both the major components of water institution and water sector performance are conceptually decomposed to define the analytical framework that highlights the institutional inter-linkages and institution-performance linkages. Third, given the non-quantitative character of most institutional components, a set of variables amenable for either objective observation or judgmental evaluation are identified for characterizing the functional linkages among institutional components and between institutional components and water sector performance. And, finally, the characterized functional relationships are empirically evaluated using data collected through a cross-country survey of water sector experts to quantitatively appraise the nature and strength of the institutional inter-linkages and institution-performance linkages.

The value and credibility of cross-country approach as a tool of analysis is critically predicated on the choice of sample countries selected for field-based first-hand evaluation. The sample needs to be large enough to capture variations in socio-economic conditions, political settings, and water sector realities but small enough to permit a rapid field-based appraisal of major water sector challenges and key institutional responses observed at the international level. After a process of careful screening, a sample of 43 regions—39 countries and four states in the US—is selected for the cross-country comparison. Since the sample covers different continents, historical backgrounds, political systems, development stages, demographic trends, water law traditions, and, more importantly, levels of water scarcity, it can represent well the reality of global water sector in all its relevant dimensions. The representative character of the sample is enhanced further by the fact that it also covers the full spectrum of recently observed institutional changes and water sector reforms in terms of their coverage and effectiveness. Although the comparison confines almost exclusively to the 34 sample countries/regions, the experience from other countries and regions will be brought to reinforce some points in few relevant contexts.

The data base for the quantitative evaluation of the linkages between water institutions and water sector performance has been developed from both the factual and perceptional information obtained by administering a pre-designed questionnaire (see Appendix-A) to 127 water experts from the sample countries. These experts with considerable international experience have different disciplinary background and represent both governmental and non-governmental perspectives. As such the sample can be expected to represent well various viewpoints on the nature and strength of the linkages between water institutions and water sector prevalent at the global level. Apart from the perception-based survey information, anecdotal evidences as well as available secondary data are also used to evaluate some of the aspects of the institution performance linkages within water sector.

Having delineated the scope as well as described the approach and empirical context of our study, let us now state its objectives. The specific objectives are to:

(a) attempt a detailed and critical review of the theoretical and empirical literature dealing with institution-performance interface both in general and in water sector contexts so as to provide background, context, and methodological foundation;

(b) delineate an analytical framework capable of capturing the operational linkages both within and among different water institutional components as well as between water institutions and water sector performance;

(c) develop an evaluation methodology to translate various layers of institutional inter-linkages and institution-performance linkages into a set of models with inter-related equations;

(d) describe and justify the empirical context used for the evaluation of the models of institution-performance interaction within water sector;

(e) undertake a cross-country review of water sector reforms within a stage-based conception of institutional change and institutional transaction cost framework in a bid to provide anecdotal evidences for institutional and performance linkages and context for their quantitative evaluation;

(f) attempt a quantitative evaluation of the models of institution-performance interaction to identify the relative role, significance, and robustness of institutional aspects in terms of their institutional and performance linkages as well as to derive empirical insights on reform design covering institutional prioritization, sequencing, and packaging as well as on timing, scale, and dose of reform; and

(g) conclude by identifying key implications for both institution theory and water sector policy.

While the chapter scheme of this study is, more or less, in terms of the above stated objectives, the next section provides more details on its outline and structure.

1.7. Structure of the Study

From here on, the study is organized into nine chapters. Chapter 2 deals with the linkages between institutions and performance both in general and in water sector contexts based on a critical review of existing literature—both theoretical and empirical—on the subject. The review is intended both to justify our study in terms of few serious gaps in existing literature as well as to provide the context and background for subsequent chapters. Against an extensive review of existing approaches and methodologies used for evaluating the process of institutional-performance interaction, Chapter 3 develops a stage-based conception of institutional change that explicitly incorporates the key roles of the subjective perception of major players within the process of institution-performance interaction. Decomposing water institution and water sector performance into their constituent components and defining variables to capture the status of these components, Chapter 4 both analytically depicts and mathematically models some of the main layers of institutional and performance linkages evident in the process of institution-performance interaction under alternative assumptions. Since the process of institution-performance interaction within water sector evolves within the general institutional environment as defined broadly by the socio-economic, political, legal, and resource-related factors, a separate model is developed in Chapter 4 to empirically evaluate the relative effects of some of these exogenous factors.

Chapter 5 describes and justifies the empirical context based on the perceptional data on all institutional and performance variables collected from an international panel of 127 water experts from 43 countries/regions. Besides providing key water sector features and socio-politico-economic profile of sample countries, it also gives the descriptive statistics for both perceptional data from expert survey and observed data from secondary sources. Chapter 6 attempts a cross-country review of water sector reforms within the stage-based conception of institutional change and explains institutional change in terms of institutional transaction cost approach. It also provides some anecdotal evidences and practical instances for few of the layers of institutional and performance linkages. Based on this review, policy relevant best practices observed in the sample countries are identified as well as certain common trends and patterns evident both in water problems and institutional arrangements are delineated.

Chapters 7, 8, and 9 present and evaluate the empirical results derived from the regression-based estimation of the models of institution-performance interaction in different estimation contexts. Comparing the single equation model representing conventional conception and a system model representing a realistic conception of the process of interaction, Chapter 7 provides econometric evidences both for the existence and performance implications of institutional linkages as well as for the relative role and significance of institutional aspects. Chapter 8 evaluates the robustness and sensitivity of results by estimating the model in various contexts defined by three sample sizes, two expert groups (engineers and social scientists), and two country groups (reform countries and others). Empirically evaluating the relation between performance variables and exogenous variables representing socio-economic, political, and demographic factors, it also provides insights both on the relative role of exogenous factors as well as on the interface between subjective perception and objective reality.

Chapter 9 takes the analysis to its next logical and policy-wise more insightful stage. Considering the coefficient of various equations in the system model as a quantitative representation of international consensus, this chapter traces the multifarious routes through which the effects of a marginal change in an institutional variable being transmitted to reflect ultimately on sectoral performance. Based on the relative size and significance of the impact of and the institutional variables involved in various impact transmission channels, this chapter sheds lights on institutional design issues. Finally, Chapter 10 concludes by identifying the major implications that this study has for institution theory and water sector policy.

Chapter 2

INSTITUTIONS AND PERFORMANCE: A REVIEW OF ISSUES

Institutional underpinnings of development both in general and in water sector contexts are now increasingly recognized because the policy prescriptions based either on the neo-classical approach or on the public choice theory proved ineffective. As a result, the policy prescriptions that moved from 'getting the prices right' to 'getting the property rights right' are now centered around 'getting institutions right' (Williamson, 1994: 3). While our main concern here is on how water sector problems can be mitigated through institutional means, as a way of providing a strong background for subsequent analysis, it is very instructive to start with a basic understanding of institutions, their features, forces inducing institutional change, and the institution-performance linkages. Of particular value for understanding the methodology and providing a rationale for its underlying theoretical and empirical approach is a working knowledge of various theoretical strands and their implications for the institutional analysis. It is towards this end that our attention is directed in this chapter.

INSTITUTIONS: NATURE AND DEFINITION

Simon observes that "it is because individual human beings are limited in knowledge, foresight, skill, and time that organizations are useful instruments for the achievement of human purposes" (1957: 199). In other words, human beings substitute institutions for knowledge and skill or institutions are evolved to complement their limitations. In a world of perfect knowledge, there will be no need for institutions (Coase, 1960). But, as economies develop and become more complex, uncertainty is also increasing, requiring institutions and their constant adaptations. Institutions are, therefore, a substitute for accurate information because they provide a basis for making decisions with reasonable assurances by ensuring the behavior of others (North, 1990a: 6&27). Institutions not only constrain choices but also open up opportunities (Achesen, 1994b: 9). Institutions are essential for providing a cognitive framework to interpret sense data as well as habits and routines for transforming the information or signal into economically and socially useful knowledge (Hodgson, 1999: 171).

According to North (1990a: 3), institutions are the rules of the game in a society as they are the humanly devised constraints for coordinating human interaction. Since institutions define what individuals can and cannot do in a given context, they, in effect, delineate the action sets for both the individual and collective decision-making (Commons, 1968; Bromley, 1989a and 1989b). Since they define and delimit the set of choices, institutions determine the incentive structure for human exchange and reduce uncertainty by providing structure to everyday life (North, 1990a: 3-4).

Our understanding of institutions can be enhanced by the distinction between institutions and organizations (North, 1990a: 4-5) or between the institutional environment and the institutional arrangements, i.e., the institutions of governance or the economic and political organizations (Davis and North, 1970: 131; Thomas and North, 1971: 5-6; Williamson, 1994: 2). Institutional environment is defined by a set of fundamental political, social, and legal rules that establish the basis for production, exchange, and distribution whereas institutional arrangements provide a structure within which the members of the society—either as individuals or as collectives—cooperate or compete.

The institutional environment captures what Commons (1968) calls as the 'working rules of going concerns'. These rules, taken together, indicate what "individuals *must* or *must not* do (compulsion or duty), what they *may* do without interference from other individuals (permission or liberty), what they can do with the aid of collective power (capacity or right), and what they *cannot* expect the collective power to do on their behalf (incapacity or exposure)" (Commons, 1968: 6). From another perspective, Schmid (1972: 893) considers institutions as "sets of ordered relationships among people, which define their rights, exposure to the rights of others, privileges, and responsibilities". Since institutions define the choice sets of individuals and groups and define relationship among individuals and groups, they are at the core of choice and behavior (Bromley, 1989b: 740). It is the aggregate of institutional arrangements that determine the economic conditions or the action situations (Bromley, 1989b: 740; E. Ostrom, 1990: 52-53).

The institutional environment covers the 'rules of the game' whereas institutional arrangement covers the governance structures and its evolution within and interaction with the institutional environment. The emphasis on organizations or institutional arrangements is to focus on the role as the 'agents of institutional change' (North, 1990a: 5). While the rules determine the outcome, the players or actors—both as individuals and as organizations—can also change the rules depending on their relative share of the outcome or their political bargaining power. As such, institutional arrangement function as a mechanism to effect changes in the institutional environment.

FEATURES OF INSTITUTIONS

In order to understand the linkages between institutions and economic performance, it is important to understand some key features of institutions. Institutions operate at different levels and contexts. There are formal institutions as there are informal institutions. There are macro level institutions and micro level institutions. There are procedural institutions as there are behavioral institutions. Schotter (1981: 3-4) identifies two distinctive interpretation of institutions, i.e., collectivist and organic. Collectivist interpretation corresponds to what Hurwicz (1972 and 1998) calls as 'designer' perspective and the organic perspective is similar to the 'endogenous or induced' institutional innovation perspective (Ruttan, 1999: 1). Institutions are also classified as ceremonial and instrumental institutions (Bush, 1987). Although the immediate purposes and the spheres of influence of these institutions vary, they are interrelated and tend to have the common objective of providing more information and reducing uncertainty in man-man and man-resource relationships.

Institutions as Subjective Construct

A major challenge for the evaluation of institutions is that they are not objective phenomenon but a subjective human mental construct or 'artifacts' that think and act through the medium of individuals (V. Ostrom, 1980; Douglas, 1987; North, 1990a; Stein, 1997; E. Ostrom, 1999). Institutions are the mental construct of the human beings and hence, "we cannot feel, touch, or even measure institutions" (North, 1990a: 107). Although institutions are formalized in tangible formats as constitution, laws, or code of conducts, their ultimate impact depends on the extent they permeate the thinking and actions of individuals. In many cases, the effectiveness of institutions depends as much on their nature as on the role of other factors extraneous to institutions themselves. In these circumstances, the nature and types of institutions themselves depend on extraneous or exogenous factors such as physical environment, natural calamities, and political factors including conquest and revolution.

Path Dependence

Institutional evolution and their performance implications are affected strongly by their path-dependent nature. Path-dependency means that history matters. Because of their path-dependent characteristics, institutions are the 'carriers of history' reproducing themselves well beyond the time of their usefulness (David, 1994; Coriat and Dosi, 1998: 7). Informal institutions play an important role in the incremental way by which institutions evolve and hence, is a source of path dependence (North 1990a: 44). An informal institutions change rather slowly as compared to formal institutions, as a result there is always a tension between altered formal rules and persisting informal rules (North, 1990a: 45). According to North (1990a: 99), since self-reinforcing mechanisms such as network externalities, learning effects, and the historically derived subjective modeling of the issues will all tend to reinforce the course of the development path, it is difficult or costly to reverse the course of the path. This means that the direction and scope of institutional change cannot be divorced from its earlier course or past history.[1] The increasing return and path-dependent characteristics of institutional change suggest that although the short-run path is difficult to predict, the long-run path and the overall direction of institutional change are more predictable and also far difficult to reverse (North, 1990a: 104).

Stability and Durability

One feature of institution that is important from the viewpoint of institutional change is its relative durability (Keohane, 1988). As we consider institutional change, it is useful

[1] Path dependence implies, in fact, the limited scope for radical changes in institutions. Although institutional change is mostly to be gradual and continuous, discontinuous institutional changes through conquest or revolution are also possible. However, the institutional change through conquest and revolution affect only the formal rules whereas the informal rules that are derived from the previous formal rules and change far slowly than their formal counterparts linker on with little change (North, 1990a:6).

to recognize that institutions are relatively more durable and self-reinforcing, and have persistence qualities (Hodgson, 1998: 179). Although the notion of structure-induced equilibrium tries to capture this feature of durability (Shepsle and Weingast, 1987; Levi, 1990a: 404), North (1990a: 94-100) explains this durability in terms of self-reinforcing mechanisms (network externalities and learning) and path-dependence. It is in view of the relative durability aspects of institutions that institutional change remains essentially gradual and incremental in nature (North, 1990a: 89). Even when formal institutions change suddenly due to conquest or revolution, the informal rules that are derived from the formal rules linker on providing institutional continuity and stability (North, 1990a: 83-91).

Institutional malleability or adaptive flexibility is the key for the initiation and sustenance of economic growth (Adelman, et al., 1992: 106). Although it is possible to find substitutes for missing institutions (e.g., government institutions as substitutes for private institutions or state for missing markets in communist states) as well as capital and skills, they cannot offer a permanent solution (Adelman, et al., 1992: 107). Institutional stability is a necessary condition for enabling complex transactions over time and space. This is accomplished partly by the anchoring role of the slowly changing informal rules and partly by the complexity of formal rules wherein rules are nested in a hierarchy with each level more costly to change than the previous one (North, 1997: 6). The institutionalizing function of institutions means that their stability at the macro level coexist with their variety and diversity at the micro level (Hodgson, 1998: 171). As a result, it is relatively easier to identify distinct forms of institutional structures along with their key components, especially in the case of formal institutions at the macro level.

Hierarchical and Nestedness of Institutions

Institutions are not a single entity but comprise of a number of fundamentally linked and carefully structured components. The major features of institutions are their structural linkages both with themselves as well as with the physical and cultural environment within which they emerge, evolve, and operate. Institutions, whether they are the parts of institutional environment or of institutional arrangements, are nested or structurally embedded within themselves (see North, 1990a: 83; E. Ostrom, 1999: 38). Similarly, there are also critical linkages between the institutional environment and institutional arrangements. Obviously, the performance impact or effectiveness of one or a set of institutions are linked with that of others.[2] For instance, Kiser and E. Ostrom (1982) distinguish three levels of rules that cumulatively affect the actions and outcomes, i.e.,

[2] There are many historical instances for these institutional inter-linkages (North, 1990:95-100). Unfortunately, this important issue has received no attention either in the analytical or in the empirical works in institutional economics with a rather few exceptions. For instance, E. Ostrom and her co-workers tackle this in terms of showing the nested structure or configural relationship within a rule-based decomposition of institutions (E. Ostrom, Gardner, and Walker, 1994; E. Ostrom, 1999). Saleth and Dinar (1999b), on the other hand, demonstrates this in terms of an analytical and quantitative evaluation of the institutional inter-linkages using a component-based decomposition of water institution.

constitutional-choice rules, collective-choice rules, and operational choice rules. These rules are nested and sequentially linked such that the collective-choice rules are derived from constitutional-choice rules and the operational-choice rules are, in turn, derived from the collective-choice rules (E. Ostrom, 1990: 52-53).

Besides, the constitutional-choice rules for a micro setting becomes also nested and linked with the constitutional and collective-choice rules of large jurisdictions (E. Ostrom, 1990: 50). While the constitutional rules cover aspects such as formulation, governance, adjudication, and modification, the collective choice rules cover policy-making, management, and adjudication. The operational rules relate to appropriation, provision, monitoring, and enforcement. These rules can be reclassified, without being inconsistent with the rule-based classification, as legal rules, policy rules, and administrative rules and such a reclassification is more instructive for the analysis of macro water institutions in terms of legal, policy, and administrative specifics of institutions.[3] There are also linkages among the rules within each set of these rules as, for instance, "[a]ppropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises" (E. Ostrom, 1990: 101).

All institutional forms and coordination mechanisms exhibit a hierarchy involving a constitutional order and the way the constituent members play the game (Boyer and Hollingsworth, 1997b: 453). The hierarchy implied here, though appears to be simple, has a greater ramifications. As we decompose the major components of the constitutional order or the institutional environment, we can find that they are hierarchically linked with a logical sequence. For a small but very general instance, since property rights system is a prerequisite for conflict resolution, it has to be created in the first place so as to develop the rules and mechanisms for resolving conflicts. Instances with still deeper hierarchical and sequential linkages among the components of institutional environment can also be found. In addition to hierarchical linkages within embedded institutions, there is also spatial nestedness in institutional arrangements from regional to global levels. Boyer and Hollingsworth (1997b: 469-477) illustrate such features very clearly in their analysis of modern capitalist institutions such as markets, hierarchies, and alliances.

The linked and nested nature of institutions has strategic role to play in cost and effectiveness of institutional change. As we know, institutional change is not a one-step change but involve gradual, sequential, and incremental transformation. The cost of

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[3] Although E. Ostrom allows the conception of the collective-choice process as a 'policy space', to her, the policy space covers the decisions concerning aspects ranging from the budget and regulative mechanisms to the creation of legislative and judicial bodies and the protection of property rights (E. Ostrom, 1990:142&192). For a better analytical clarity, however, it is useful to distinguish clearly the legal issues, policy issues, and operational (administrative) issues involved in these three set of rules and classify them accordingly. This has the benefit of not only distinguishing the legal provisions from their policy and administrative implications but also allowing the collectively agreed policy provision to eventually become formal legal provisions. In this sense, there can be two-way linkages between the constitutional and collective choice process with the corresponding implications for the operational choice rules.

changing the rules varies across rules, level of analysis, political regimes, and time periods (E. Ostrom, 1990: 140-141). Since each institutional change became the foundation for subsequent and higher level institutional changes, the cost of each subsequent institutional change declines suggesting some scale economies in institutional change. The knowledge on the cost implications and practical advantages of institutional sequencing and prioritization is indispensable for specifically planned institutional reform programs. We share with the main message of a careful study of the reform process and policy implementation (White, 1990) that the way the reform program is structured and packaged has much to contribute to the successful implementation. It is also equally valuable even in the case of naturally evolving or self-organizing institutions for creating the second and third-order institutions so as to enable autonomous and voluntary changes in the first-order institutions (E. Ostrom, 1990: 141).

This feature has considerable significance both for institutional change and institutional performance. Not only does the performance of the lower level rule hinges on the performance of higher level rules but also the synergy and scale economy effects ensure that the aggregate performance implications of the a set of hierarchically nested rules are more than the sum of their individual performance.[4] Apart from the scale economy effects on the performance side, the nested nature of institutions and their linkages can also be exploited to minimize the total transaction cost of institutional change through a strategy of institutional sequencing and packaging.

Embeddedness and Complementarity

The sources of institutional changes are many. This is especially so when we consider the structure of institutional arrangement where many institutions are linked with each other and embedded within an environment characterized by the interaction of economic, social, and political factors. The inter-linked nature and the embedded characteristics of institutions are recognized well by North (1990a: 22). Some institutions are governed by market selection or transaction cost criterion whereas others are explained by social and political factors. Formal institutions are embedded within informal institutions. Some of the market and market-substituting institutions such as the hierarchies (firms, networks, joint-ventures, and strategic alliances) are influenced by the ongoing transformation occurring in the social systems of production and the changing status of regions, nation-states, and the world economy (Boyer and Hollingsworth, 1997a: 54).

Since the society needs a variety of inter-linked institutions to govern different spheres of human interaction, markets alone cannot be considered as the ideal and universal institutional arrangement. Neither the markets can perform without them being embedded in a nexus of obligational rules/public interventions nor the state can be effective without the reliance on market and delegation of some of its functions to private

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[4] Although there was a large initial setup cost in creating de novo institutions such as the US Constitution of 1787, the "inter-dependent web of an institutional matrix produces massive increasing returns" and also could minimize the negative performance implications of inefficient individual institutional components (North, 1990a: 95&100).

groups. The pervasive and unrealistic dichotomy between state and market has to be discarded and a broader array of institutional arrangements that mixes them in varying degrees has to be considered (Boyer and Hollingsworth, 1997a: 51-53).

An economy consists of a combination of institutional arrangements and all of which are complementing each other to improve their mutual and collective efficiency (Boyer and Hollingsworth, 1997a: 53). It is the 'institutional thickening' in terms of increasing inter-linkages and complementarity among institutions that determine their ultimate performance efficacy. Therefore, it is important to understand how various institutional arrangements are related to each other and to identify, thereby, their common principles or typologies (Boyer and Hollingsworth, 1997a: 51). Although the approach towards the decomposition of institutions and the identification of their typologies remains the same, the criteria and relevant particulars vary by the kind of institutional arrangements being considered.

Markets are only one among various alternative, and often complementary, coordinating mechanisms. Markets, hierarchies, networks, associations, and the state have frequently been important mechanisms for coordinating human interaction when adequately designed and blended (Boyer and Hollingsworth, 1997b: 433-34). How important the embedded character of market is for its effectiveness can be judged by the fact that markets cannot create the various prerequisites that are necessary for their operation (Boyer and Hollingsworth, 1997b: 434). In the absence of these institutional prerequisites, an excess of markets leads to instability (Polanyi, 1957). Markets become embedded in the social and political institutions at both the national and regional levels (Lazonick, 1991). This feature ascribed to market institution is perfectly generalizable to all kinds of social, economic, and political institutions.

Institutions not only 'parameterize' the system or state variables and 'constrain' the menus of actions actors but also, in a given context, shape the vision of the world and the very identity of the actors (Granovetter, 1985; March and Olson, 1989; Coriat and Dosi, 1998). Such an embedded perspective of institutions implies that to understand the nature and direction of change over time, we need much more details on the multiple institutions of which the agents are a part (Coriat and Dosi, 1998: 7). The analysis of Boyer and Hollingsworth (1997b) develops the ideas of contextually and spatially embedded and nested nature of institutions in the particular context of modern capitalistic institutional arrangements such as networks and alliances. These notions can be applied to institutions in general. Modern capitalistic institutions are embedded and nested within a system of trust, reciprocity, tacit or shared knowledge, and risk sharing arrangements (Boyer and Hollingsworth, 1997b: 445-447).

Although transaction cost analysis tends to minimize the normative-cultural and power-political explanations of institutional arrangements, these explanations are very pertinent. For instance, Schmitter (1997: 312), among others, supports the importance of these explanations as different nations tend to develop culturally distinct 'styles of capitalism'—each with a distinct institutional configurations involving different combinations of market, state, and other institutions.[5] The point of relevance for our purpose here is the embeddedness of institutions, including the market mechanism, within the cultural and political milieu and non-market institutions.

INSTITUTIONS AND PERFORMANCE

The intimate linkages between institutions and economic performance can be demonstrated using the stylized schema of the main theoretical concepts such as institutional environment, institutional framework or governance structure (i.e., the combination of economic and political organizations), and the economic outcomes for individuals. Figure 2.1 that summarizes the main arguments of Williamson (1993: Figure 1) and Eggertsson (1996: Figure 3) can be used to show the dynamics of institutional change, especially the key role of the agents of change. Although the economic and political organizations form part of the notion of institutional arrangements, they have a different role to play in the process of institutional change and its economic consequences. The economic organizations that determine economic outcome can influence institutional environment and framework only through political organizations. Similarly, exogenous changes such as technology or changes in international trade and investment climates influence institutional changes by first affecting economic outcomes that, in turn, prompting economic organizations to induce political organizations to make the necessary changes in the institutional environment or framework. However, institutional changes can also originate from political and economic organizations themselves. North (1981) gives a scholarly attention on the economic impact on political institutions. Factors such as war and other political changes as well as economic and political ideologies provide instances for the latter case.

Institutions influence economic performance in terms of their effects on the cost of exchange (transaction costs) and production (transformation costs) (North, 1990a: 5-6). Since institutions minimize uncertainty, they facilitate exchange both directly by providing information and indirectly by reducing the costs of transactions. Given the benefits of institutional changes, it is normal to expect that the existence of economic benefits will ensure the institutions to evolve into their efficient forms. Alchian (1950) argued that competition would weed out inefficient institutions and reward the survival of efficient institutions. North and Thomas (1973) argued that changes in relative prices provide incentive for the creation of more efficient institutions. However, North (1981) has not only abandoned the view of institutions evolving into efficient form but also refined the explanation for the persistence of inefficient institutions. The explanation starts with the distinction between institutions and organizations and shows how the interaction between them shapes the direction of institutional change. The explanation, though seems to hinge apparently on rent-seeking behavior, it goes much deeper. For, it incorporates the role of the lock-in effects and the attendant network externalities emerging from the symbiotic relationship between institutions and organizations in

[5] Hall (1986) and Wilks and Wright (1987) are some examples of comparative studies that presume nationally distinct capitalist institutions and doctrines.

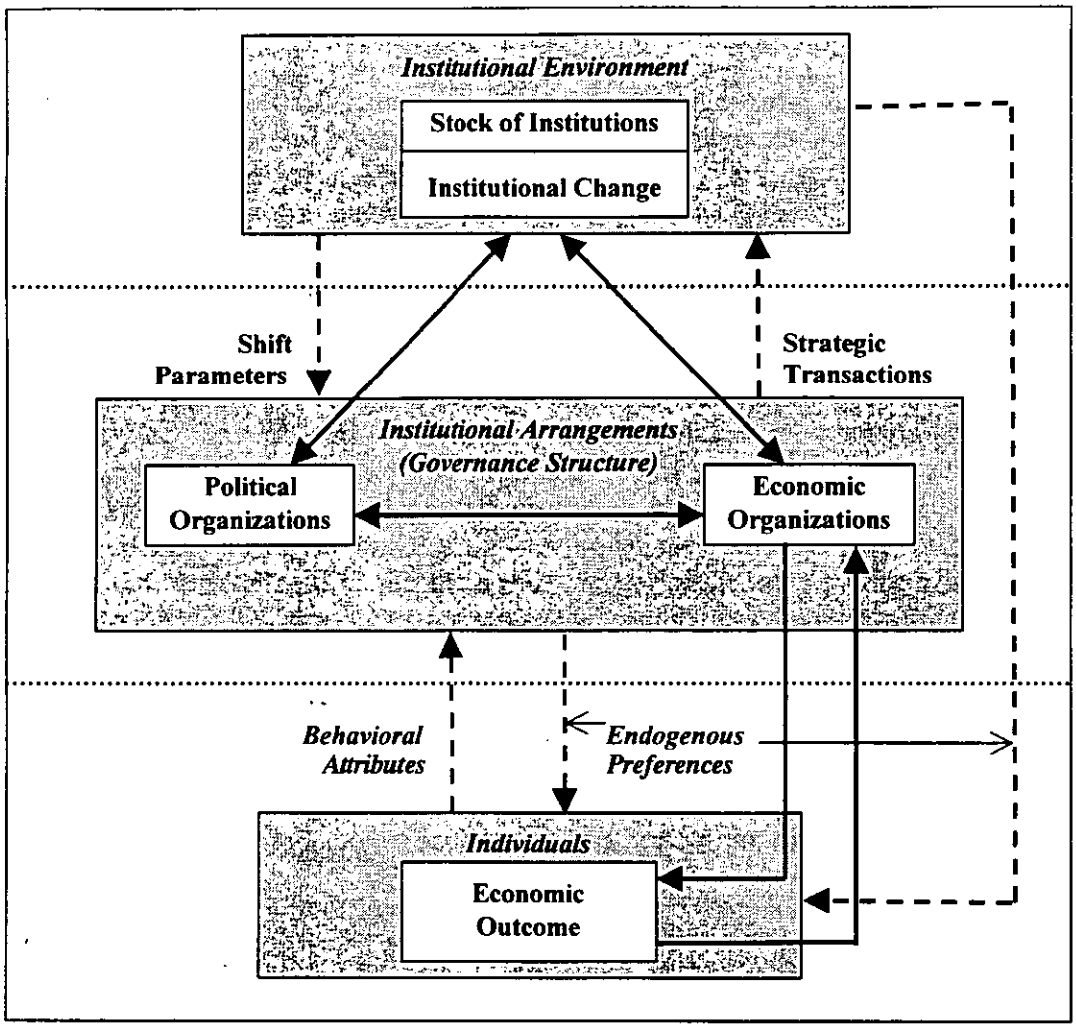

Figure 2.1

Institutional Environment and Governance Structure

reinforcing the ongoing path and resisting any shift to new path of institutional change (North, 1990a: 7-8).

Figure 2.1 illustrates the possible circular process involved in the long-terms changes in formal institutions. Since the changes in formal institutions reflect the power as well as constraints of the rule-makers, the role of changing power relationship in institutional change cannot be ignored (Eggertsson, 1996: 14-17). While the prevailing system of property rights describes the distribution of private power, the power of the state emerges from its capacity to change or alter the distribution of property rights or economic opportunities and advantages. The politically dominant groups can wield these powers to enhance their economic control. But, there are also powerful mechanisms that can moderate and even neutralize the predatory behavior of power groups as well as government by bringing some consistency between the individual rationality of people controlling power and the collective rationality of the society.

While institutional thickening is generally considered to improve the effectiveness of institutions and hence, the overall economic performance, Olson (1982) argues that a proliferation of institutions is a source of economic decline. The reasoning is based on the politically divisive role of the 'distributional coalitions' that dominate the organization 'space' of the society and the attendant slow down in the adoption of new technologies and constraints for resource reallocation. But, North (1983: 163-164) has contested this view. There is an exaggeration of the negative political and economic roles of the interest groups and a corresponding underestimation of the power of the normalizing roles of political and economic institutions such as the constitution and collective efforts to avert the socially harmful economic decline. Apart from factors such as altruism and ideology, there are also mechanisms such as the constitution, congress or parliament, multi-party system, and bureaucracy that broaden the time horizon of policy-makers and reduce the extreme role of power and self-interest in institutional change. This is especially so in a democratic system. For instance, political parties in democracy require the incumbent might be induced to protect the interests of future politicians. Similarly, the factors such as the creation of the rule of law, empowerment of technocrats, and international influence have the effect of neutralizing excessive and exploitative forms of political power (Bates, 1996: 22-23). Since the role of institutional transaction costs that takes into account not only the economic constraints and opportunities but also real constraints and opportunities, institutional changes need not always lead to a reduction in transaction cost or increase in social welfare.

EXISTING LITERATURE: A REVIEW OF ISSUES AND APPROACHES

No single attempt at a comprehensive review of the institutional economics can be adequate given the vast amount of literature on institutional economics with its varying strands of perspectives, levels of analysis, and disciplinary orientations, and methodological basis. Given our present purpose, the focus can be narrowed by limiting the review only to studies dealing with the macro institutional aspects. Even here, the attempt can be unwieldy given the growth of the theoretical and empirical studies on macro institutional aspects since the works of Coase (1937), Williamson (1975 and 1993), and North (1981 and 1990a). A useful strategy for a manageable, yet a comprehensive, review is to group the literature on the analytical level of analysis. In this respect, the approach suggested by Alston (1996: 26) and Eggertsson (1996: 10-11) is of direct value. Eggertsson (1996), in particular, suggests that the research in the economics of institutions can be organized into three analytical levels.[6] The first level deals with the linkages between institutions and economic performance whereas the

[6] As will be obvious from below, as one move down these three levels, the relevance of neo-classical approach declines and the need for new methods and trans-disciplinary approaches increases. Even at the first analytical level, the neo-classical approach needs to be extended to cover transaction costs and property rights approaches. Otherwise, neither the variety of institutional arrangements nor their economic consequences can be understood and evaluate properly (Eggertsson, 1996:10).

second level is concerned with the influence of institutional environment on the structure of economic organizations and contractual arrangements. The analysis at the third analytical level covers a panorama of miscellaneous issues that attempts to explain various elements of the institutional framework and the structure of property rights[7]. As we see, these analytical levels correspond to different segments of Figure 2.1.

Theoretical Literature

Although the analytical levels identified are only a few of many possible constellations, they are extremely useful as a framework for organizing our review of and identifying, *inter alia*, some of the major gaps in the extant literature on institutional economics. Among the studies that fall under these three analytical levels, those that fall in the first level of analysis are of direct relevance to our present purpose. However, as a way of indicating the kind of studies that come under the other two analytical levels, it is useful to touch on some of them before undertaking a review of the studies in the first level. For that purpose, we recognize that at the first level, both the institutional environment and the institutional or governance structures (i.e., organizations and contractual arrangements) are treated as exogenous variables.

The literature falling in the first analytical level inquiring into the interface between institutions and economic performance are also substantial. The most notables among them are the works of North (1981 and 1990a). Also a substantial part of the works in the law and economic literature that explores the economic consequences of legal arrangements (e.g., Posner, 1986 and Cooter and Ullen, 1988) can also be included in this category. But, our attention will be focused more on the empirical work dealing with the performance impact of institutions in various contexts. But, at the second level, the second of the two sets of exogenous variables become endogenous (Eggertsson, 1996: 10). Thus, the studies at second level deal with the way the institutional environment defines and limits the sets of practical economic organizations available to the society. Examples of such studies include the seminal works of Coase (1937) and Cheung (1968) as well as the pioneering works of Williamson (1985 and 1993) and Milgrom and Roberts (1992). Unlike these studies that focus on industrial organizations and rely on transaction cost perspective, North (1981 and 1990a),[8] Douglas (1986), Grief (1989), Ostrom (1990), and Landa (1994) not only generalize the relation between institutions and organizations to non-capitalistic environment but also incorporate non-economic factors like ethnicity, culture, religion, and ideology.

[7] The elements often transcend the boundaries of economics to enter into the domain of politics, sociology, anthropology, law, and history because institutional framework consists of both formal and informal rules and their enforcement. For a survey of these issues see Eggertsson (1990:ch.8-ch.10).

[8] Although North's studies fall properly into the first analytical level dealing with the linkages between institutions and economic performance, they also have implications for the second level analysis.

Empirical Literature: General

Concurrent with the solidification of the main theoretical foundations of institutional economics, there is tremendous growth in the empirical literature dealing with various issues related to institutional structures, institutional change, and economic performance. But, most of the research on institutions is either too descriptive or too abstract to be of use for policy (Alston, 1996: 25), though there are studies with a fair degree of quantitative and analytical reliance. Some of the most important among them are reported and reviewed in edited volumes such as Alston, Eggertsson, and North (1996a) and Clague (1997). The central question addressed by the papers in Cook and Levi (1990) is related to factors behind the secular changes in institutions. The debate centers around biological evolution, social evolution, contracting and recontracting, leadership (or ideas and ideologies), or their combination. The volume by Acheson (1994a) includes a number of case study based analysis of both macro and micro institutions especially from anthropological perspective. The coverage of the study ranges from the institutions generated by military governments to the discrimination of involution in Chinese farm families. The works reported in these volumes as well as others that will be reviewed here are based either on detailed case studies or regression-based cross-country analysis. Since institutional change is a multidimensional and multilevel phenomenon, empirical studies, even those with relatively a sophisticated methodology, cannot be expected to capture the process in all its complexity and detail. Obviously, there is a considerable extent of simplification either by limiting the scope, detail, and context of the analysis (Alston, Eggertsson, and North, 1996b: 3).

To provide background and set contrast for the methodology to be used in the present study, it is useful to review a subset of existing studies in the institutional economics literature that try to empirically evaluate the issue of institution-performance interaction both in general and in water sector contexts. The focus of this review is mainly on three aspects, i.e., the dimensions of the institution-performance interaction being evaluated, the nature of the variables being developed to capture institutional aspects, and the methodological framework and evaluation context being used by the existing studies.

To begin with, a temporal analysis is used by Wallis and North (1986 and 1988) to study the size, structure, and implications of the 'transaction sector' (i.e., the institutional structures that facilitate, enforce, and maintain economic exchanges within the market setting) in the US during 1870-1970. Although Williamson (1985: 21-22) consider the transaction costs as basically unmeasurable, there are very notable and successful attempts at the empirical measurement of the transaction costs, especially within an economy wide context (Wallis and North, 1986; Porat and Rubin, 1977). Wallis and North 1986 estimate that the transaction sector accounts for about 47-55 percent of the GNP of the US in 1970. Porat and Rubin (1977: 8), who estimate the transaction sector from the perspective of information, gives a figure of 46 percent of the GNP in 1967.[9]

Adelman and Morris (1974) and Adelman and Lohmoller (1994) combine both temporal and cross-section analysis to study the impact of political structures and economic institutions on economic growth in the context of 23 countries during 1850-1914. The study by Adelman and Lohmoller (1994) is particularly important in view of its methodological implications for the purpose of the present study. It evaluates the institution-performance interaction within a quantitative framework using a latent variable regression model where many latent or unobservable institutional variables are captured by their relationship with manifest or observable variables. Most of the latent variables (e.g., the character of national political leadership, favorableness of land institutions to improvements, and the spread of technology in different sectors) have also been formulated as categorical variables with categories ordered based either on actual evidence or on a priori reasoning (Adelman and Lohmoller, 1994: 351-354).

A combination of temporal and cross-sectional analysis has also been used for studying both general as well as specific aspects of institution-performance interaction. For instance, the study by Remmer (1998) uses this hybrid approach to evaluate the relationship between democracy and international cooperation in the Mercosur region (comprising of Argentina, Brazil, Paraguay, and Uruguay) during 1947-85. While the actually observed economic and international treaty data are combined to quantitatively evaluate the democracy-cooperation linkages within a logistic regression framework, the main dichotomous variable, i.e., democracy, has been created using secondary information from a comparative research on Latin American democracy. There are also theoretical and analytical studies addressing particular aspects of the institution-performance interaction such as the relationship between organizational performance and economic development status (e.g., Clague, 1994) and the role of state in building new institutions and managing conflicts during the process of structural change (Chang, 1994). Although these issues can be addressed quantitatively, since these two studies use only a cross-section of few countries, they evaluate these issues only theoretically within an analytical framework.[10]

There is another interesting set of studies which show how data problems inherent in an empirical evaluation of institution-performance interaction can be overcome by combining subjective information with objective data particularly within cross-sectional contexts. As for instance, in their logistic regression-based cross-country study of institutions and economic performance, Knack and Keefer (1986) combine observable

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[9] According to Eggertsson (1990:15) the transaction costs "are in one way or another associated with the cost of acquiring information about exchange" thus, the transaction costs are identical with the information costs in all context where an exchange is involved.

[10] This is not, however, to undermine the importance of these and other similar studies but to illustrate how the subject of enquiry, evaluation context, data problems, and evaluation techniques are inter-related. This is particularly so in the case of institution-performance interaction because of an innate difficulty in quantifying an essentially qualitative and subjective phenomenon.

variables like investment, gross domestic product, and prices with subjectively evaluated institutional variables like quality of bureaucracy, corruption level, expropriation risk, and infrastructural quality. They obtain these institutional variables—evaluated within a 0-10 or 0-4 scale—from the compilation of private professional bodies providing international investment risk services such as the International Country Risk Guide (ICRG) and the Business Environment Risk Intelligence (BERI). These investment service firms, in turn, develop these institutional indicators based on a survey of international executives. Similarly, Gray and Kaufmann (1998) evaluate the linkage between corruption and development in a cross-country context utilizing the executive perception-based institutional information compiled by the World Economic Forum (1997).[11]

Cukierman, Webb, and Neyapti (1992) have studied the nature of the relationship between the degree of independence of central banks and the level of inflation within a regression framework. This study provides an interesting case not only for combining temporal and cross-sectional analysis but also for obtaining institutional information from a cross-section of policy experts through a custom-made questionnaire. While their dependent variable, i.e., inflation, is observable and objective, their independent variable, i.e., the independence of the central bank, is reflected by a set of coded and appropriately weighted legal aspects pertaining to the functioning of the central bank and its top executive. Notably, the survey of experts in 23 of the 72 sample countries has been used to obtain both parallel information as well as perceptional weights on all relevant institutional variables. Brinkerhoff (1994) evaluates the effects of institutional design features on the performance of projects by considering a random sample of 80 World Bank-funded projects undertaken in different countries during 1983-90. The scope of this study is confined to a cross-section of projects and its evaluation technique is limited to a statistical analysis of tabulated data. Nevertheless, it is notable for its detailed analytical decomposition of institutional design features as well as for its use of a rating scheme for the numerical conversion of some of the institutional aspects on a scale of –3 to +3.[12]

Cross-country comparative studies carried out within the quantitative framework by Adelman and Morris (1967) and Morris and Adelman (1988) provide some interesting generalization about institutions and performance. Although institutions are found to be more important than resources, technology, and capital, they are only the necessary not the sufficient conditions for stimulating economic growth. Based on a critical review of several informal and formal irrigation and water institutions around the world, E. Ostrom (1990: chs. 3&6) has identified some of the key principles for their enduring success as well as those responsible for their failures. She has also evaluated their institutional

[11] For instance, the 1997 Global Competitiveness Report of the World Economic Forum has compiled and processed the responses from 3000 firms in 59 countries.

[12] The rating scheme involves subjective considerations in the sense of 'learned judgment'. Few instances for the rated variables are the level of government, stakeholder, and public support; economic, policy, and social contexts; and environmental stability.

performance in terms of eight design principles related to the nature of the rules, monitoring, sanction, and conflict resolution mechanisms, and institutional nestedness (E. Ostrom, 1990: 180).

Relative costs can be a criterion for comparing alternative institutional arrangements. For instance, Demsetz (1964) and Hurwicz (1972) suggested the relative costs as a criterion for comparing the efficiency of market (private) and non-market (public) provision of services. But, in contexts involving sovereign transactions (e.g., defense, foreign affairs, and judiciary) as well as in cases where there is no superior feasible alternative, non-market institutions such as the public bureaucracies are the most suitable mode of governance (Williamson, 1999).[13] Utilizing the transaction cost economics framework, Williamson (1999) makes a qualitative comparison of the four main alternative governance structures (i.e., markets, hybrids, hierarchies, and public bureaucracies). He also makes a similar comparison of three alternative organizational forms of public bureaucracies, i.e., privatization, regulated privatization, and public agency. In both cases, the qualitative comparison is based on the relative performance of the alternatives in key institutional attributes such as incentive intensity, administrative control, adaptation (autonomous and cooperative), and the relevance of contract law (see Williamson, 1999: 314&336).

Based on a detailed case study of a Philippine village, Ruttan (1999) evaluates the interrelated effects of resource endowments and technical changes on the demand for institutional changes in the sphere of land tenure and labor relations. In contrast to micro or partial studies of institutional change, there are also studies that take macro or general equilibrium view by explaining institutional change in terms of its complex relationships with a diverse set of economic, political, and organizational factors. Examples for the latter include the study of North and Weingast (1989 and 1996) on the political foundation of secure markets in the seventeenth Century England and that of Alston and Ferrie (1996) on the linkages between production methods, technological change, labor contract, and political system in the southern US.

The case studies reported in Haggard and Webb (1994b) evaluate how political liberalization and democratization initiate and sustain economic reform including institutional changes in eight different countries. The main emphasis of these studies was on the differential sequencing of economic and political reforms and the roles of the party and electoral system as well as the bureaucratic organization in the reform process (Haggard and Webb (1994a: 3-5). These studies also provide evidence for the role that political variables (e.g., number of political parties, election cycle) and economic

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[13] Williamson (1999:316) calls the absence of such superior and feasible alternative as the remediableness criterion. To him, the fact of the mere survival of some governance modes within a comparative institutional competition can be taken as a 'rough-and-ready test' for the remediableness criterion in practice. However, the survival of certain extant modes [e.g., QWERTY typewriter keyboard (see David, 1986)] is also due to path dependency problem reflected in the exorbitant cost of switching to more efficient alternative modes. In the presence of these costs, it is, therefore, not reasonable to compare the existing institutions with their new alternatives (Williamson, 1999:316).

variables (e.g., level of fiscal deficit and inflation) have on the reform process (see Haggard and Webb, 1994a).

Using cross-country statistical analysis, Clague, et al. (1997a) evaluate how measures of property rights and contract enforcement explain the differences in income, growth rates, and investment. The institutional variables for their regression analysis are developed from the cross-country ratings obtained and reported by private investing and risk rating services such as the International Country Risk Guide (ICRG) and Business Environment Risk Intelligence (BERI).[14] The same set of institutional variables along with the variables capturing regime type and duration are also used by Clague, et al. (1997b) to evaluate the impact of political regimes on economic growth, again, within the context of a cross-section of countries. Based on his evaluation of how different features of democracy affect economic policy, Haggard (1997) finds that well-organized interest groups that facilitate the compromise needed for effective policy reforms can play a much more positive role in promoting economic growth than that envisaged by Olson (1982). Li (1999) evaluates the casual link between the institutional arrangements and trade performance of trade block. Central to the analysis is the 'institutional variations index' that captures the inter-bloc variations in institutional arrangements. The index is constructed by summing the respective values obtained by seven dummy (0-1) variables representing trade-related institutional aspects such as tariff elimination, non-tariff elimination, free trade in service, free labor movement, free movement of capital, specific timetable for liberalization, and dispute settlement procedures. The analysis could have been much more realistic had Li (1999) used judgmental values, instead of the 0-1 values, for the variables as obtained from an appropriate sample of experts to reflect the effectiveness of the institutional aspects.

Based on quantitative and qualitative data from 1088 households from India and Sri Lanka, Isham and Kahkonen (1999) evaluate how institutional aspects such as service rules and practices, social capital, and governmental and non-governmental organizations affect the impact and performance of rural water supply projects. A notable aspect of this paper is the use of a 'social capital index' developed from the number of community groups to which a household belongs with the 'group characteristics' being defined in terms of caste, religion, occupation, decision process, and performance rating (Isham and Kahkonen, 1999: 23). The use of proxies for evaluating institutional performance is a common practice in many empirical studies in institutional economics. The choice of the proxy variables, of course, depends upon the purpose. For instance, Ostrom, Parks, and Whitaker (1978) use variables such as the number of streetlights and trashcans as proxies for the evaluating the effectiveness of the neighborhood policy system.

Empirical Literature: Water institution Context

Most of the discussions on the institution-performance interaction attempted above from a general perspective can obviously be specialized to the water sector context. Both the

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[14] The ICRG has been publishing its ratings since 1982 with month update and the BERI has been publishing its scores since 1972 with quarterly updating.

general and specific aspects of the linkages between water institutions and water sector performance have been recognized widely either within a theoretical, anecdotal, or case study framework (e.g., Hartman and Seastone, 1970; Dinar and Latey, 1991; Frederiksen, 1992; Guggenheim, 1992; Le Moigne, et al., 1992 and 1994; Gazmuri and Rosegrant, 1994; Herne and Easter, 1997; Howitt, 1998). While the scope, purpose, and methodology of these studies vary, the common element binding them together is their focus on the performance implications of one or more aspects of water allocation and management institutions. But, there is hardly any study that either posits or evaluates the issue of institution-performance interaction in the water sector with such a broader perspective as outlined in Figure 2.1. However, there are few studies that evaluate some of the aspects of this interaction using different evaluation contexts and methodologies.

Wade (1982) compares the yield and employment performances of irrigation water control institutions (i.e., the water distribution system and procedure) in Southern India with that in Korea within an essentially descriptive and non-quantitative framework. The better performance of Korea is explained in terms of a better water supply, small, decentralized, and demand-controlled system, and good management structure. Lo and Tang (1994) utilize, again, a case study framework of descriptive nature to explain the differential performance of institutional arrangements (governance and management structures) in controlling water pollution from different sources (industrial and domestic) by considering the case of Guangzhou Municipality, China. The main result is that since no one set of institutional arrangements can solve all types of collective problems, a better institutional performance can be ensured only by designing them to be compatible with the type of problems they confront.

There are also studies that specifically consider the role of the context within which the institution-performance interaction occurs in the water sector. For instance, Rausser and Zusman (1991) provides a theoretical model that considers the political, economic, and physical aspects of the water systems as parts of a co-evolutionary process. Although this study does not deal with either institution or its performance directly, it suggests a way for endogenizing the context of institution-performance interaction within the evaluation process itself. Similarly, utilizing the case of the River Platte in the northwest US, Yang (1997) describes the way water institution, resource system, and competing economic and social interests interact and co-evolve through time.

Studies evaluating various aspects of water institutions and their performance impacts in various contexts are indeed many. Although most of them are either descriptive, analytical, or theoretical, there are also a number of studies that attempt quantitative or numerical analysis of different dimensions of the process of institution-performance interaction within water sector. The general approach followed by them is centered on game theory or optimization-based simulation models. Some of the most important among them requires elucidation especially focusing on their methodology and their level and detail of institutional analysis. Utilizing a simulation of a multilateral bargaining model of a water allocation problem under different property rights regimes, information conditions, and water supply levels, Saleth, Braden, and Eheart (1991) and Saleth and Braden (1994) have identified price and quantity-based exchange rules capable of minimizing the inefficiency due to strategic behavior. The focus of these studies is on the evaluation of alternative rules in terms of their impact on the efficiency of water market essentially from a micro perspective. Utilizing a large-scale simulation of the irrigation and drainage issues in the San Jocquim Valley, California, Dinar and Latey (1991) have evaluated how water markets can improve water use efficiency and reduce the negative economic and environmental consequences of drainage-induced waterlogging and soil salinity. The description-based analysis of V. Ostrom and E. Ostrom (1972) of the Southern California water economy is an interesting original analysis of the way water institutions (water law and water-related organizations) evolve with the changing water resource realities of the region. Besides the focus of their study on the way the macro water institutions are crafted within the physical and economic environment of the region, the attention is also focussed on the role of private incentives for collective actions.

The theoretical literature elaborating the additional gains possible from institutional changes—both in the general and in the water sector contexts—are vast and growing. While the literature in a general institutional context covers the seminal works of Olson (1971), Bromley (1989), and North (1990a), that in the water institution context covers the important works by E. Ostrom (1990), Frederiksen (1992), Le Moigne, et al., (1994), and Picciotto (1995). Apart from this theoretical literature on the gains from institutional change, there are also few recent studies which try to quantify the potential gain from changes in a particular segment of water institutions like water markets, inter-regional transfers, and water quality institutions (e.g., Vaux and Howitt, 1984; Dinar and Latey, 1991; Zilberman, et al., 1998; Howitt, 1994; and Herne and Easter, 1997).

There are also few studies which provide some rough numerical estimates for the opportunity cost (i.e., the potential social gain) of change in water institution as a whole for countries like Chile (Gazmuri and Rosegrant, 1994: 24) and India (Saleth, 1996: 274). In both cases, the calculation involves first an estimation of actual or potential efficiency-induced additional irrigated area and then the estimation of the cost of creating that area by new construction. The estimated opportunity costs vary from $ 400 million for Chile to $ 14 billion for India. Similar, but simulation-based, estimates for the context of San Joaquin valley place the opportunity cost to be $ 223 million (Archibald and Renwick, 1998). As distinct from the approach of trying to estimate the opportunity costs of institutional change, there are also attempts which tries to directly estimate the transaction costs of reform (e.g., Colby, 1990; Easter, 1998).

The present approaches towards estimating both the opportunity and transactions costs of institutional change in the water sector remain admittedly partial. For, they do not adequately account either for the segment-specific institutional needs of different water sub-sectors or for the component-specific cost variations across various components of water institution (i.e., water law, water policy, and water administration). Variations in the opportunity and transactions costs across water sub-sectors and water institution components make institutional changes easier in some contexts but difficult in other contexts. For example, it is easier to formulate and declare a water policy than to design and promulgate a water law. Similarly, it is much easier to have both water policy and water law than to create new or reform existing administrative structures needed for an effective field level translation of legal provisions. Since institutional change is a continuum, the easier reforms initiated in the early stages brightens the prospects of further and higher level institutional changes. This means that there is an intricate and functional linkage between the transaction costs of subsequent reforms and the opportunity costs of earlier reforms. Although these linkages appear to be highly abstract and theoretical, their practical influence within the political economy of reform process should neither be ignored nor be underestimated.

Since the magnitude of net benefits from institutional changes in water sector is a direct function of the degree of water scarcity, the economic incentives for institutional change increases with every increase in the level of water scarcity as induced by factors like population growth, economic development, and climate change. Increasing water scarcity also magnifies the real and economic costs of inappropriate water sector policies (e.g., treating water as an 'open access' resource and subsidized water provision) which can be approximated by the gap between the scarcity value of water and the prevailing water charges. Besides, the opportunity cost of institutional change within the water sector is also strongly influenced by some factors that originate outside the strict confines of the water sector. These factors, which are often underestimated, include the macro economic adjustment policies and socio-political liberalization and reconstruction programs. Macro economic reform magnifies the fiscal implications of the opportunity costs of institutional change. In contrast, the socio-political reform attempts (e.g., in Chile during the 1970s, Spain during the 1980s, China since the 1980s, and South Africa since the 1990s) reduces the transaction costs directly because the institutional changes in water sector form part of a system-wide reform. The opportunity cost of institutional change is also being magnified further by water-related natural disasters such as droughts (e.g., California), floods (e.g., China), and soil salinity (e.g., Australia and Pakistan). This means that the original opportunity costs of a crisis-ridden water sector, though remain a potent force for change, need, however, additional support and context to get the much-needed political economy thrust to prompt and sustain the process of institutional change.

DARK AND GRAY AREAS

While the research in the first analytical levels are numerous and growing, there are still key areas where there are dark and gray areas in existing knowledge. Some of these areas have been already identified by North (1986) as the frontier area for research in institutional economics whereas others are implied in his seminal work (see North, 1990a).

Information plays a key role in institutional economics as a major component of the transaction cost. But, uncertainties in human interaction cannot be reduced just by information alone as individuals differ in the interpretation of the same information. The difference originates from the differences in perception or, more accurately, differences in the mental models. Many researchers—from North (1990a, 1993, and 1995) and Eggertsson (1996)—now emphasize the mental model approach as an attempt to reconstruct the software that people use for processing information (Eggertsson, 1996: 19-20). North (1995: 25) and Eggertsson (1996: 20) consider this approach involving the extension of cognitive sciences to institutional economics as an important frontier of research. According to North (1995: 25), institutions are themselves an outcome of the mental construct of the individuals designed for the purpose of interpreting the environment they face in various situations. It is obvious that such an approach of mental models bring into considerations both the economic and non-economic factors.

Another agenda specified by North (1995: 25) relates to the analysis of the political markets within the transaction cost framework with a view to evaluate the institutional change in various countries as a salutary medicine of the over-concentration on the rational choice models. Similar is also the need for research on path dependence with a focus on how initial institutions constrain downstream institutional choices and how institutions and mental construct of the players interact in that process of institutional change (North, 1995: 25). There is another most important level of analysis where the institutional environment becomes endogenous. Here the focus is on the effects of economic and political organization and processes on the institutional framework. Yet another level of analysis that is of critical importance but received very little direct attention in the existing literature relates to the performance implications of the innate structural features of institutional environment and institutional arrangements themselves. In this context, there is a clear need for a much deeper understanding of the composition and the inner dynamics of institutional environment and institutional arrangement.

The supply side of institutional change is one of the most ignored dimensions of institutional economics. Supply-side factors include the existing stock of knowledge, the costs of institutional design, incentive for political entrepreneurs to innovate, and the expected benefits for elite decision-makers (Feeny, 1993). The supply of institutional innovation is strongly influenced by the cost of achieving social consensus that, in turn, depends on the power structure, cultural tradition and ideologies, resource endowment, and advances in the knowledge of the process of institutional change itself (Ruttan, 1999: 9).[15] There are many instances throughout history that the demand for institutional change came from relatively narrow interest groups seeking their own goals, which happened to benefit the society at large (Clague, 1997b: 23).

It is asserted that as long as the private return of political entrepreneurs diverge from the social return, institutional innovations will not be supplied at a socially optimal level (Guttman, 1982). The implicit assumption here is that all possible institutional innovations are known before hand. But, in most contexts, the choice is restricted only to the institutions known from current knowledge. Even when the institutional options are limited, the costs can still be minimized to a substantial degree by the way institutional

[15] The Institutional Analysis and Development framework developed by E. Ostrom (1990) for comparing alternative institutional arrangements is a novel attempt to supply institutional innovations for small self-organized groups. The other instances for intellectual efforts towards institutional design both from a micro and macro perspective include Dinar and Lohman (1995) and Saleth and Dinar (1999b).

options are designed, structured, timed, sequenced, and packaged (Haggard and Webb, 1994a; Saleth and Dinar, 1999b). Since institutional design and packaging can be used to influence the process of coalition formation, it can influence the private return of the political entrepreneurs. Similarly, timing can better exploit the pro-reform climate fostered by a crisis situation. But, to exploit well these positive aspects of the institutional features well, we need a more detailed knowledge than that available at present on institutional structure, nestedness of institutional components, and its embeddedness with the physical, social, and economic environment. As such, there is a critical need for adding more to the stock of our knowledge on the process of institution-performance interaction focussing especially on the role of institutional linkages.

Governance structure is the institutional matrix within which transactions are negotiated and executed. Williamson (1993) considers the institutional environment as a shift parameter or the datum for the actions that can alter the comparative costs of governance alternatives such as markets, hierarchies, and hybrids. But, the main attention of the transaction cost approach is on the way the institutional arrangements evolve within and change the institutional environment from without so as to minimize the transaction costs rather than the structural features of the institutional environment. However, as long as the main objective of the latter aspect of interaction between institutional arrangement or governance structure and institutional environment is to minimize the transaction costs, the transaction cost minimizing potential of issues such as institutional design as well as its structure and sequencing is implied. Unfortunately, this aspect has not received much attention in the extant literature.

It is necessary to begin the analysis with the institutional environment within which the actors (individuals and organizations) are embedded. It is only then that the set of alternative governance structures chosen by the actors becomes known (Groenewegen, Kerstholt, and Nagelkerke, 1995: 474). The interest on the structure of and linkages within institutions are as old as institutional economics itself. In fact, the analytical scheme of Veblen (1914) is one of "cumulative causation" in which each step in institutional evolution is shaped by what happened before. The same fact has also been elaborated in a more formal way in terms of his concept of path dependency. In either case, present institutions are linked with past institutions so do future institutions with present institutions. Beyond these overall evolutionary linkages, there are also analytical and functional linkages of fundamental importance and deeper linkages.

Institutions of different kinds hang together in more or less coherent systems characterized by interactions of various institutions (Johnson and Nielsen, 1998: xiii). Despite a fast growth in the institutional economics literature, we still hear the complaints of the absence of a comprehensive taxonomy of institutions and institutional change and the imprecise and tentative nature of the description and comparison between institutional settings (Johnson and Nielsen, 1998: xiii). There are many historical instances for these institutional inter-linkages (North, 1990a: 95-100). Unfortunately, this important issue has received no attention either in the analytical or in the empirical works in institutional economics with a rather few exceptions. For instance, E. Ostrom and her co-workers tackle this in terms of showing the nested structure or configural relationship within a rule-based decomposition of institutions (E. Ostrom, Gardner, and Walker, 1994; E. Ostrom, 1999). Saleth and Dinar (1999b), on the other hand, demonstrate this in terms of an analytical and quantitative evaluation of the institutional inter-linkages using a component-based decomposition of water institution.

Demonstration effects play a powerful role in creation and perfection of institutions. North (1990a: 137) underlines this by stating that "the existence of relatively productive institutions somewhere in the world and low-cost information about the resultant performance characteristics of those institutions is a powerful incentive to change for poorly performing economies." Obviously, the cross-country flow of information on comparative performance of institutions can contribute significantly for the design of more efficient institutions.

Chapter 3

EVALUATING INSTITUTIONAL CHANGE: APPROACH AND METHODOLOGY

The indispensability of multi-disciplinary approach is rather obvious for a comprehensive analysis of institutions. As important as the need for a multi-disciplinary perspective is also the requirement for multiple methodologies. To explain the rationale for such multiple methodologies or approaches, E. Ostrom, Gardner, and Walker (1994: 23-25) distinguish between models, theories, and frameworks. While models capture the elements of a particular situation and theories are concerned with the features of a class of models, frameworks help to organize various theories to gain both diagnostic and prescriptive insights into the subject of an enquiry. The IAD framework developed by E. Ostrom and her co-workers at Indiana University is a particularly very relevant for synthesizing various theories relevant for the analysis and evaluation of institutions.

Since institutions are entities that emerge, evolve, and operate in the intersection of economic, legal, organizational, political, social, and physical spheres, no single model or theory can be sufficient for its evaluation. For a comprehensive evaluation of their different dimensions, we need theories from classic political economy, neo-classical economics, institutional economics (e.g., Coase, 1937; Commons, 1957), public choice theory (e.g., Olson, 1957; Buchanan and Tullock, 1962; Riker, 1962), transaction cost economics (e.g., Williamson, 1975 and 1982; North, 1990), and game theory (e.g., Shubik, 1982; Harsanyi and Selton, 1988). While all these theories and their underlying approaches are relevant for institutional analysis within the IAD framework, they are not equally relevant to deal both with macro and micro level institutions.

Given our focus on the macro aspects of institutions in the water sector, we need essentially the theories from political economy, institutional economics, transaction cost economics—especially the institutional transaction cost economics (Bromley, 1989: 49&110; Landry, 1996: 4-6), and governance perspective. These theories, either in isolation or in combination, will be used in different parts of our framework. Our methodology for the evaluation of institutions in the water sector relies heavily on the institutional transaction cost approach and political economy perspective for explaining the direction and pattern of ongoing institutional changes in the context of global water sector. The institutional economics approach and governance perspective are also used for the evaluation of institutional inter-linkages and institution-performance linkages.

SCOPE AND APPROACH

To begin with, it is necessary to clarify the basic approach as well as to specify the scope and foci of this study. Given the objectives of the study, its reliance on the institutional approach is rather straightforward and obvious. But, given the diverse traditions of institutional analysis, it is important to delineate the particular tradition of the institutional approach that we will use in the evaluation of institutional change and its economic outcome. Since institutional change is a broad area, it is also necessary to specify the level at which the evaluation will be carried out.

Institutional Approach

As compared to both neo-classical and old institutional economics, the new institutional economics approach is more realistic and appropriate both for explaining institutional change as well as for evaluating institutional alternatives. As against the hostile relationship between the old institutional economics and neo-classical approach, the new institutional approach has essentially a complementary relation with the orthodox theory. The neo-classical view of firms as production units has evolved to see them as governance structures as does the emphasis moved from technology and production costs to economic contracting and transaction costs (Williamson, 1994: 1). This approach, therefore, recognizes the role of market forces even while allowing for the explicit consideration of the role of economic and political organizations, and other non-economic factors such as ideology and changing social goals (Bromley, 1985; North, 1990a). Since it addresses both the positive as well as the normative aspects (Tool, 1977), it can shed considerable light on the nature of institutions and the type of and linkages among various institutions.

The institutional approach that prescribes the setting of institutions right can be viewed either "as an exercise in (general) theory or as an exercise in governance/mechanisms" (Williamson, 1994: 5). The former aims to contribute "...a general conceptual framework that provides an overview of the entire transition process, viewing it through a wide-angled lens. An ideal formulation would provide an exhaustive, conceptual classification of the decisions that have to be made, the players that have to make them, the institutional structures within which decision making will take place and a set of performance criteria against which the process can be evaluated" (Rausser and Simon, 1992: 270). The present study is an attempt towards such an exercise combining institutional theory with a multi-pronged empirical analysis based on analysis of contemporary institutional changes in global water sector, anecdotal evidences for their performance implications, and a perception-based evaluation of institutional inter-linkages and institution-performance linkages within water sector.

Since institutions are exogenous to the neo-classical approach, it is unable to provide a framework for the evaluation of alternative institutional arrangements. Although the public choice theory makes institutions endogenous to its framework of analysis and also highlights issues that are outside the scope of the neo-classical approach such as rent-seeking and transactions costs, it neither allows the comparison of institutional alternatives nor supports institutional change by political means (Livingston, 1987: 282-283). The role of government is recognized by public choice theory but state role is limited to defining and protecting of property rights. Since a precise definition of rights is no guarantee for how the rights should be structured (Randall, 1974), the issue of evaluating institutional alternatives still remains outside the purview of analysis within public choice theory.

Focus on Macro Institutions

The choice of institutionalist approach does not end the problem as it has many variants. A brief overview of the foci and approaches of various institutional theories is useful to provide an idea of existing theoretical traditions in institutional economics and indicate the way these theoretical traditions have implications for the approach and methodology of the present study. The institutional approach has many variants applicable at different levels and contexts. These variants have both commonalities and differences. One of the key common aspects of these variants is their attempt to address some of the major gaps in neo-classical approach, emerging mainly from its inability to include institutional aspects into its analytical framework. Apart from their role in clarifying the definition of institution, the distinctions between institutional environment and the institutions of governance (or, organizations) also have implications for the nature of approach to institutional analysis at different levels. According to Williamson (1994), normative approach works at the macro level of institutional environment and a partial or positive approach works at the micro level of the institutions of governance. Since we are interested in the macro perspective of institutional environment and the institutional structures, our approach is essentially normative with a predominant macro-analytic orientation.

In institutional economics, there is a considerable tendency to examine macro system to find the patterns and regularities in human behavior, especially expecting to find a great deal of imitation, inertia, lock-in, and 'cumulative causation' (Hodgson, 1993: ch. 9 and 1998: 171). Veblen's idea of institutional change as a process of 'cumulative causation' (Veblen, 1919: 70-77) suggests not only path dependence but also the linkages among institutions in a temporal sense. Institutional linkages—both over time and at a given time—are also recognized well (North, 1990a: 22). These ideas are important for the evaluation framework being used in our study as they have implications on experts' judgment and choice among institutional typologies or configurations. According to Landry (1996: 32-33), research programs on institutions can be differentiated in terms of the level of analysis and focus. While micro institutional analysis considers stylized institutions as exogenous factors at a highly abstract level, the macro institutional analysis tackles institutions at a high level of aggregation while focussing on the production of *ad hoc* descriptions and taxonomies.

In terms of their overall approach, the existing theories of institutions can be grouped into five categories (Landry, 1999: 9). Table 3.1 shows how these five approaches differ in terms of their generic scope, assumptions, unit of analysis, focus, explanations, and limitations. Of particular relevance for the specific purpose of our

Table 3.1. Stylized Comparison of Institutional Approaches.

Aspects of Comparison	*Approaches*				
	Old Institutionalism	**Neo-Institutionalism**	**Meso-Corporatism Policy Community Networks**	**Game Theory**	**Transaction cost theory Agency theory Theory of contract**
1. Generic Scope	Macro-analysis of complete institutions	Macro-analysis of incomplete institutions	Variations on macro-analysis of incomplete institutions	Micro-analysis of complete institutions	Micro-analysis of incomplete institutions
2. Assumptions					
2.1 Interdependence	No	No	Yes	Yes	Yes
2.2 Information	Complete	Incomplete	Incomplete	Complete	Incomplete
2.3 Rationality	Comprehensive	Bounded	Bounded	Comprehensive	Bounded
3. Unit of analysis	Institutional Structures	Institutional Structures	Meso-institutional Structures	Institutional Structures	Institutional Transactions
4. Casual Explanations	Institutional structures determine individual behavior	Incomplete institutions create incentives for opportunistic behavior	Actions of individuals are rendered compatible through efficient and equitable use of incomplete institutions	Rational individuals select equilibrium solutions	Incomplete institutions create incentive for opportunism which induces individuals to invest in institutions that minimize cognitive competence and opportunism
5. Focus	On formulation of classifications of institutional structures	On opportunities and constraints built into institutional structures	On opportunities and constraints built into meso-institutional structures	On the degree of stability of equilibrium solutions	On technical coordination, warranty, monitoring and costs of incentives
6. Limitations	. High level of aggregation . Ad hoc description . Individuals do not calculate	. High level of aggregation . Ad hoc explanations	. Average level of aggregation . Ad hoc explanations	. Institutions are highly abstract . Institutions are exogenous . Institutions are minimal	. Difficult to derive equilibrium solutions

Source: Adapted from Landry (1999).

study are the differences in the approaches in terms of their level and unit of analysis, and the degree of institutional disaggregation. Although these approaches have differences, they are not alternatives but complementary for a comprehensive understanding of institutions as well as their evolution and performance implications in various levels and contexts. Since our attempt aims at evaluating water institutional structures and their performance impacts from a macro level and a disaggregated perspective, our approach has to be based on a judicious combination of the relevant elements from various traditions of institutional theory and analysis represented in Table 3.1. In this particular sense, our evaluation framework and methodology have some resemblance with the IAD framework of E. Ostrom and her co-workers.

The advantage with the IAD-type framework is that it allows the use of multiple methodologies from various theoretical traditions including neo-classical economics, public choice theory, new institutional economics, and transaction cost economics and governance approach. The problem with this approach is that it is too micro in focus and it could face tremendous challenge when it is generalized to the macro level. For our purpose, the elements of the institutionalist traditions—both and old and new—and the transaction cost theory, particularly their emphasis on institutional structures and institutional transactions, focus on macro institutions, and reliance on institutional disaggregation will form the building blocks of our evaluation framework.

Focus on Formal Institutions

The informal institutions are not purposively designed but evolve through spontaneous interaction whereas formal institutions can be purposively designed (North, 1990a). All these purposively designed institutions need not necessarily minimize transaction costs and enhance social welfare. This is in view of the fact that the changes in formal institutions are brought about by politically dominant interest groups to favor their own interests. Nevertheless, the mere role of power and bargaining need not imply that such institutional changes are always Pareto-inferior.

The difference between formal and informal rules is only of degree but not of kind and in many cases, some of the informal rules gradually become formal rules and some formal rules take informal forms. However, they need to be treated differently because the fundamental differences in their sources and rates of change (North, 1990b: 386) as well as their amenability for inclusion in formal analysis. The change in formal institutions can be dealt within the transaction cost approach that is actually based on an extension of the neo-classical framework. But, for explaining the changes in informal institutions, the neo-classical framework is not sufficient (Eggertsson, 1996: 6-7).

From the perspective of monitoring and enforcement, unlike the formal mechanisms created and maintained by state apparatus, informal rules, such as norms, customs, and conventions, provide self-enforcing arrangements close to the point where actual decisions are made, that too, at lower costs. Informal rules are considered as extensions and local level translations of formal rules. In reality, however, formal rules are also derived and dependent on informal rules, especially for their stability and strength. Since informal institutions are the foundation on which formal institutions operate, as exogenous phenomena, they are of key value for policy. Obviously, any effort to design efficient formal institutions has to consider the way new formal rules interact with prevailing informal rules (Eggertsson, 1996: 22).

Since informal institutions change very slowly (North, 1990a: 45), they can be taken for granted in studies dealing with marginal changes in formal institutions (Eggertsson, 1996: 13). This is especially so, when the main focus is on the macro aspects of the structure and changes in formal institutional aspects, the consideration of informal institutions that operate mostly at the micro level has to be relegated for the sake of sharper focus and simplicity.

EXPLAINING INSTITUTIONAL CHANGE

In order to explain and justify why different methodologies are used in this study in a complementary way, it is necessary to outline the way institutional change is conceived in this study. Before doing so, it is, however, instructive to have a brief review of the dominant theories of institutional change as well as some of the major factors motivating institutional change in a generic perspective.

Theories of Institutional Change

The old institutional economics places considerable importance on cultural context (Rutherford, 1995: 443). The exchanges and contracts are also influenced by ethnic, cultural, and even religious beliefs (Landa, 1994, Grief, 1994). North (1990a) has incorporated some of the central ideas of the old institutional economics such as the role of ideology, mental models and belief systems, influence of culture on the process of learning in an attempt to synthesize the old with the new institutional economics. Without these ideas, it will not be possible to explain a number of anomalies (e.g., the existence of inefficient institutions and the role of non-economic factors in institutional change) that remain unexplained with an extension of neo-classical approach to institutional issues. As a result, the distinction between the 'old' and 'new' institutional economics is declining with the later increasingly incorporating some of the most important aspects of old institutional economics such as culture, habit, and ideology (Groenewegen, Kerstholt, and Nagelkerke, 1995; Rutherford, 1995; Hodgson, 1998). As a result, institutional economics, at present, is increasingly departing from the neo-classical economics, though the transaction cost economics, one of the major branches of institutional economics, still retains the analytical advantage and rigor of the neo-classical economics.

There are three distinct theories of institutions, i.e., theories of the evolutionary emergence of social conventions, market-based theories of exchange and selection through competition, and a bargaining theory explaining institutions in terms of asymmetries of power in a society (Smith, 1976; Knight, 1995). Commons (1943) views institutional evolution in terms of political and judicial processes of decision-making and the activities of private collective organizations, where economic efficiency may be important but it is not necessarily the only or the dominant factor. Earlier works of North (e.g., North and Thomas, 1970 and 1972) treated institutional change as endogenous. Field (1981) critically contested such a perspective. However, subsequent works of North (e.g., North, 1990a) have recognized the scope for exogenous sources of institutional change, including ideology, conquest, and war. There are now strong evidences that new insights on the process of institutional change can be obtained by treating it as an economic response to changing resource endowments (Ruttan, 1999: 6). Changes in resource endowments, cultural endowments, and technology have been important factors that lead a shift in the demand for institutional innovation and hence, change (Ruttan, 1978 and 1988; Ruttan and Hayami, 1984).

Clearly, the emergence and change of different sets of institutions require different kind of theoretical explanation. Theories of planned or intentional design generally adopt a contractarian approach, describing institutional change as a product of free and voluntary exchange in the political market (e.g., Buchanan and Tullock, 1962). The induced institutional innovation theory of Ruttan and his colleagues (e.g., Ruttan, 1978 and 1988; Ruttan and Hayami, 1984) is actually a part of the evolutionary approach as the sources of institutional change are related to resource, technology, and culture.

According to public choice theory, institutional changes are essentially market-based and they occur whenever their benefits exceed their costs. The latter part of the assertion is consistent with the new institutional economics perspective of institutional change provided it is amended on three counts. The first is to avoid the confusion of equating property rights with institutional arrangements as property rights are but only one of the many components of institutional arrangements. The second is to recognize and capture the political economy aspects of institutional change by incorporating the institutional implications of the distribution of both the benefits and costs of institutional change across various groups. Since these distribution effects are an outcome of the initial system of property rights, the initial resource endowment and the attendant bargaining strengths of individuals and groups condition the nature of subsequent institutional evolution.[1] Finally, it is also necessary to account for the effects of exogenous and non-market forces (e.g., natural disasters, war, revolution, and ideologies) on the relative bargaining strength of these groups.

The rational choice approach (e.g., Rawls, 1972; and Harsanyi, 1977) modeled the choice of institutional arrangements within a decision situation involving extreme uncertainty or a veil of ignorance. That is, the individuals and groups choose the primordial institutional configurations such that they are not worse off regardless of the change in the state of nature. In contrast, the approach of other rational choice theorists (e.g., Twight, 1972) considers institutional choice in a situation where institutional arrangements already exist and individuals and groups invest in institutional modifications and maintenance to change the distribution of payoffs, economic opportunities, or economic advantage. The emergence of hierarchies as an alternative to market can be understood well from this perspective.

1 The pattern of distribution of the impact of institution also determines both the occurrence and effects of institutional change. For instance, when the externalities are so widely distributed across a vast number of unorganized individuals, the transaction cost may be so high to be Pareto relevant to support a market-driven institutional change (Livingston, 1987: 285).

There are also notable attempts to synthesize competitive selection with intentional attempts to create rights or forms of organizations through market exchange (Coase, 1960; Williamson, 1975 and 1985; North, 1990a). Theories of intentional design have been primarily invoked to describe the creation of political institutions based either on the transaction cost approach or on pure intentional efforts, implied in the explicit emphasis on distributional consequences of institutions is the role of political bargaining as a mechanism of institutional change (Knight and Sened, 1995b: 4-5). Riker (1995), in his study of the framing of the U.S. Constitution as a case study of the more general phenomena of intentional institution creation, identifies two important factors, i.e., the importance of predecessor institutions and the internal consistency in political institutions. By internal consistency, he means that various provisions of constitutions are all tuned to achieve the overall objective in an ordered way.

The institutions created purely on intentional efforts include bureaucratic organizations and constitutions as well as property rights. In these cases, the explanations for the creation and change of institutions is based on the relative bargaining power of relevant social actors (Knight and Sened, 1995b: 5). The papers included in the volume by Knight and Sened (1995a) provide a detailed commentary both on the evolutions of informal institutions as well as on the intentional design of formal institutions. Levi (1990: 407) views formal institutions as an outcome of social bargain and institutional change is "most likely when there is an increase in the bargaining powers of individuals seeking change and a decrease in the blocking power of individuals whose interests are served by the current institutional arrangements." Clearly, the bargaining-based logic of institutional change is applicable only to formal institutions but not to informal institutions. From an anthropological perspective, Douglas (1987) argues that most of the informal institutions and their formal counterparts have evolved from natural principles and hence, are a social reflection of arrangements found in nature. This is the reason why they are relatively more durable than formal institutions.

Not all writers supporting to evolutionary theory subscribe to the view that the process will lead to socially efficient institutions. For instance, Posner (1980), Schotter (1981), Coleman (1990), and Williamson (1975 and 1985) expect that socially efficient institutions of different forms will emerge through the evolutionary process. On the other hand, Coase (1960), North (1981 and 1990a), Barzel (1989), Libecap (1989) view that the evolutionary process can lead to socially inefficient institutions as well (Knight and Sened, 1995:2-3). Demsetz (1967) though argues that institutions emerge when the benefits outweigh the costs. But, this does not mean that the emergent institution will always be efficient, as the distribution of benefits and costs across economic groups are not taken into account. According to North (1990a:9&73), institutions tend to be inefficient because they are devised by those with the bargaining power to devise new rules. As a result, institutions are always a mixed pack of those that induce productivity and those that reduce productivity.

The efficiency motive for institutional change is endogenous to the model of institutional change whereas the case of income redistribution is exogenous. The emergence of additional gains from changes in relative prices and technology and the inability of existing institutions to capture such gains are the primary reasons for institutional innovation. The essential requirement for initiating institutional change in such condition is that the discounted expected gains should exceed the expected costs of undertaking the change (North and Thomas, 1970: 3). The study by Libecap (1978) has used the institutional transaction cost approach for explaining institutional changes in the context of mineral resources in Western US. Libecap's empirical analysis led him to conclude that there will be a demand for a greater precision of legal rights as long as there are private gains to be realized and such gains are higher than the additional cost of institutional change (Libecap, 1978: 341). In the context of water resources, the switch from the riparian to the prior appropriation doctrine can also be explained in terms of the additional net gains of the institutional change under conditions of increasing scarcity (Bromley, 1989b: 738-739). In this particular case, institutional innovation is an essential precondition for development of private investment in irrigation technologies.

The selection of institutional arrangements through market mechanism can be myopic and inefficient (Polanyi, 1957) and may lead to deadends (Hayek, 1976). Boyer and Hollingsworth (1997b: 442-443) describe the theory of voluntaristic and rational self-building of institutions where organizational innovations are derived from the rational calculus of individuals and firms who compare alternative solutions. By incorporating an explicit role for transaction costs into welfare diagrammatic analysis, Griffin (1991) deals with the issue of evaluating institutional alternatives in the context of mitigating externality problems. Zero transaction cost need not ensure efficient economic outcome when relevant institutions or their major components, such as property rights system are imperfect (Griffin, 1991: 607). It is impossible to invoke economic efficiency in a Pareto sense as a norm to guide institutional choice because the selection is only from a subset of the actually available institutions and also because of our limited ability to characterize and consider many other alternatives (Griffin, 1991: 614). Williamson (1999) also recognizes this in terms of his 'remediablesness criterion' according to which inferior governance mode is chosen due to an absence of feasible alternative mode of governance.

For a better understanding of the process of institutional change and its implications for economic performance, it is necessary to understand the role of ideology (culture), historical specificity (path dependency), power, strategy, and, most of all, the process of learning (North, 1994). Of particular relevance from the perspective of our study are the importance of strategy and learning. Strategy here does not confine itself only to the plans of rival interest groups but is also related to the strategies of the reformers or government related to the structure, design, timing, sequencing, and packaging aspects of the reform program itself. Similarly, learning also has wider ramifications by underlining the role of knowledge and best practice examples. Research on and documentation of international experience on institutional reform could add much to the learning of policy-makers and executives.

We know that the direction of reforms and institutional changes, is an outcome of the prevailing power balance of interest groups. Since interests are not fixed but change due not only to the changes in the economic conditions but also to the features of reform program itself (Haggard and Webb, 1994b: 5). It is thus possible to minimize political opposition or counter special interest groups with pro-reform coalition with a careful design of reform program. In this sense, the design of the reform program also involves indirectly a coalition building exercise. The importance of interest groups should not downplay either the independent role of government and commitments of political leaders, and the power or 'politics' of ideas (White, 1990: 11; Horowitz, 1989: 207).

The inevitability of subjective and incomplete processing of information allows ideology to play a major role in human choices. This gives rise to an additional source of inefficient institutions. According to North (1990a: 26), "institutions alter the price paid for one's convictions and hence, play a critical role in the extent to which non-wealth-maximizing motivations influence choices". A parallel argument can show how resource degradation, fiscal crisis, and natural calamities resulting from inefficient institutions enhance conviction for radical reform. In these circumstances, partisan politics and interest group considerations tend to become weak. While politically dominant groups may favor status quo, the crisis situation weakens their bargaining power and strengthens new ideas and policies relaxing in the process most of the previously insurmountable obstacles (White, 1990: 16).

Institutional maintenance and stability can be explained in terms of their capacity to produce either collective benefits for all social groups or distributional advantage to the powerful groups. Institutions are understood as responsible for stability rather than change in the economy. But, then, how do they themselves undergo change? The answer lies in the connection between institutions and power structure on the one hand and between them and, knowledge and learning on the other hand. While institutions shape people's cognition, views, vision, and action, they are also influenced by the same factors (Johnson and Nielsen, 1998: xiv-xvii). It is in the latter sense that subjective perception of reality or the mental construct of the world of the actors becomes an important factor affecting the nature and direction of institutional change (North, 1990a: 17).

Motivations for Institutional Change

Conventional view holds that institutional change occurs either to enhance efficiency or to improve equity (e.g., North, 1981, North and Thomas, 1970 and 1971; Binswanger and Ruttan, 1978; Ruttan and Hayami, 1984). However, Bromley (1989b) argues that institutional change is also motivated by two other considerations, i.e., the reallocation of economic opportunity and the redistribution of economic advantage. Although these considerations appear to be related to equity, they have a larger sense and different origin than the equity argument, as they are neither related to the redistribution of income stream nor motivated by changes in the relative prices and technology. The real origin of these considerations is the changes in the collective attitude about the full consumption set and social welfare function of the society (Bromley, 1989b: 745-747).[2] Since some of the institutional changes that are motivated by these considerations (e.g., import restriction) do not achieve social efficiency (Bromley, 1989b: 756), there is an additional reason why institutional changes may not always be efficient. This apparent reason is linked

[2] Instances for institutional changes induced by these considerations range from mine safety and anti-poverty laws to environmental acts and regulations (Bromley, 1989b).

closely to the logic based on interest groups (or organizations) and the subjective model of individuals (or, social attitudes) that led North (1990a: 7) to accept the persistence of inefficient institutions.

There is also a need for an analytical decomposition of institutional change in terms of the level of analysis (Alston, 1996: 26; Eggertsson, 1996: 10-11). One simple approach involves the delineation of the causes from the effects or the demand side from the supply side of institutional change and then to decompose the supply and demand sides so as to identify and evaluate the role of both the proximate and fundamental factors (Alston, 1996: 26-27). Institutional change is also viewed from a supply-demand perspective (Feeny, 1988 and 1993; Ruttan, 1999). The demand for institutional change originates from the latent gains emerging from the disequilibria as induced by changing resource endowments, product prices, and technical change (North and Thomas, 1971 and 1973; North, 1990; Ruttan, 1999). The demand for institutional services should increase substantially to overcome the transaction costs involved both in negotiating and in implementing the changes in institutional arrangements (Williamson, 1985: 15-42).

Institutional change is an outcome of a growing "tension between an existing structure of property rights and the production potential of the economy" (North, 1981: 62). That is, the tension between the 'structural production frontier' as determined by the prevailing property rights systems and the 'technical production frontier' as determined by resource endowment and technology (Eggertsson, 1990: 319).[3] Eggertsson (1990: 319) notes that "for each structure of property rights, there is *structural production frontier*, which is reached by selecting, from a set of feasible organizations, those structures that minimize costs and maximize output". Given the prevalent state of technology and other exogenous factors, the set of feasible forms of organizations is defined by the property rights structures, which, in turn, depend on the political structure. According to Eggertsson (1990: 319), some political systems provides incentive to place the economy close to its technical production frontier.

According to North (1997: 6), in order to understand institutional change, one needs to comprehend first the following four aspects, i.e., the stability characteristics of institutions, sources of change, the agents of change, and the direction of change and path dependence. Our understanding of both the institutional change as well as the specific position and role of these aspects can be enhanced further by identifying first the various stages in the process of institutional change. For analytical convenience, the following three broad and interrelated stages can be considered, i.e., perception change, political translation and articulation of such perception change, and institutional changes of procedural nature and institutional changes of substantive nature. As we can see that the process of perception change is very crucial, as it is here that the role of the four aspects noted above can be seen more clearly. Perception change focuses on the agents of change, reflects the effects of the tension between the existing institutions and the sources of change, and indicates the direction of institutional change. The

[3] For a theoretical illustration of this point based on the recent experience of South Africa, see Dollery (1995).

institutional changes of both procedural and substantive nature that capture the political process also takes the hues from perception change, especially in a democratic setting.

Sources of Institutional Change

Institutional change is an incremental process in which short-run profitable activities cumulatively create the long-term path of institutional change (North, 1990b: 397). The change in relative prices has been a dominant source of institutional change throughout history (North and Thomas, 1973). Changes in relative prices are only the proximate factor as they just capture and reflect the effects of changes in fundamental factors such as technology and resource endowments. Other major sources of institutional change include ideas or ideologies (North, 1990a and 1990b).

According to new institutional economics, the motive force for institutional change originates from the scope for reducing the cost of economic and social transactions. However, the existence of dense networks of social relations (e.g., family, religion, and culture) and other non-economic institutions can also be used to build useful economic institutions (Polanyi, 1957; Granovetter, 1985). Since traditional norms and values become the framework within which the economic institutions are embedded, social and cultural aspects play a strong role in the evolution and change of institutions. The other major vision of institutional change considers power as the core of institutional change (Marglin, 1991). Given the coercive and persuasive powers of modern states, they can play important role in avoiding deadends and in defending societal values (North, 1981 and 1990a).

In the case of the layer schema in Figure 2.1, the main sources of institutional change and equilibrium are individual preferences and the physical context. Since the institutional environment is defined broadly to include a set of "fundamental political, social, and legal ground rules that govern the economic and political activity" (Davis and North, 1970: 133), the roles of political and social factors are considered as endogenous in Figure 2.1. From the viewpoint of institutional change, it is, however, necessary to treat the political and social factors as exogenous, especially given the powerful role that war, revolution, ideology, and the social impact of natural calamities play in institutional change.[4] In any case, since individual preferences and strategic motives (e.g., rent-seeking) evident in governance structure—both endogenous to the existing institutions—are considered as the main forces of institutional change, the institutional change and equilibrium are 'structure-induced' (Shepsle, 1979: 135).

Shepsle (1979) put forward the idea of structure-induced equilibrium model of institutional change, which, unlike other equilibrium models where equilibrium is driven by individual preferences and the physical aspects of the game, argues that the attributes of the institutional arrangements themselves induce institutional equilibrium. Notice that the argument here adds an additional dimension to the path dependency notion of North (1990a) by underlining the roles that the inherent features of existing institutions themselves play in the

4 For some historical evidences for this fact, see North (1990a). For some recent cross-country evidences for this fact in the particular context of water institutional change, see Saleth and Dinar (1999a).

process of institutional change. If we like to understand and evaluate these roles more clearly, we need to first decompose institutions into their main components and sub-components and then identify various feasible forms that each of the components and sub-components can take.

While institutions evolve naturally through time and respond to market forces, purposive changes are also necessary to expedite the process and shape the direction of institutional change. It is desirable that institutional change strengthens voluntary exchanges and interactions. But, it is not necessarily desirable that the market process itself shapes the direction of institutional change. Imaginative collective forms of coordination mechanisms are necessary and it is here purposive and induced institutional change is both necessary and desirable (Boyer and Hollingsworth, 1997b: 477).

Another major source of institutional change is the state. In fact, the new institutional economics, unlike the neo-classical economics, assigns a key role for the state in lowering the transaction costs by providing both a stable system of property rights system as well as enforcement and monitoring mechanisms. In fact, the economies of scale make the state relatively more efficient in lowering the overall transaction costs by providing these institutional services (Eggertsson, 1996: 9). These institutional functions of the state are, therefore, indispensable to support the functioning and operation of both market and non-market institutions. Efficient markets require a government that specifies, monitors, and enforces a system of property rights and reduces, thereby, the costs of transaction per unit of exchange (North, 1986: 236). But, unrestrained state powers can create disincentives for decentralized decision-making and one way for containing the state power is to strengthen the rule of law (North, 1990a and 1993; North and Weingast, 1989; Weingast, 1993).

The state has a more active role in our scheme of institutional analysis than just protecting property and other political rights. It has an active role in shaping institutional changes in resource like water where there is not only a 'market failure' but also a 'government failure'. From the demand-supply perspective of macro level institutional change, the state plays an important role as the supplier of institutional change (Alston, 1996: 27) as well as an instrument for promoting other suppliers of institutional change such as research and information systems. The state also plays a key role in reducing the transaction costs by creating new and strengthening existing institutions. The development of governments in Western Europe is strongly connected with the establishment and enforcement of property rights, weights, measures, legal institutions, banking institutions and capital markets (North, 1990a: 52-53 and 64). There is also an increasing international influence on the institutional changes at the national level and such influences come from donor agencies as well as multilateral and bilateral economic and political agreements (White, 1990: 3; Haggard and Webb, 1994a: 25-29).[5] The widespread and dominant trend towards political liberalization and democratization observed in the last few decades (see Huntington, 1991) has increased the

[5] How important are the multilateral economic agreements, especially trade agreements, for institutional changes at the national level can be judged from the fact that the number of trade blocs that was about 30 in 1994 has increased to about 50 by 1999 (Li, 1999: 1).

prospects for economic reforms in general and institutional changes in particular (Haggard and Webb, 1994a: 1-2).

APPROACH AND EVALUATION METHODOLOGY

Having outlined the various theoretical perspectives on nature, sources, and motivation for institutional change, let us now explain the approach and evaluation methodology of our study based on an alternative perspective of institutional change. In this alternative perspective, institutional change is viewed as a stage-based process. Various methodologies are then identified for capturing the dynamics of the process of institutional change in different stages. Besides, two of the key aspects providing the theoretical and conceptual basis for the methodological framework will also be expounded. These aspects are the role of subjective perception and institutional transaction costs in the process of institutional change.

Process of Institutional Change: A Stage-based Perspective

The approach underlying the evaluation framework is based on a stage-based perspective of institutional change. The central question in the old institutional economics has not been on the influence of institutions on economic behavior but on the understanding of the process of institutional change itself. Veblen (1899) viewed this process essentially in evolutionary terms whereas Commons (1934) viewed it as a man-made process characterized by collective rule-making, purposive selection constructivism.[6] Although dramatic and revolutionary changes in institutions, especially in their formal segments, can occur through war or conquest, institutional changes occur as a cumulation of incremental or evolutionary process such as the gradual modification of contractual relations or shifts in the boundaries between market and non-market activities (Davis and North, 1970: 9).

There are few distinct stages that can be identified in the process of institutional change. Broadly speaking, the following three stages are crucial: mind change, i.e., the changing perception of the decision-makers both at the micro and macro levels, political reflection and articulation, and operationalization that begins first with procedural changes and then with substantive changes. Of these stages, the first is the most crucial. Although the focus here is on subjective aspects, objective phenomena such as the impending water scarcity, prevalent fiscal crisis, emerging success stories, and even, natural calamities all influence different segments of the society in varying degrees. In the process, the thinking and the language of those who can influence institutional change undergo gradual change creating an economic and political environment propitious for institutional reform. Given the pro-reform climate and increasing commitment and support towards reform, institutional change begins first with procedural changes (e.g., declaration of water policy and creation/modification of administrative structures) and then moves gradually towards substantive changes (e.g., water law reform, corporatization/privatization of water services, and basin-based water allocation). If the

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[6] For a critical review of the old institutional economics and its linkages with the new institutional economics, see Groenewegen, Kerstholt, and Nagelkerke (1995).

predominant thinking is against any reform, business-as-usual trend continues and there will not be any procedural and substantive institutional changes.

It is true that the mind change has to first crystallize into economic and political forms so as to induce procedural and substantive institutional change. While factors such as ideologies do influence the mental model of individuals, economic factors, especially the expected benefit and its share, also play equally a powerful role in the mental construct of desirable institutions. The relative bargaining strengths of the political and other interest groups are also important in determining the desired direction of institutional change. However, the relative bargaining strengths of groups can also change with the changing resource realities and national and international economic environment. We can find that all these issues, which are essentially in the interface between the first and second (or third) stages, are recognized and evaluated in different contexts and varying levels of details in the existing literature. But, the evaluation of the insightful first stage and its impact on subsequent stages is still lacking.

The first stage involving the mind change plays, therefore, a critical role in the whole process of institutional change.[7] It is precisely the reason why North (1990a and 1995), among others, underlines the subjective model(s) of individuals and groups as a key factor in the process of institutional change. Unfortunately, the evaluation of this stage is a missing element in the institutional economics literature. A careful evaluation of the first stage of institutional change is instructive in understanding critical issues such as the following. How the institution-performance interaction is perceived? What are the casual linkages implied in the perception of such interaction? What are the dominant preferences over various institutional configurations? These issues can provide key insights both on institutional inter-linkages as well as on the potential for and the direction of institutional change.

In the case of institutions, the immediate output is a process of change and their ultimate output depends on the impact of such change on actual exchange and production decisions.[8] The material outcome of the process is not immediate but takes considerable time, often going far beyond the program period, to manifest in terms of observable and measurable benefits. In the interim period, the performance impacts of institutional change can be measured in other forms such as the extent the policy decisions in the new setting conform to the policy intent

[7] In the context of policy reforms initiated by donor and lending agencies such as the World Bank, White (1990: 10-12) considers the perception and understanding of the reform package by the country officials as the most important prerequisite for its effective implementation. This observation is equally valid in the context of institutional change as it indicates the potential for the subsequent stage of procedural and substantive changes in the institutional structure.

[8] An instance from the water sector can clarify this. Unlike the case of water resource development projects where the outcome is the extent of resource created and its use in meeting irrigation and other water needs, in the case of programs aiming to reform water institutions, the outcome is a process of change. As such, the ultimate effect of institutional reform programs depends on the ability of the process in sustaining itself and producing the ultimate effects of improving economic performance through better resource allocation, use, and management.

(Bromley, 1985). Such an instrumental approach to institutional performance, though considered as the 'ultimate problem-solving criterion', are not free from difficulties and problems in practical situations (Livingston, 1987: 287). For, there is neither any objective means for evaluating the consistency between decisions and goals nor any way for ensuring such consistency actually leads to the realization of goals without knowing the process of implementation.[9] Another major problem in evaluating institutional change is the substantial difference between intended outcome and actual outcome due to the limited capabilities of individuals and the complexity of the problem at hand (North, 1997: 8). As a result, perception-based subjective evaluation becomes also inevitable even in evaluating the third stage where actual institutional changes are taking place.

As noted already, the perception change is not free from the influence of objective factors such as resource crisis and the relative benefits and costs of existing and alternative institutions. In other words, transaction costs—both economic and non-economic—play a key role in the direction and strength of perception change. With an extension of the same logic, political transaction costs that play a key role in the second and third stages of institutional change is also affected by the perception change. Thus, when there is a strong perception for institutional change and such perception also gets crystallized into the political sphere, the political entrepreneurs are induced to undertake institutional reforms on the desired lines. Clearly, transaction costs—both economic and political—remain a key force both in the cognitive and observed phases of the process of institutional change.

Complementary Methodologies

The political economic models of institution are evaluated using either one or all of the three following methods, i.e., case studies, comparative methods examining several cases together, and econometric analysis of cross-country data (Alesina, 1994: 55; Alston, 1996: 29-30). In our case, we use here all the three methods in a complementary way. The cross-country comparative analysis of recent institutional changes is used to evaluate water institutional changes within the framework of institutional transaction cost. Even though our attention here is limited to the changes in the recent years, the approach resembles the historical and teleological analysis of institutional changes used by North and Thomas (1971) and North (1990a). However, we will also rely on the econometric analysis of cross-country data at two levels. First, observed or secondary data on social, political, and economic variables will be used to evaluate the role of exogenous factors on the process of institutional changes within water sector and on the performance of water sector. And, second, we will also use survey-based primary information for capturing the perception of water sector experts and executives

9 These problems point to the need for a clear distinction between procedural and substantive aspects of institutional change. For instance, although water rights can be legally obtained for instream and environmental purposes in Colorado, there are few instream water rights because the issuing power for such water rights is with the Colorado Water Conservation Board with a traditional orientation to irrigation and municipal water needs. Under this condition, the acquisition of rights by private environmental groups instead of by a public agency may serve well the policy intent (Livingston, 1987: 293).

from the sample countries to quantitatively evaluate the casual linkages among water institution components and their implications for water sector performance.

The evaluation of institutional linkages and their performance implications will be done within a 'pattern model'. The 'pattern model' is very useful in describing the form of analysis that links various elements of a general pattern together by logical connections (Fusfeld, 1980: 33). Given the multi-casual nature of the relationships of such model, it remains always 'open' as it cannot include all the variables and relationships of relevance and also requires multidisciplinary approach (Wilber and Harrison, 1978; Caldwell, 1982). Ruttan (1999) uses the pattern model to show the multi-casual relationships among resource endowments, cultural endowments, technology, and institutions. E. Ostrom (1990: 214) uses a 'framework' rather than a 'model', as one cannot encompass the degree of complexity of institutional linkage within a single model. In a broad sense, the framework conception of E. Ostrom (1990) resembles the pattern model insofar as both encompass within themselves a set of logically linked relationships. Obviously, the 'pattern model' and the 'framework' can be specialized to characterize the intrinsic linkages among various components of institutions themselves. It is this approach that we rely on for the characterization and evaluation of institutional inter-linkages within water institutions and their implications for water sector performance.

Finally, the analysis of successful and unsuccessful episodes of policy reform is one of the standard approaches in the study of political economy of policy reforms (e.g., Nelson, 1990; Bates and Krueger, 1993; Haggard and Webb, 1994). Success stories and anecdotal cases will also be used for illustrating various kinds of casual relations within institutions and between institutions and economic performance.

Subjective Perception

Subjective perception plays a powerful role in institutional choice and change. According to North (1990a: 43), when formal institutions make it possible for individuals to express preferences at little cost to themselves, then, indeed the subjective preference of individuals can play a big role in institutional change.[10] North's (1990a: 17) idea on the role of the "mental construct" and "subjective model" in the process of institutional change is related to Veblen's (1919: 239) notion of "the prevailing habits of thought" as well as Commons' (1934: 69) idea of "habitual assumptions". The same can also be said about the role of learning and knowledge in institutional change.

Interestingly, Commons (1934: 654) links the ideology, habitual assumptions, and knowledge within a single process as he views ideological evolution as a process of modifications in "habitual assumptions" brought about by experimental problem solving by individuals, organizations, courts, and governments. Veblen (1919: 239) defines institutions as "settled habits of thought common to the generality of men". Similarly, Commons (1934: 69) considers behavioral habit and institutions are mutually self-reinforcing. Although the new

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[10] North (1990a: 43) sights voting and life time tenure for judges as instance for formal institutions that lower the cost of acting on one's convention.

institutional economics does not include habit in the definition of institutions, North (1990a) places a strong emphasis on the 'mental construct' or the 'subjective model' of individuals as a major factor affecting institutional change. According to Hodgson (1998: 181), "[i]nstitutions, are both "subjective ideas" in the heads of the agents and "objective" structures faced by them". The agents and structures, though distinct, are connected in a circle of mutual interaction and interdependence (Bhaskar, 1979; Hodgson, 1998: 181).

Bromley (1989b) assigns an important role to 'collective attitude' as a source of institutional change. The attitudinal change of the society acquires power to induce institutional changes because most people including those in the interface between public perception and political decision-making process concur on the need for change. In other words, the mental constructs of reality of most individuals converge on the issue of undertaking the change. In this sense, there is a clear conceptual link between the role of 'collective attitude' and the role of the 'subjective model' or 'mental construct' of individuals underlined by North (1990a). Both these perspectives, however, relate to the first and second stages of institutional change, i.e., the perception change and its political translation and articulation, that together determine the direction and effectiveness of the both the procedural and substantive changes in institutions.

The political entrepreneurs—whether a government, legislators, or a set of experts, technocrats and opinion-makers—can provide the initiatives for institutional change. Such initiatives can be considered as a pubic good. Whether or not these political entrepreneurs work for institutional change and provide the public good depends not on any comprehensive benefit-cost analysis but on their perception of a tangible political benefit to themselves or their political parties or groups (Knight and Sened, 1995a: 12). In this context, the convergence of social expectation play an important role, even though such a convergence is no guarantee for institutional convergence (Knight and Sened, 1995b: 12). This is due to the notion of path dependence, which leads that at any stage of the history of institutional evolution; there will be multiple equilibrium. Still then, the institutional equilibrium at each stage of institutional evolution has a significant effect on the evolution of institutional structures in the future. Therefore, the final institutional structure may not converge to any specific form (Knight and Sened, 1995b: 13). Although most technical literature on institutional structure takes a very deterministic approach, non-deterministic aspects of human interactions such as natural fortunes and misfortunes of individuals (or, even of the entire community) as well as the ingenuity of those who construct the institutions can not be dismissed.[11]

The divergence in the subjective perception also gets often minimized due to both cultural influences as well as by the state or other moral authorities that reduce the transaction costs and motivate people to collective action (Bates, 1994). In addition to cultural and political influences, information flow and learning can also contribute to convergence in perception. Although the subjective perceptions of actors are culturally derived, they, however, undergo continuous modifications through experience and information. The lower the cost of

[11] In the sense, forming institutions is an art not a science (Knight and Sened, 1995: 13).

the information, the faster will be the alterations in subjective perceptions (North, 1990a: 138). The change in the subjective perception of actors remains as the source for changes in attitudes and ideologies and depending on the nature of these changes, the cost of institutional transactions can either increase or decline.

Human behavior both influences and is being influenced by institutions. The rationality postulate assumes that the actors posses cognitive capacity to see the true models of the world about which they make the choices or at least that the actors receive information with which they can correct the initial model, when it is different from the true model. Unfortunately, since the information being received is incomplete, the subjective models of individuals diverge from those of the others and, in most cases, show no tendency to converge (North, 1990a: 17). From the perspective of our study what this means is the fact that the divergent tendencies of the subjective models of individuals ensures that the analysis of perception-based data need not lead to self-fulfilling prophecies.

Institutions incorporate values and processes of normative evaluation. Since institutions reinforce their own moral legitimacy, that which endures is often—rightly or wrongly—seen as morally just (Hodgson, 1998: 179). From this perspective, the institutions that are being adopted by more countries or contexts tend to gain legitimacy and so does those that are found or projected repeatedly as the best form in various national and international fora. Since these considerations shape the ideas and influence the judgmental values of the respondents, international and inter-personal interaction and knowledge flow tend to create certain amount of regularity in the evaluation pattern of respondents. However, we hasten to add that the general tendency in the convergence in the choice and values of the experts on institutional configurations does not negate the potential for divergence. Such divergence emerges from practical experience with poorly performing best institutions due to contextual and implementation snags and other ideological orientation. Knight and Sened (1995b) alludes to the slippage in the socially shared knowledge of the concerned rules as one of the explanation for the violation of even self-enforcing institutions. According to Knight and Sened, such slippage comes from "lack of knowledge of these rules on the parts of members of the community, or from the differences in the part of the substantive content of the rules (Knight and Sened, 1995b: 11).

Institutional Transaction Cost

Of particular relevance from the perspective of macro institutional structures are the theories related to institutional transaction cost and governance perspective. The transaction cost economics approach that originated from Coase (1937) and developed by Williamson (1975 and 1985) was applied originally to explain the evolution of market and non-market organizations. Although the approach has a bearing on the relationship between transaction costs and institutional evolution, it captures the transaction costs only within the existing institutional environment but faces problems in capturing the transactions pertaining to the creation of new institutional arrangements as well as the modifications of existing institutional environments. In the context of such institutional transactions, there is a problem of complicated and hierarchically inter-related choice among institutional alternatives, institutional configurations, and the methods of their implementation.

The organization theory within the transaction cost economics focuses mainly on the changes in the contractual relations within a given institutional arrangement.[12] As a result, although governance perspective and transaction cost economics are interdisciplinary in nature, focusing on economics, law, and organization, they are unable to account for the political economy aspects of institutional change. In contrast, the political economy aspect is central in the new institutional economics approach that deals with how the governance structure and other extraneous factors lead to or shape the changes in the institutional environment itself (North, 1990a). Extraneous factors include not only the role of war, revolution, natural calamities, and bilateral and multilateral agreements (contracts) but also the physical and social attributes of the economy within which the institutional environment evolves and governance structures operate.

While recognizing the limitations of the transaction cost economics approach, Williamson (1985: 393) has himself noted that although it is "useful for displaying the core features of the contract, interdependencies among a series of contracts may be missed or undervalued as a consequence". This incompleteness of the approach is especially serious, as it is not capable of capturing the transaction cost implications of institutional inter-linkages and nestedness. While the institutional inter-linkages can be demonstrated both analytically as well as with historical case studies, they are rather difficult to be quantified. Experimental approaches and survey methods can provide some initial break through in this respect and could also provide information for institutional design aspects. There are reservations as to whether the transaction cost approach can incorporate institutional and organizational change.[13] But, North and Thomas (1971) generalized the transaction cost idea to capture the total costs of establishing the legal and enforcement mechanisms that support market transactions.

Transaction costs are opportunity costs, just like any other costs in economic theory. There are both fixed and variable transaction costs.[14] Transaction cost refer essentially to the effort, time and expense necessary to obtain the information necessary to make an exchange, negotiate the exchange and enforce the exchange (Williamson, 1985: 2). The exchange can also include the enactment of laws, declaration of policies, and the creation of organizations. Obviously, all the relevant transaction costs cannot be fully accounted just in narrow economic terms because institutional transactions, like other transactions are embedded within the normative and cultural systems of the society (Commons, 1934; Granovetter, 1985). Transaction costs—related to both commodity and institutional transactions—are influenced by four variables, i.e., the cost of measuring the valuable attributes of a commodity or service, the

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[12] This is the fact that underlies the assertion of transaction cost economics that each generic mode of governance is supported by a distinctive form of contract law (Williamson, 1994: 16).

[13] For a set of papers that make such reservation, see Groenewegen (1996).

[14] See Dahlman (1979) for various definitions of transaction costs.

size of the market, the need for monitoring and enforcement, and the ideological attitudes (North, 1997: 2-3).[15]

The emphasis on the ideological variable by North (1990a and 1997) assumes theoretical and practical significance. What is more significant is the direct relationship between the level of transaction costs as determined by the first three variables and the importance of the ideological variables that North (1997: 3). Thus, ideology counts the most when the measurement and enforcement costs are the highest and *vice versa*.[16] Ideology is related to the subjective models that individuals possess to explain and evaluate the world around them and also involve non-economic aspects and motives. As such, its incorporation enables the theory of transaction cost economics to be more realistic in explaining institutional choices both from an economic, social, and political perspective.[17] Since the cost of transacting in political markets is very high even in most perfect political markets (North, 1990: ch.12), the political actors have substantial degree of freedom and they are far less constrained by constituent pressure (Bates, 1989; North 1990a). In these circumstances, the issues such as leadership and its commitment to reform as well as the pressure from international actors become far more important than otherwise.

Three other factors can also raise the transaction costs. They are the opportunism, frequency of exchange, and assets specificity. The last factor raises the transaction cost because the exchange in question depends on the specific person, specific location, or specific physical assets. In this condition, the bargaining ability becomes low and the potential for opportunism becomes high (Acheson, 1994b: 11). Many sociologists and anthropologist (e.g., Granovetter, 1985; Douglas, 1987) find the emphasis on opportunism is missing the neutralizing role of social and cultural factors within which the economic relationships are embedded. Rules or institutions that make the activities of others more predictable can reduce the transaction costs. In contrast to the transaction cost in commodity exchange, those related to institutional exchange or reform can be reduced by factors such as increasing returns or scale economies in institutional change (North, 1990a: 95). Moreover, the institutional transaction cost can also be minimized through better institutional design and sequencing. But, this requires a clear understanding of the structure and composition of existing institutions and their relationships with those of the proposed institutions. In other words, a greater knowledge on the specific

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[15] In the context of institutional transaction, as we can see, the transaction costs are influenced by the attributes of institutions such as their structure, linkages, and embedded characters as well as the size of the political market as characterized by the number of groups demanding institutional change.

[16] The importance of ideology also increases with a declining cost of conviction (ideas, dogmas, and prejudice). See North (1990a: 40 and 1997: 5) for the elaboration of this point and Nelson and Silberberg (1987) for empirical evidence.

[17] Three other factors can also raise the transaction costs. They are the opportunism, frequency of exchange, and assets specificity. The last factor raises the transaction cost because the exchange in question depends on the specific person, specific location, or specific physical assets. In this condition, the bargaining ability becomes low and the potential for opportunism becomes high (Acheson, 1994b: 11).

features of the institutional asset can reduce the costs of transacting the institution in any given context.

The coordinating, enforcing, and adapting functions of institutions are associated with costs that are affected by the structure of property rights in particular and institutions in general (Eggertsson, 1990). This means that given a particular condition of the physical and socio-political environment, each distinct institutional structure is associated with a given level of transaction cost. Obviously, the level of transaction costs associated with a given institutional structure can vary depending upon the changing physical and socio-political environment within which it is embedded. As long as the level of change in transaction costs exceeds the potential benefits to be gained from an alternative institutional structure, there is an economic incentive for institutional change.

The state has a double-edged role with respect to institutional transaction costs. According to North and Thomas (1973: 8), "[e]conomic growth will occur if property rights make it worthwhile to undertake socially productive activity. The creating, specifying, and enacting of such property rights are costly.... As the potential grows for private gains to exceed transaction costs, efforts will be made to establish such property rights. Government can take over the protection and enforcement of property rights because they can do it at a lower cost than private volunteer groups". But, unfortunately, "the fiscal needs of government may induce the protection of certain property rights which hinder rather than promote economic growth...".[18]

As we decompose institutions and understand their structure and sequential linkages, we encounter another but nontrivial form of path dependency that is of critical value for institutional design from the perspective of planned or induced institutional change. Since the choice of the individual institutional component determine its subsequent choices, both the direction and speed of institutional change can be influenced by a careful choice of vital institutional components or their sequence. The familiar example is the role of property rights as a necessary condition for the emergence of market institution. Here, path dependency is related to the particular sequence in which institutional components are created to have an institutional structure with a better performance. Path dependency of this nature is, therefore, equally important for institutional performance. As we categorize institutional components or aspects in terms of their performance implications, political feasibility, and upstream and downstream linkages with their counterparts, it is possible to identify various schemes of institutional sequencing and prioritization and select among them the one with the least transaction costs and most political acceptance. Since the choice here is not among institutional components and aspects but among their sequentially linked configurations, the transaction costs include both the effects of scale economies as well as political feasibility. Since transactions are embedded within the social and cultural context, the transaction costs are also

[18] Although North and Thomas (1973) consider only the fiscal needs of the government as the main reason for inefficient institutional outcome, others (e.g., North, 1981, 1990a, and 1990b; Olson, 1982; Eggertsson, 1990) recognize the role of interest coalitions and the susceptibility of government to interest group politics.

influenced by reputation and credible commitments (Williamson, 1994) as well as social capital such as moral standards or shared norms and trust (Coleman, 1987 and 1990; Yaffey, 1998).

INSTITUTIONAL DECOMPOSITION: PREVIOUS ATTEMPTS

The inter-linked and nested nature of institutions makes it difficult to evaluate their individual and joint performance. One approach to solve this problem is to decompose institutions into its major components and sub-components and, then, trace the linkages among them. Institutional decomposition can proceed either from an *abstract schema of institutions* or from a *typology of institutions* (Levi, 1990: 405). These strategies are not alternatives but complementary in the sense that the institutions can be decomposed first into components and different typologies can then be identified for each institutional component.

The emphasis on rules-based conception of institutions should neither divert our attention on the distinction between institutions as rules and other institutional arrangements necessary for enforcement and monitoring nor the variations among different kinds of institutions (Levi, 1990: 404). For incorporating the institutional variations as well as for the generalization to the context of macro institutions, we can follow a component or aspect-based decomposition of institutions instead of the rule-based decomposition. The rule-based decomposition and component or aspect-based decomposition are related as we view each of the functional components or aspects as defined by a particular set of rules or their configurations.

The issue of institutional decomposition and the performance implications of the linkages among them have also received some attention in the institutional economics literature. But, the attempts at the analytical decomposition of institutions are either too broader or too narrow and micro in focus. Institutions are decomposed in varying levels of abstraction and detail depending upon the way the institutions are conceived and the level at which they are evaluated. Institutions are conceived predominantly as rules (e.g., Buchanan and Tullock, 1962; Shepsle, 1979; Ostrom, 1990), norms emerging from social conventions (e.g., Schotter, 1981; Axelrod, 1984; Coleman, 1990), and the macro level characteristics of economic and political structures (e.g., Weaver and Rockman, 1993). On the other hand, institutions have also been conceived in the broadest form as comprising of both formal rules, informal rules (norms), and economic and political organizations (e.g., North, 1990a; Williamson, 1975 and 1985).

Institutions are also viewed purely as a system of property rights. For instance, by taking a very broad view of property rights, Bromley (1993: 133) classifies institutions into institutional rights, i.e., those that are "concerned with negotiations and bargains over the structure of choice sets", and commodity rights, i.e., those that are concerned with "market transactions from within choice sets". It is on the basis of this classification, he has distinguished between 'institutional transactions' and 'commodity transactions'. From a micro perspective, since institutions are generated from the aggregation of networks of contracts or "nexus of contracts" (Williamson, 1990), they can also be decomposed in terms of a set of embedded contracts. For instance, using a micro- analysis of incomplete institutions from a theoretical perspective, Landry (1996) explains the differences between contracts and structures (set of contracts) and shows how formal rules can be added to enhance the rational choice of individuals.[19] The focus on the institutional structure is certainly interesting. But, the still more interesting aspect, i.e., the process by which the added formal rules enhance institutional linkages and institutional intensity and reduce, thereby, uncertainty, is still missing in the theoretical attempt of the micro-analysis of incomplete information.

Although institutions are usually treated as a single entity, in reality, they are made up of analytically and functionally distinguishable components. North (1997: 4), who talks explicitly of the 'composition of institutions', provides a basis for decomposing institutions into their major components. Formal rules are also further decomposed into "political and judicial rules, economic rules, and contracts" and the political rules are, in turn, further decomposed into "the hierarchy of polity, its basic decision structure and the explicit characteristics of agenda control" (North, 1997: 4). Even though these decompositions are very broad and indicative, the important point to note here is that the administrative structure dealing with the decision process is included as part of the formal rules. From this perspective, we encounter the first and broadest decomposition of institutions in terms of rules, norms, and organizations.

The laws and constitution, the key components of the institutional environment are not self-enforcing. Organizational mechanisms are, therefore, needed for their enforcement and also for resolving conflicts. Such mechanisms, though have the advantage of correcting some of the defects of the legal system, they (when they are themselves defective) can, nevertheless, make a better law ineffective as well (Williamson, 1994: 18-19). This shows the key role that organizations or institutional mechanisms play in determining the strength of institution-performance linkages. In contrast to the legal components of the institutional environment, the political components create a governance structure that both allows the society to deal with the emerging problems as well as ensures a degree of durability to economic and political rights (Weingast, 1993: 288). Unfortunately, the political institutions often become susceptible to the prevailing power structure as determined by the relative bargaining strengths of political and economic groups (Levi, 1990).[20]

Feeny (1993) and Clague (1997b) identify three categories of institutions, i.e., constitutional order, institutional arrangements, and cultural endowments. The cultural endowment forms part of the social capital (Coleman, 1987 and 1990). Since the constitutional order and cultural endowments change rather slowly (except in extreme cases of revolution or disasters), the focus of much of the literature on institutional innovation and change is on institutional arrangements (Clague, 1997b: 18). Coriat and Dosi (1998: 6) distinguish three

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19 These rules pertains to coordination, warranty (or assurance), monitoring, sharing of benefits, and the duration of the contracts. Note that different combinations of the variants of these rules produce different structures of contract (Landry, 1996: 26).

20 While institutions create social order, they also create unequal bargaining power and access to coercive powers. The redistribution of the coercive and bargaining resources of power within the institution itself is an important source of institutional change (Levi, 1990: 403).

components of institutions, i.e., formal organizations (e.g., firms, other social and economic organizations, and state), shared pattern of behavior (e.g., routines, social conventions, and ethical codes), and norms and constraints (e.g., moral prescriptions and formal laws). Note here that institutions are considered to include organizations as well as individual actors.

Yet another, again a broader, decomposition is in terms of the distinction between institutional environment and institutional structures (North, 1990a, Bromley, 1989, and Williamson, 1994). This decomposition, as we know, is basis for the development of transaction cost economics dealing with the interaction of institutional structure or governance structure covering economic and political organizations with the institutional environment as defined by formal rules (laws and declared policies) informal rules (conventions and norms).[21] Even with the a simple and rather broad decomposition of institutions into institutional environment/framework and institutional arrangements, Williamson (1975 and 1985) is able to provide a new insight into the economic and institutional implications of the interaction between the two segments within the transaction cost framework.

Institutional arrangements are also categorized into emblematic forms such as state, markets, hierarchies, contracts, networks, community, and associations (Landry, 1996; Williamson, 1999; Boyer and Hollingsworth, 1997b). These institutional forms including the state, market, and hierarchies are interrelated. Comparatively high performance can also be achieved by exploiting the competitive and cooperative relationships that exist between the polycentric governance structures consisting of federal, state, and local governments as well as various forms of non-governmental enterprises (V. Ostrom, Tiebout, and Warren, 1961: 831). However, they also differ in terms of their basic features and performance implications.

Boyer (1987: 127) identifies different 'regimes of regulation'[22] that captures the specific characteristics in the "mechanisms and principles of adjustment associated with the configurations of wage relations, competition, state interventions, and hierarchization of the international economy". Here, the decomposition is in terms of institutionally distinct configurations of market, hierarchies, and state interventions on the geographic plane. Coriat and Dosi (1998: 10) also attempt a similar kind of taxonomic decomposition of 'regimes of accumulation' in terms of distinct set of institutional arrangements. White (1990: 109) provides another instance of decomposition when he makes a detailed mapping of various aspects of the policy arena in a generic context. Although it is not exactly a decomposition of institutions, the work is still instructive in that it shows how a complex situation can be understood better with an ubundling or unpacking exercise.

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[21] Unfortunately, in his analysis of governance structures, Williamson (1975 and 1985) considers the institutional environment or institutional framework as given (North, 1990b: 392). While it is true that Williamson (1993 and 1994) recognizes the important interaction between the governance structure and institutional framework, his main concern is on explaining alternative modes of governance structures within a given institutional framework.

[22] The term 'regulation' here does not mean the legal regulatory apparatus but used to capture the notion of system theory that different parts of the process, under certain conditions, reciprocally adjust yielding certain orderly dynamics (Coriat and Dosi, 1998: 9).

Hodgson (1998: 173) indicates the functional separation of financial and industrial institutions as well as the sparse nature of the institutional connection. Williamson (1985: 73-78) also categorize governance structures into market governance, bilateral governance, trilateral governance, and unified governance. As we know from neo-classical literature that the market itself assumes various forms ranging from perfect competition to monopoly and similarly, the hierarchies also have a variety of forms (Williamson, 1975: 151-154). One way of identifying the broad typologies of institutional arrangements is to classify them in terms of how they relate the pursuit of individual self-interest with the principle of coordination (Boyer and Hollingsworth, 1997a: 51). Using different modes of coordination and the number of organizations as classificatory criteria, the Hage and Alter (1997: 100&116) identifies the typologies in the particular context of inter-organizational relationships and networks in terms of symbiotic and competitive linkages and alliances.

Broader decomposition, though useful, requires further and finer decomposition for deeper understanding of the strategic value and performance implications of institutional linkages and their mutually nested and embedded features. In this respect, stylized and taxonomic categorizations are very important for indicating various possible alternative or complementary forms an institutional component or sub-component can take. It is now necessary to advance the analytical focus to the still more interesting but less studied aspects of tracing and evaluating the performance implications of the linkages among these taxonomies or institutional components. The two segments of the institutional sphere (i.e., institutional environment/framework and institutional arrangements) can be decomposed further. For instance, the institutional arrangements are classified into economic and political organizations and the economic organizations are, in turn, classified further into the alternative modes of governance: Markets, hierarchies, hybrids and state are the broad typologies or taxonomic categories of the institutional arrangement. The 'regimes of regulation' identified by Boyer (1987) and Coriat and Dosi (1998) characterize actually some of the configurations of various combinations of these modes of governance.

In a similar vein, the institutional framework or the environment can also be decomposed further into broad categories like formal rules (constitution and other laws, contracts, and declared policies), informal rules (shared values, social conventions, and social capital such as norms, trust, and moral codes of conduct), and enforcement mechanisms. Each of these categories can also be decomposed into still finer categories depending upon the analytical requirement. For instance, the property rights system, one of the many important components of the legal system, can be classified into some of the feasible forms or types that can range from open access system to private property rights system (Hanna, et al., 1996: 4-5; Bromley, 1989: 204-206).

Another way for decomposing institutions is to place them in one of the three categories: (a) social mores and norms, (b) laws and regulations, and (c) contractual arrangements intended to effect transaction (Adelman and Head, 1983).[23] Another simple approach is to classify institutions from a disciplinary perspective as social, political, and economic institutions. But, this is a mere pedagogical classification as they are form part of an overall structure for regulating different kinds of social, political, and economic interactions or transactions among individuals and groups.

Utilizing the IAD framework, E. Ostrom and her co-workers (see E. Ostrom, 1986, 1982, 1990, and 1999; E. Ostrom, Gardner, and Walker, 1990 and 1994) have also made an interesting and very original attempt at institutional decomposition. They have distinguished the institutions from their physical and social environment and decomposed institutions into three hierarchically related categories: constitutional-choice rules, collective-choice rules, and operational rules. Since the physical and social factors define the overall institutional environment itself, they have a powerful influence at all these three level of institutional analysis (E. Ostrom, Gardner, and Walker, 1994: 37; E. Ostrom, 1999: 60-61). In a general sense, these three sets of rules can be approximated in terms of laws, policies, and administrative mechanisms.[24] Such an approximation is also consistent with the layer schema depicted in Figure 2.1 as the laws and policies form part of the institutional environment and the administrative or organizational mechanisms form part of the governance structure.

Continuing with their conception of institution as a set of rules, E. Ostrom and co-workers have also decomposed institution as comprising of seven sets of rules that together determine the action situation. These seven rule configurations are the position rules, boundary rules, scope rules, authority rules, aggregation rules, information rules, and payoff rules.[25] As we can see, when these rules are known, it is possible to trace the possible linkages among them and also to identify various rule configurations each defining a different institutional arrangement. This is easy to do in a micro context of specialized institutions. But, it is rather difficult to operationalize such an approach in a macro context involving many institutions and rule configurations. Apart from the fact that these rule configurations represent essentially the decomposition of only the institutional environment, the exercise can be attempted mostly in the micro context of local common pool resources.[26]

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[23] The first two categories define the 'rules of the game' within which category (c) takes place. It is the confusion of (b) with (c) that leads the confusion of institutions with mere property rights as in the case of both neo-classical economics and public choice theory.

[24] This is because the laws are nothing but the outcome of constitutional choice as policies are the results of collective choice whereas the operational rules comes into play when the laws and policies are operationalized by the administrative mechanisms involved in monitoring and enforcement. The laws and policies are also related in so far as the policies are the political translation of laws and policies of fundamental importance often get formalized as laws.

[25] The structure of any action situation is also an outcome of the interaction that these rules have with both physical and behavioral laws (E. Ostrom, Gardner, Walker, 1994: 41-42).

[26] Theoretically speaking, it is possible to apply the framework of institutional decomposition at the macro level. But, it is practically difficult and unmanageable. Besides, since the framework focuses mainly on how outcomes vary under different set of rules rather than how they induce the players, as individuals and groups,

The significance of the analytical distinction between these broad components of institutions discussed above emerges from the fact they vary in terms of their amenability to purposive modifications, rate of change, level of operation, and enforcement characteristics. Unfortunately, this decomposition—being very broad and abstract—makes it rather difficult to clearly trace and demonstrate the linkages except in a few micro situations and narrow contexts. Although such decomposition can be specialized to micro contexts, it is still too broad and way beyond the scope of any single work to identify and capture the intricacies of institutional linkages and their performance implications. For the purpose of gaining practical insights into the issue of institutional inter-linkages and their implications for institutional packaging and sequencing, there is a need for further and finer decomposition of both the institutional environment and institutional structures. For a manageable analysis, however, it is necessary that the decomposition exercise is focused on the main parts of the institutional environment and institutional structures and performed in a more specific context (e.g., water institutions, trade institutions, and environmental institutions). This is what is being attempted in the ensuing chapter.

to change those rules, it has limited value for providing policy insights needed for initiating institutional change, especially from a macro perspective. However, the notion of generic rules does enable the comparison of institutions and their variants operating in varying contexts (Landry, 1996: 15).

Chapter 4

ANALYTICAL FRAMEWORK AND EMPIRICAL MODELS

Having discussed the theoretical and empirical context as well as the methodological basis of our study vis-à-vis other studies within the existing literature in the previous chapters, the present chapter attempts to outline the analytical framework and identify a set of empirical models of institution-performance interaction. Since institutions are entities defined by structurally linked *institutional components* and *institutional aspects*,[1] the analytical framework is based on a decomposition of both water institution and water sector performance into their major analytical components and aspects. The methodological purpose of such decomposition exercise is twofold. The first objective is to demonstrate the various layers of institutional inter-linkages and institution-performance linkages evident in the process of institution-performance interaction within water sector, and also to identify the influence that some of the factors exogenous to both water institution and water sector have over the interaction process. The other objective is to provide an analytical basis for defining a set of institutional, performance, and exogenous variables that are useful for developing empirically testable models that capture some of the most important facets of the process of institution-performance interaction.

ANALYTICAL FRAMEWORK

The analytical framework underlying the evaluation methodology involves three steps. First, the concepts of 'water sector', 'water institution', and 'water sector performance' are defined to set the broad contour of analysis. Second, water institution and water sector performance are conceptually decomposed to identify some of their major components and sub-components (or, aspects). And, finally, the decomposition exercise is used as a basis to analytically highlight various layers of institutional inter-linkages and institution-performance linkages evident within water sector.

Water Sector and Water Institution: Conceptual Basis

For the purpose of this study, water sector is considered to cover all consumptive uses of water such as irrigation, domestic consumption, and industrial use from both surface and sub-surface sources as well as reclaimed or recycled sources. The non-consumptive uses such as power generation, navigation, and ecological water needs are considered but only to the extent they influence the dominant consumptive uses either directly or indirectly. Although the macro perspective entailed by a broader concept of water sector involves an obvious sacrifice of micro details, such a perspective is taken deliberately to sharpen the

[1] The distinctions between institutions, institutional components, and institutional aspects will be made clear when describing the analytical decomposition of water institution in a subsequent section below.

focus on the main thrust of this study, i.e., the evaluation of the process of institution-performance interaction within water sector.

Consistent with the institutional economics literature that was reviewed in earlier chapters, institution is conceived in a much broader sense than mere organization. Since institutions set the rules of the game and define, thereby, what individuals can and cannot do in given context, they, in effect, delineate the action sets for both individual and collective decision-making (Commons, 1968; Bromley, 1989a and 1989b; North, 1990). Institutions are influenced by a variety of factors such as historical precedents, constitutional provisions, political arrangements, demographic conditions, resource endowment, and economic development. Since the influence of these factors are formalized into three inter-related aspects, i.e., legal frameworks, policy issues, and administrative arrangements, institution can be conceptualized as an entity defined interactively by three main components, i.e., law, policy, and administration. As we specialize such a general notion of institution to the particular context of water sector, water institution can be characterized in terms of water law, water policy, and water administration.[2] As in the case of water sector, water institution is also approached from a national perspective. Besides, water institution as used in this study covers only its formal dimensions, i.e., formal water law, water policy, and water administration but excludes their informal counterparts such as conventions, customs, and administrative traditions. Since the formal dimensions of water institutions, unlike their informal counterparts, evince remarkable stability and regional similarity, they are more opt for the purpose of establishing an internationally comparable standard characterization and decomposition.

Water Institutions: Some Special Features

An important distinction of water institutions is that unlike the case of general social and economic institutions, informal and local level rules and conventions change relatively faster as compared to formal and macro level rules that are beset by political economy constraints.[3] Although this feature of water institutions provide one important exception to the observation of North (1990a: 45) that informal rules change slowly, it still does not contradict his main point that formal and macro level rules are more amenable for purposive modification as compared to informal rules. Further, from the perspective of

[2] Note that water institution is also influenced by non-water-related legal, policy, and administrative aspects (e.g., constitution, and land and environment laws, agricultural and fiscal policies, and agricultural and credit administrations). As such, the influence of these aspects has also to be taken into account when dealing with water institution and its performance.

[3] Instances for this fact include the emergence of local level water sharing arrangements among users including informal water markets in many parts of the world even in the face of no formal water laws and policies (Easter, Rosegrant, and Dinar, 1998). Similarly, the innumerable instances of collective action in the context of water resources in particular and common pool resources in general can also vouch for the relatively faster changes of informal and local rules as compared to formal and macro level rules (Ostrom, 1990).

theoretical and empirical evaluation, formal rules are also more consistent with the transaction cost framework as compared to informal rules where neo-classical approach and its extensions including transaction cost framework fail to be effective (Eggertsson, 1996). Another practical consideration is that the variety and diversity of informal institutions also present problems for cross-country comparison and evaluation. It is these theoretical and practical considerations that our study focuses only on formal and macro level institutions rather than micro level informal institutions.

According to North (1990a), any institutional form needs to be organized on a clear distinction between two levels: the rules of the game and the interaction of individuals and groups within the institutional setting. Williamson (1975 and 1985) developed the distinction further by delineating the governance structure from the rules of the game and also showed how the former evolves within and also changes the institutional setting from without. As we transpose this into water sector context, the rules of the game covers not only the legal and policy aspects but also the administrative system influencing water sector so that the interaction of users—either as individuals or groups—becomes distinguished.

Notwithstanding the crucial distinction between institutions and organizations (e.g., Bromley, 1989b: 740; North, 1990a: 7), there are many practical and analytical reasons for including water administration as a part of the institutional environment rather than as a part of the institutional arrangement governing the water sector. It is true that the components of water administration are being defined by water laws and water policies that characterize the institutional environment. But, since they are defined and created for the translation and enforcement of the legal and policy provisions, they should be considered actually as a part of the institutional environment. From another perspective, it is also true that water administration, represented by public sector bureaucracy in most contexts, itself becomes another player with a vested interest in enhancing and protecting its power and influence. But, the vested interests of water administration relate mainly to budgetary allocations and inter-bureaucracy competition for power rather than to water allocation and use. From the perspective of water use and allocation, therefore, they become part of the rules of the game rather than part of the players. These important distinctions between water institution and general institutions need to be understood well while delineating the institutional environment from the institutional arrangement in the particular context of the water sector.

Based on the considerations noted above, water institution can be decomposed into three broad components: water law, water policy, and water administration. While water law captures the legal framework of the water sector, water policy represents the political translation of water law. Water administration, on the other hand, can be considered as the executive arm for the enforcement, implementation and monitoring of both the legal and policy provisions. For instance, Saleth and Dinar (1999b) have decomposed each of these broad institutional components further into several institutional sub-components or aspects. Thus, property rights system and conflict resolution mechanisms can, among other things, form as sub-components of water law. In the case of property rights, it is possible to identify typologies in term of water rights format such as appropriative rights, riparian rights, etc. It is possible to see each of these components and aspects as a set of rules or their configuration. That is, in terms of the approach of E. Ostrom and her co-workers, water law can be seen as a part of 'constitutional choice rules', water policy as part of 'collective choice rules', and water administration as part of 'operational rules'. As such, it is possible to trace and evaluate the institutional inter-linkages as well as their performance implications with no loss of generality.

From a more general perspective, with a decomposition of institutions into components, sub-components (aspects), and typologies, it is also possible to identity broad macro level institutional typologies. Each of these typologies is characterized by a combination of the institutional components and aspects as well as and micro-typologies. It is important to recognize—especially given our discussion on the nature of institutions (see chapter 2) and institutional decomposition (see chapter 3)—the embedded character of water institutions. Water institutions, like any other institutions, are also embedded within the social and cultural milieu, resource realities, the political conditions, as well as other social and economic institutions. From the viewpoint of the performance of water institutions, these aspects forming as the exogenous factors have a strong influence both on the nature/operation of water institutions and on the performance of water sector.

Water Institution: Analytical Decomposition

The analytical decomposition of water institution is done at two stages. First, water institution is decomposed into three broad *institutional components*, i.e., water law, water policy, and water administration. And, then, each of these institutional components is decomposed further to identify its constituent *institutional aspects*.[4] While it is easy to identify all the institutional aspects involved in each of these three components of water institution, it is rather difficult to consider all of them within a single and tractable framework. For a focused and manageable evaluation, therefore, it is necessary to concentrate on some of the major institutional aspects. It is desirable from a policy perspective that the institutional aspects selected for a focussed treatment are those which are noted frequently as the key factors influencing the overall performance of both water institutions and water sector. The institutional aspects that are finally selected under each of the three institutional components of water institution are given below.

The **water law** component of water institution includes the following law-related institutional aspects:

(a) Legal treatment of water and related resources,
(b) Format of water rights,
(c) Provisions for conflict resolution,

[4] Notice the way the concepts of 'institutional components' and 'institutional aspects' are used in this study. While the former is used to denote a broader decomposition of water institution, the latter is used to denote a further decomposition of the three water institution components. Thus, the latter can also be used denote a finer decomposition of water institution *per se*.

(d) Provisions for accountability,
(e) Scope for private sector participation,
(f) Centralization tendency, and
(g) Degree of legal integration within water law.

Similarly, the **water policy** component of water institution includes the following policy-related institutional aspects:

(a) Project selection criteria,
(b) Pricing and cost recovery,
(c) Inter-regional/sectoral water transfer,
(d) Private sector participation,
(e) User participation, and
(f) Linkages with other economic policies.

Likewise, the **water Administration** component of water institution includes the following administration-related institutional aspects:

(a) Spatial organization,
(b) Organizational features,
(c) Functional capacity,
(d) Pricing and finance,
(e) Regulatory and accountability mechanisms, and
(f) Information, research, and technological capabilities.

As can be seen, the institutional aspects selected for evaluation here capture some of the policy issues that dominate the current debate on water sector reform. These issues are; integrated water resources management, conflict resolution, accountability, financial viability, decentralization, and capacity building within water sector. All these issues also have a strong bearing on the overall performance of both water institution and water sector. The coverage of water institutional aspects can, therefore, be considered adequate to evaluate most of the currently relevant policy issues operating in the interface between water institutions and water sector performance.

Besides these institutional aspects, there is also a need for a set of **performance aspects** to capture the overall effectiveness or performance of not only each of the three institutional components but also water institution taken as a whole. They are as follows:

(a) Overall effectiveness of water law,
(b) Overall effectiveness of water policy,
(c) Overall effectiveness of water administration, and
(d) Overall effectiveness of water institution.

The overall effectiveness of each of the three institutional components depends not only on the effectiveness of its constituent institutional aspects but also on the strength of their linkages with other institutional components. Similarly, the overall effectiveness water institution depends on both the individual and interactive effects of the performance levels of the three institutional components. In this way, the overall performance of water institution is linked ultimately to both the individual and joints effects of the institutional aspects underlying all the three institutional components. In addition to the direct impact of institutional components and their underlying institutional aspects, the performance of water institution is also influenced by the general socio-economic, political, and resource-related environment within which it operates.

Although the overall performance of water institution is relatively more difficult to conceive and measure as compared to that of its components, it is, however, possible to capture it indirectly in terms the progressiveness of water institution. Broadly speaking, the progressive nature of water institution can be conceived in terms of four inter-related factors, i.e., adaptive capacity, scope for innovation, openness for change, and ability to tackle emerging problems. While adaptive capacity is indicative of the flexible nature of water institution to change with time and space, the scope for innovation allows it to acquire new and more appropriate institutional structure and get itself updated constantly. Similarly, the openness for change suggests the absence of institutional rigidity within water institution and the ability to tackle emerging problems indicates its performance efficiency even with changing resource realities within water sector. Obviously, all these factors are fundamentally interrelated in the sense that the openness of water institution for change is a basic condition for ensuring its adaptive capacity and innovation potential, and all these three factors are indispensable for creating a flexible and performance-oriented water institution.

Given the decomposition of water institution and its performance outlined above, it is possible to link—both analytically and functionally—the performance of each institutional component with their constituent institutional aspects. Similarly, the overall performance of water institution can also be linked not only with the performance of institutional components but also with the institutional aspects themselves. In this way, the analytical decomposition exercise outlined above provides a framework for evaluating both the institutional inter-linkages as well as institution-performance linkages within water sector.

Water Sector Performance: Analytical Decomposition

Rigorous performance criteria have been developed and applied at the level of particular projects within the irrigation sub-sector (e.g., Sampath, 1990; Bos, 1997; Burt and Styles, 1997; Brewer, Sakthivadivel, and Raju, 1997; Renault, 1998). But, the same cannot be said about the criteria needed for an evaluation of the overall performance of water sector taken as a whole. Efforts to develop objective and internationally comparable economic and equity criteria are severely constrained both by the data and methodological problems involved in capturing the economic or scarcity value of water as well as by the subjective issues inevitable in evaluating equity performance. While there are indicators for the physical gap (i.e., between water demand and supply) and financial gap (i.e., between water charges and supply cost), their aggregate/sector-specific nature and data problems limit their ability to serve as objective criteria for the overall water sector performance.

Even with well-developed objective performance criteria, water sector performance cannot be evaluated in all its dimensions due to the presence of crucial subjective but very pertinent aspects of performance such as the smoothness of water transfers and the adaptive ability of water institution. Although the number of water conflicts can be used as a proxy for the smoothness of water transfers, it is not clear how the relative seriousness of such conflicts can be factored into the evaluation. Similar is also the case with the extent of science and technology application because the number of scientific and technical instruments need not necessarily reflect the effectiveness with which they are used. Even in cases where objective criteria are available or theoretically possible, subjective aspects (in the sense of learned judgements of experts) are still inevitable either to substitute or supplement prevailing knowledge. Since water sector performance is an entity having both physical, financial, economic, and equity dimensions, it is logical to decompose it in terms of these four performance dimensions or components. The performance aspects selected under each these four performance components of water sector performance are listed below.

The **physical performance** of water sector is evaluated in terms of the following aspects:

(a) Demand-supply gap,
(b) Physical health of water infrastructure,
(c) Conflict resolution efficiency (low-cost and less time), and
(d) Smoothness of water transfers across sectors/regions/users.

The **financial performance** of water sector is evaluated in terms of the following aspects:

(a) Investment gap (actual vs. required) and
(b) Financial gap (expenditure vs. cost recovery).

The **economic efficiency** of water sector is evaluated in terms of the following aspects:

(a) Pricing gap (water prices vs. supply cost) and
(b) Incentive gap (actual water prices vs. scarcity value of water).

And, finally, the **equity Performance** of water sector is evaluated in terms of the following aspects:

(a) Equity between regions,
(b) Equity between sectors, and
(c) Equity between groups.

One issue deserves special mention partly because of its policy significance and partly as an example for the inter-dimensional synergy evident among performance components. This is the mutual performance impact of physical, financial, economic, and equity components. For instance, the pricing and cost recovery aspects have an influence on the physical health of water infrastructure because of their implications for funding maintenance and system improvement activities on a regular basis. Similarly, an enhanced service quality as induced by a healthy water infrastructure is likely to facilitate a better recovery of costs. Likewise, efficient conflict resolution mechanisms can ease the process of inter-sectoral and inter-regional water transfers and contribute, thereby, to a more efficient and equitable allocation of water resources. Besides their financial implications, efficient water prices can also contribute to water use efficiency and conflict resolution. Similar kinds of inter-dimensional synergy among the water institution components and institutional aspects have already been discussed in the context of the analytical decomposition of water institution. It is in view of its ability to capture such linkages that the analytical framework developed from a detailed decomposition of water institution and water sector performance becomes important as an analytical tool for a systematic evaluation of the institution-performance interaction within the water sector.

WATER INSTITUTION AND SECTOR PERFORMANCE: ANALYTICAL LINKAGES

With the analytical decomposition of water institutions and water sector performance, it is now possible to demonstrate their analytical and operational linkages. To distinguish the linkages with water institution (i.e., the linkages among water institution components and aspects) from those between water institution and water sector performance, the former are denoted as *institutional inter-linkages* whereas the latter are denoted as *institution-performance linkages*. As stated already, these two sets of linkages constitute actually the two main dimensions of the process of institution-performance interaction within water sector. Since the institutional inter-linkages are the underlying causes for the institution-performance linkages, it is logical to begin with the former. In this respect, it is useful to recognize certain special features of the linkages among the three components of water institution.

Although water law and water policy are related, it is difficult to establish whether water law precedes or succeeds water policy as history provides evidence for both cases. But, in any case, neither of them can be effective without the other in view of their mutual feed backs and adjustments occurring through time. Under ideal conditions, water law empowers water policy and water policy, in turn, provides a political economy translation for water law. Taken together, they define the framework and determine the capacity of water administration that actually implements the legal and policy provisions at the field level. Intuitively speaking, both the water law and water policy form the software component of water institution whereas water administration forms as the hardware component of the same.

Linkages within Water Institutions

The overall performance of water institution and its ultimate impact on water sector performance depends not only on the capabilities of its individual components but also on the degree of integration evident among them. The degree of integration within water institution can be formalized in terms of the strength of institutional inter-linkages. An illustrative set of these institutional inter-linkages is depicted in Figure 4.1. To begin with, the legal aspects dealing with the way water sources as well as water, land, and environmental resources are treated have an influence on water policy aspects such as the prioritization of water sources and project selection criteria. For instance, a water law that does not discriminate water by its source but does recognize the ecological linkages between water and other resources is more likely to encourage a water policy that assigns a higher priority for environmental imperatives and hydrological inter-connectivity in project selection. Such a legal-policy linkage also creates a favorable institutional environment for promoting an integrated approach to water resource management. This particular linkage also indicates the way in which water law and water policy are influenced by the laws and policies relating to other resources like land and environment.

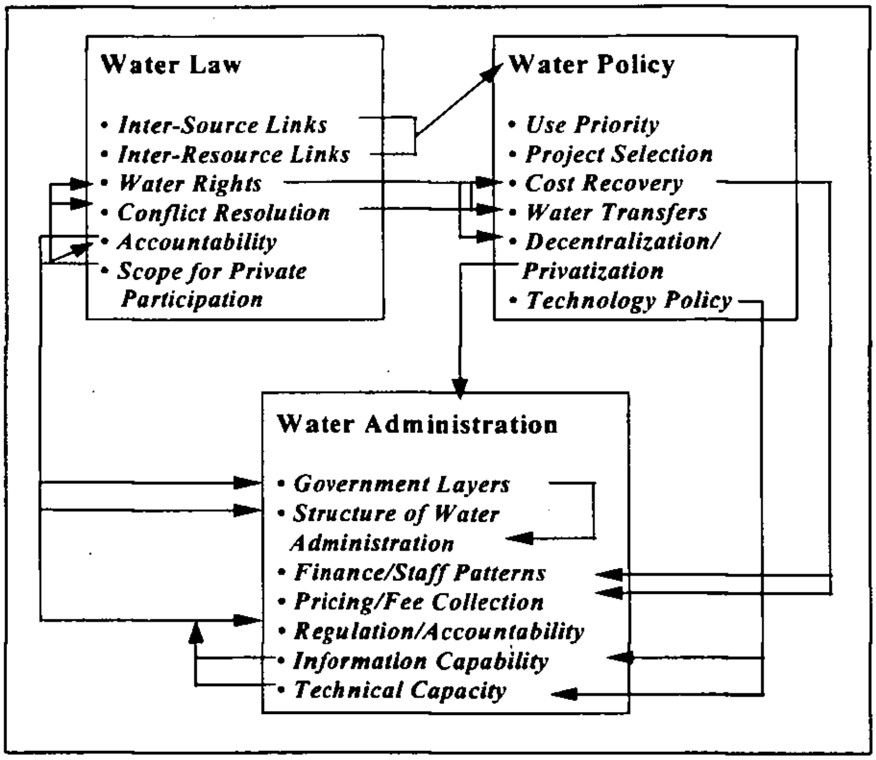

Figure 4.1

Water Institution: Illustrative Inter-linkages

The most important legal aspect having multiple linkages with other legal, policy, and administrative aspects is related to water use rights. It reinforces further the effects of the already inter-related legal aspects of conflict resolution and accountability and also influences the water policy through its effects--both implicit and explicit--on policy aspects such as water pricing, cost recovery, management decentralization, and private sector participation. The three legal aspects related respectively to water rights, conflict resolution, and accountability also have a strong effect on water administration because their implementation requires special administrative mechanisms and functional capabilities. Taken together, they also determine the regulatory powers of water administration. Different policy aspects also influence water administration. The most important among them are the policy aspects involving user participation, management decentralization, and private sector participation. These policy aspects can strengthen water administration by tapping private skills and funds even while contributing to staff reduction and de-bureaucratization. Water policy with regard to the application of water, information, and management technologies contributes to skill formation and capacity building within water administration. Besides the institutional inter-linkages noted here, there are also many more linkages—both straightforward and subtle—that are equally important in determining the overall performance of water institutions.

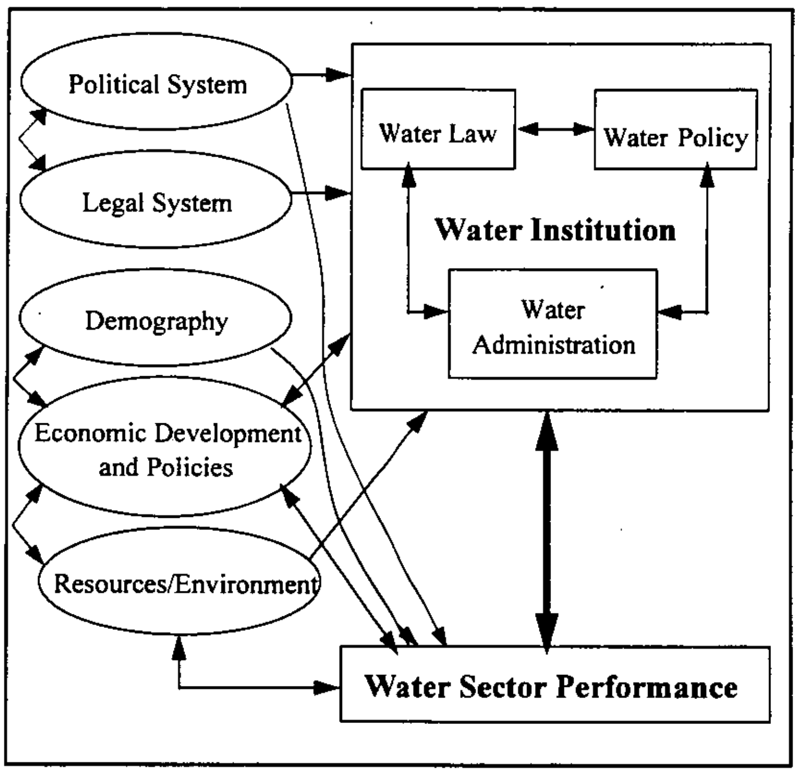

Figure 4.2

Institutional Environment and Institution-Performance Linkages

For a better understanding of the institution-performance linkages, it is necessary to recognize two factors, i.e., the specific role of institution and the intervening influence of factors that are strictly outside the realm of both water institution and water sector. Since the main role of institutional arrangements is to structure the incentive system in vogue, they underpin the operation of the allocation mechanisms and guide water resource allocation and utilization on a continuing basis. Thus, the performance impact of an institutional arrangement depends critically on its incentive properties and allocation abilities. This applies equally to water institution. In view of its deep operational linkages with the incentive structures and allocation mechanisms, water institution has a strong and direct impact on water sector performance. The strength of the performance impact of water institution depends, of course, on the efficacy of its individual components as well as the degree of integration among those institutional components themselves.

Linkages with Exogenous Factors

The overall context in which the institution-performance linkages are evaluated also exerts a strong influence on the strength of the performance impact of water institution. Given the influence of exogenous factors such as political condition, economic development, demographic growth, and resource scarcity, the stronger the incentive features and integration properties of an institutional arrangement the more likely it will yield a better water sector performance. The operational implication of this argument—which forms the basic logic behind the institutional approach to water resource management in this study—is that water sector performance can be improved through induced changes in water institutions. The nature of the institution-performance interaction within water sector is represented in Figure 4.2.

Figure 4.2 has two parts, i.e., the institution-performance interaction within water sector and the general context within which such interaction occurs. Taking first the institution-performance interaction, notice the two-way arrow that links water institution and water sector performance. While institutions do influence water sector performance through the economic medium, both the nature of the water sector and the level of its performance influence water institution through the hydro-geological and political mediums. This two-way linkage has three major implications. First is the role of economic factors in initiating institutional change in water sector. Next is the role of hydro-geological factors in explaining institutional variations across countries and regions. Since water institutions are shaped by the nature of water sector, they are not entirely independent of the basic characteristics of the water sector itself. Thus, water institutions in areas with water abundance differ obviously from those in areas with acute scarcity. The last implication is the role of water sector crisis in building political pressure for institutional change. The crisis-induced institutional responses being observed now in most countries do provide evidence for the central role that political pressure plays in institutional change (Saleth and Dinar, 1999a and 2000). The political impact of the hydrological phenomenon of water crisis has an underlying economic urge for change as well. With a crisis-ridden water sector, the marginal benefits of institutional change in terms of improved performance become very high relative to both the real and monetary costs of transacting the institutional change. This provides a welfare theoretic logic for initiating changes in the institutional arrangements governing water sector. Although the incremental net benefits from institutional change can decline as water institution matures over time, they are quite high in the initial stages of institutional evolution.[5]

The context within which the institution-performance interaction occurs is as important as the mechanics of the same because of its conditioning effect on the two-way linkages between water institution and water sector performance. In reality, the general context or the environment is defined by an inter-play of innumerable factors that are strictly exogenous to the water sector. But, for analytical convenience and simplicity, Figure 4.2 focuses only on the most important among them such as the political system, legal framework, economic development, demographic condition, and resource endowment. Although these factors are themselves inter-related, for expositional purpose, Figure 4.2 highlights only on the nature of their relationship with the process of institution-performance interaction. While the political system and legal framework affect mainly the structure of water institution, the other factors influence and are also being influenced by water sector performance. Since these factors represent the exogenous constraints and opportunities, they play a major role in shaping both the nature and character of the institution-performance interaction within water sector.

Although institutional differences provide the major explanation for variations in water sector performance, the general context of the institution-performance interaction is still important for providing residual explanations.[6] In many instances, the context can even explain better the reasons as to why similarly placed water institutions (or its components) lead to a differential water sector performance. The performance variations in the turnover policy across countries (Johnson, 1997; Vermillion, 1997) and basin level organizations (Kliot, Shmueli, and Shamir, 1997) are cases in point. These instances show that political and legal commitments to declared policies, though necessary, are not sufficient in the face of administrative inadequacy and other bottlenecks including the structural basis of political system (e.g., federal vs. unitary form or presidential vs. parliamentary form).

The economic factors including macro economic reform and trade policy change also play a strong role in providing impetus for institutional changes within water sector. The success of the turnover program in Mexico, the extensive water sector reform initiated already in China, and the growing policy attention to water sector reform in India

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[5] The evaluation of the benefits and costs of institutional change is often blurred in view of the political context in which the exercise is being done. Because of the myopic calculus, the transaction costs—both real and monetary—are overestimated while the benefits stream that continues over a longer time span and spills over far beyond the water sector are underestimated. However, the point being made here takes purely an economic stand with a welfare theoretic perspective.

[6] Regarding the important role that the social and political contexts play in determining the effectiveness of institutions in general, North (1990: 101) notes that the adoption of either the US constitution by many Latin American countries or the western property rights laws by many developing countries has not been successful because "the enforcement mechanism, the norms of behavior, and the subjective model or models of the actors are not the same". This means that institutional similarity does not necessarily assure performance consistency across contexts.

can all be traced to their macro economic reforms of the late 1980s (Saleth and Dinar, 1999a and 2000). Almost similar is also the role of environmental factors including drought and floods as illustrated by the cases of California and China respectively. These instances for the powerful role that exogenous factors play in process of institution-performance interaction within water sector clearly underline the need to incorporate within the evaluation framework both the synergy as well as discord emanating from both within and outside the water sector.[7]

IDENTIFICATION AND DEFINITION OF VARIABLES

The analytical framework outlined above provides a basis for developing a methodology for a quantitative evaluation of both the institutional inter-linkages (see Figure 4.1) as well as the institution-performance linkages (see Figure 4.2). To translate the analytical framework into an empirically applicable form, it is necessary to identify and define the variables that can capture well various layers of institutional inter-linkages and institution-performance linkages within water sector. In this respect, two sets of variables are identified and defined. The first set of variables is supposed to capture various analytical components and aspects of both water institution and water sector performance. The selection of each of these variables is guided not only by its ability to reflect the status of a given component or aspect but also by its amenability for numerical translation within an empirical setting. Obviously, some of these variables are quantitative or, at least, quantifiable by proxies whereas others are inherently qualitative and, therefore, relative involving subjective or judgmental considerations. The second set of variables is supposed to capture some of the exogenous factors such as economic development, demographic changes, education, degree of water scarcity, and resource and environmental situation that affect the process of institution-performance interaction within water sector (see Figure 4.2). The selection of these exogenous variables is obviously based on their relative importance and the availability of comparable data.

Definition of Institutional and Performance Variables

The definition of both the institutional and performance variables flows directly from the analytical decomposition of water institutions and water sector performance. Each of the decomposed institutional and performance aspects is captured by one or more variables depending upon the desired level of detail. To facilitate a better interpretation of these variables, it is necessary to describe their nature and format, including the range of values they can take. The institutional and performance variables are defined below.

[7] One way of conceptualizing and analytically tracking the influence of these exogenous factors is to consider their effects both on the social benefits and transaction costs of institutional change. While political and legal factors have a dominant role in determining the transaction costs, others have a larger role in defining the social benefits from institutional changes within water sector.

Water Law Variables

LTRWSA = Legal treatment of surface and subsurface sources, a dummy variable with 1 if both sources are treated alike but 0 otherwise;

LPRSRF = Format of surface water rights with a value range of 0-7 where 0 for no rights, 1 for unclear/unauthorized/scattered rights, 2 for common/state property, 3 for multiple rights, 4 for riparian system, 5 for appropriative system, 6 for correlative (proportional sharing) system, and 7 for licenses/permits;

LCRMEE = Effectiveness of conflict resolution mechanisms[8] captured in terms of judgmental perception and expressed on a 0-10 scale;

LACPRE = Overall effectiveness of accountability provisions[9] evaluated in terms of judgmental perception and expressed on a 0-10 scale;

LINTRE = Overall ability of water law to provide a legal framework for an integrated treatment of water from various sources evaluated in terms of judgmental perception and expressed on a scale of 0-10;

LOECEN = Extent of centralization tendency within water law evaluated in terms of judgmental perception and expressed on a scale of 0-10;

LOEPRV = Legal scope for private sector participation in water sector evaluated in terms of judgmental perception and expressed on a scale of 0-10;

LOEFWL = Overall effectiveness of water law[10] evaluated in terms of judgmental perception and expressed on a scale of 0-10;

Water Policy Variables

PPSCRI = Project selection criteria having a value range of 0-6 with 0 for no response, 1 for political dictates, 2 for equity factors, 3 for ecological factors, 4 for benefit-cost ratio, 5 for internal rate of return, and 6 for multiple criteria;

PCOREC = Cost recovery status with 0 for non-response, 1 for full subsidy, 2 for partial recovery, and 3 for full-cost recovery;

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[8] The conflict resolution mechanisms considered for evaluation include: bureaucratic systems, national water council and the like, tribunals, water court systems, judicial/legislative mechanisms, river boards, basin level organization and the like, WUAs, and multiple arrangements;

[9] The accountability provisions considered for evaluation include both those related to officials (e.g., indemnity clause, penalty provisions, and administrative actions as well as those related to users (e.g., injunctions, sanctions, and tortious liabilities).

[10] The key issues considered in the evaluation of the effectiveness of water law include: its current and future relevance, synergy with other laws, and capacity for conflict resolution as well as its ability to adjust with environmental issues and emerging technologies.

PIRSWE = Smoothness of inter-regional and inter-sectoral water transfers evaluated in terms of judgmental perception and expressed on a scale of 0-10;

PGPIPP = Impact of private sector promotion policy evaluated in terms of judgmental perception and expressed on a scale of 0-10;

PGPIUP = Impact of the policy for promoting users' participation evaluated in terms of judgmental perception and expressed on a scale of 0-10;

POPAWE = Extent of the influence of other policies[11] on water policy evaluated in terms of judgmental perception and expressed on a scale of 0-10;

POELWL = Extent of linkages between water law and water policy evaluated in terms of judgmental perception and expressed on a scale of 0-10;

POEFWP = Overall effectiveness of water policy evaluated in terms of judgmental perception and expressed on a scale of 0-10;[12]

Water Administration Variables

AORGBA = Spatial organization of water administration taking a value of 0 for non-response, 1 if organized in terms of administrative divisions, 2 for the hybrid basis, i.e., in terms of both geographic divisions and hydro-geologic regions, 3 for broad hydro-geological regions, and 4 for river basins;

ABALFS = Balance in functional specialization, a dummy with 1 if balanced and 0 otherwise;

AIBDWP = Existence of an independent body for price determination/revision, a dummy with 1 for existence and 0 otherwise;

ASBUDC = Seriousness of budget constraint facing water administration evaluated in terms of judgmental perception and expressed on a scale of 0-10;

AACCME = Effectiveness of the accountability arrangements[13] evaluated in terms of judgmental perception and expressed on a scale of 0-10;

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[11] These policies include agricultural policies, energy/power policies, fiscal policies, economic policies, credit/investment policies, environmental policies, trade policies, and foreign policy.

[12] The overall effectiveness of the water policy is obtained by averaging the judgmental values reported for the effectiveness of policies with respect to project selection, cost recovery, water pricing, regulatory and incentive aspects, water education and extension, application of water, and information, and management technologies. For getting the score for the composite variable, the simple addition of scores reported for various variables represented by the composite variable is a normal practice in the quantitative literature in institutional economics [e.g., Clague, et al., (1997b: 72); Isham and Kahkonen, (1999: 23); Li, (1999: 6-7)].

[13] The accountability arrangements considered here include the following categories present both within and outside formal water administration: administrative oversight, financial auditing (Public Accounts Committees), work auditing, grievance cells, monitoring procedures for sectoral/regional water allocation, inter-ministerial committees, statutory bodies, local administration, user groups, and NGOs.

AARINF = Adequacy/relevance of the information base evaluated in terms of judgmental perception and expressed on a scale of 0-10;

AEXTST = Extent of science/technology application[14] in water administration evaluated in terms of judgmental perception and expressed on a scale of 0-10;

AOEFWA = Overall operational ability of water administration evaluated in terms of judgmental perception and expressed on a scale of 0-10;

Performance Variables

WSPPHY = Physical performance[15] of water sector evaluated in terms of judgmental perception and expressed on a scale of 0-10;

WSPFIN = Financial performance[16] of water sector evaluated in terms of judgmental perception and expressed on a scale of 0-10;

WSPECO = Economic Performance of water sector evaluated in terms of judgmental perception and expressed on a scale of 0-10;

WSPEQU = Equity Performance of water sector evaluated in terms of judgmental perception and expressed on a scale of 0-10;

WSPOEV = Overall performance of water sector obtained by averaging WSPPHY, WSPFIN, WSPECO, and WSPEQU; and

WIPOEV = Progressiveness or the overall adaptive capacity of water institution taken as a whole evaluated in terms of judgmental perception and expressed on a scale of 0-10.

Although the variables as defined above are self-explanatory, few words are in order to recognize some of their general characteristics. Both the institutional and performance variables can be grouped into two broad categories, i.e., the factual and perceptional variables. The factual variables can be observed whereas the perceptional variables, involving judgmental considerations, cannot be observed. Even though the factual variables are observable, problems like uncertainty and incomplete information can lead to multiple answers. For instance, the legal format of water rights is subject to

[14] The extent of science/technology application is evaluated by considering the use computers, remote sensing and satellite, research/experimental information, modern accounting/auditing techniques, management information system, geographic information system, wireless communication, water measuring technologies, and computerized dynamic control of canal/water delivery networks.

[15] Physical performance of the water sector is evaluated by considering the following aspects: ability to bridge the overall demand-supply gap, physical health of water infrastructure, conflict resolution efficiency (low-cost and less time), and smoothness of water transfers across sectors/regions/users.

[16] While financial performance is evaluated in terms of overall cost recovery and investment adequacy, the economic performance is evaluated with due considerations to both the gap between water charges and supply cost as well as the gap between water charge and the economic or scarcity value of water.

multiple interpretations notwithstanding a complete legal clarity in water law. In contrast, there are institutional and performance variables which specifically require judgmental considerations to have numerical information on them. Instances for these cases are the variables aiming to capture both the overall as well as component-wise performance of water institution.[17] As alluded already, value judgments are also unavoidable even in the case of water sector performance in view of the need to circumvent data problems and to incorporate futuristic considerations into the evaluation process.

The variables can also be grouped into three categories based on the value they take, i.e., dummy (0 or 1) variables, categorical variables taking integer values within a given range, and scale variables taking a value in the 0-10 range. The first two groups of variables are essentially factual and are involved only in the case of water institution whereas the variables in the third group are basically perceptional or judgmental in nature and involved in all cases where performance evaluation is needed. While the dummy variable indicates the existence or otherwise of a given institutional aspect, the categorical variable tries to place a given institutional aspect into a fixed number of feasible categories.

In the case of categorical variables, the categories are identified either in terms of their actual occurrence or in terms of theoretical possibilities. For instance, the categories identified for water rights are based on a modification and extension of the four-way classification of property rights made by Bromley (1989a: 205) to the particular context of water resource. In the context of all categorical variables, the numerical value for each category is assigned consciously to obtain an ascending order in terms of their values. While there is some value judgement involved in the ordering of categories, the process does utilize both the available empirical evidence and acceptable theoretical justification. For instance, the higher value for appropriative rights is based on its superior allocation efficiency over both the state/common property rights as well as the riparian/correlative rights (Burness and Quirk, 1979; Hartman and Seastone, 1970; Saleth, Braden, and Eheart, 1991). On the other hand, the ordering of categories in cases like project selection criteria and cost recovery is based purely on economic reasoning. Finally, the bounded nature of the scale variables within the 0-10 range has important implications. Since zero means the worst situation and 10 means an ideal situation, the intermediate values taken by the scale variables can be interpreted as the extent the actual situation deviates from either the worst or the ideal situation. In this sense, the scale variables add a relativity dimension to evaluation of various institutional and performance aspects.

[17] This is not to deny the fact that some institutional aspects can be captured through observable and quantifiable variables. For instance, the effectiveness of the conflict resolution aspect of water law can be expressed in terms of the number of unresolved water conflicts. Similarly, the size of water administration can be expressed in terms staff strength and the effectiveness of cost recovery policy can be captured by the gap between water rates and supply costs. But, apart from the usual information problems, the need for incorporating factors like futuristic considerations, qualitative dimension, and regional variations increases the value of subjective and judgmental information.

Definition of Exogenous Variables

Let us also identify and define few additional variables to capture factors that are exogenous to both water institution and water sector performance but have significant effects on both of them (see Figure 4.2). Since these exogenous factors not only provide the general context for the institution-performance interaction in water sector (see Figure 4.2) but also define the overall institutional environment facing the economy (see Figure 2.1), they play a critical role in determining both institutional changes as well as their performance impact. The exogenous factors are many, diverse, and contextual. For analytical convenience, they can be broadly grouped under the following general categories: economic development, social equity, demographic changes, cultural factors, and physical status of resources (water and land) and environment. Notice that from the perspective of a particular sector such as water sector, the exogenous factors will also include the institutional conditions facing the economy as a whole (e.g., legal systems and regulatory arrangements) as they affect sectoral performance indirectly through their effects on sectoral institutions. To capture the effects of some of the most important exogenous factors, we define the following set of variables.

GNPPPC = Purchasing power parity-based GNP/capita in $,

POPDEN = Population density in people/km^2,

DCPOUP = Decadal change in urban population in percentage,

FWATWC = Freshwater withdrawal/year/capita in cum,

PWATAG = Agricultural share in total water withdrawal in percentage,

ALANDC = Arable land/capita in ha,

FPIIND = Food production index,

EXPEDU = Public expenditure on education as percentage of GNP,

GININD = Gini index,

NCNATW = Share of natural capital in total wealth in percentage,

ENVRRI = Environmental Regulatory Regime Index in score,

ININCR = Institutional Investors' Credit Rating as index.

Before proceeding further, let us note four points on the listed set of exogenous variables both as a clarification and as a justification for their choice. First, it is obvious that these variables are defined essentially at the national or regional level for a given time period. Second, while the first nine variables are too obvious to need any clarification, few words are in order to explain the last three variables. The variable NCNATW representing the share of natural capital in national wealth is based on the total value of six natural capital assets: timber, non-timber, crop land, subsoil resources, protected areas, and pasture land.[18] The variable ENVRRI is defined as a composite index of 17 variables pertaining to the stringency of regulations, the structure, information, and enforcement aspects of regulatory institutions, level of energy subsidies, and membership in international environmental organizations.[19] The variable ININCR is an index of credit rating by institutional investors and hence, captures the overall credit worthiness of the country.[20] Third, although there are many variables to capture the exogenous factors in the economic, social, demographic, physical, and institutional realms, we have identified these 12 variables mainly in view of their close relationship with water institution and water sector performance and the availability of comparable data. And, finally, but more importantly, even though both FWATWC and PWATAG are directly related and hence, endogenous to water sector, we consider them still exogenous because they are objectively observed outside the subjective process of evaluation from which our endogenous variables are generated.

While GNPPPC captures economic growth as adjusted to regional differences in population and purchasing power, POPDEN and DCUPOP represent two of the key demographic aspects. POPDEN captures the interface between demography and geography, and DCUPOP takes stock of the impact of population growth on urbanization. FWATWC that is selected to provide a general measure of water scarcity captures also the effects of development and demographic pressures on water resources whereas PWATAG captures the extent that water sector is orientated towards agriculture. Although ALANDC that captures the demographic pressure on cultivated land can also serve to indicate the overall scope for equity in the access to arable land, GININD is also selected to have an explicit focus on the overall equity in terms of income distribution. FPIIND can take stock of production and food security and implications of water sector in particular and agricultural sector in general whereas EXPEDU can capture not only the importance assigned to social sector investment in general but also the role of education in particular. The variable NCNATW that is selected to represent the value of natural resources relative to human and produced assets can provide some indication on the ecological status. The variable ENVRRI that captures the effectiveness of environmental regulatory regime can also provide some indirect measure of the effectiveness of the overall legal and regulatory apparatus. Finally, the variable ININCR is selected to capture the external perception as to the overall fiscal and economic health of the economy.

With the identification and definition of the set of exogenous variables, it is instructive at this stage to note the following four aspects that distinguish them from the

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[18] For the calculation procedures and data sources for this variable, see Kunte, et al. (1998: 4-10).

[19] Notably, all the variables except the last one on membership are based on the judgmental information from a panel of 4022 executives from 50 countries being collected by the World Economic Forum and reported regularly in its *Global Competitiveness Report*. For further details on the construction of and data sources for ENVRRI, see Esty and Porter (2000: 74).

[20] For details on this index that is reported in the *World Development Report: 2000, see* the World Bank (2000).

institutional and performance variables defined in the previous section. First, in contrast to the institutional and performance variables that can vary across individuals both within and across countries/regions/periods, the exogenous variables vary only across countries/regions/periods but remain the same for a country/region at a given time. Second, in contrast to the subjective nature of the institutional and performance variables, most of the exogenous variables listed above are actually observable and data on all of them are easily obtainable from available secondary sources.[21] Third, while exogenous variables capture the objective status of a given magnitude as observed in the past, the institutional and performance variables as defined here can, in fact, incorporate the past and future trends observed/perceived not just in a given dimension but also in all related dimensions. And, finally, although exogenous factors such as GNPPPC are influenced by the institutional and performance factors, given the way the institutional and performance variables are defined to represent them, they do not affect but, in turn, get affected by the exogenous variables.[22] As such, the evaluation of the relative level and significance of the effects of the exogenous factors on the institutional and performance variables constitutes an important part of our modeling exercise and empirical analysis.

Empirical Models of Institution-Performance Interaction

With the definition of the institutional, performance, and exogenous variables, it is now possible to translate various facets of the institution-performance interaction evident in figures 4.1 and 4.2 into a set of functional models that can be empirically estimated within a regression framework. A closer look at these figures reveals that there are two distinct sets of relationships that are to be formalized for a quantitative evaluation of the process of institution-performance interaction. The first set of relationships characterizes the institutional inter-linkages (Figure 4.1) and institution-performance linkages (Figure 4.2) whereas the second set of relationships characterizes the effects that the exogenous factors have on the overall process of institution-performance interaction (Figure 4.2). We need, therefore, two sets of empirical models. The first set of models will formalize both the institutional inter-linkages and institution-performance linkages by relating institutional and water sector performance variables with those representing various institutional components and aspects. The second set of models will capture the influence of exogenous factors on institution-performance interaction by relating the exogenous variables with the institutional and water sector performance variables. Let us now specify these models.

[21] The subjective nature of the institutional and performance variables does not, however, mean that they are temporally unstable. This is due partly to slow and gradual process of institutional change and partly because the subjective process of evaluation can summarize the temporal change in institutional and performance aspects as observed in the recent past and also as perceived in the foreseeable future.

[22] This is because the fact that the subjective process from which the institutional and performance variables are generated uses objective information pertaining not only to them but also to relevant exogenous variables.

Models of Institutional and Performance Linkages

Given the set of institutional and performance variables, it is rather straightforward to specify the models that characterize some of the policy-wise most important layers of the institution-performance interaction within water sector. To provide contrast, we specify two versions of the models—one representing the popular conception of institution-performance interaction that does not recognizes institutional inter-linkages and the other more realistic conception that recognizes the performance implications of those institutional inter-linkages.

Model A, capturing the conventional conception of the relationship between water institution and water sector performance, can be represented in the following equation.

WSPOEV $= f_1$[LTRWSA, LPRSRF, LCRMEE, LACMEE, LINTRE, LOECEN, LOEPRV, PPSCRI, PCOREC, PIRSWE, PGPIPP, PGPIUP, POPAWE, POELWL, AORGBA, ABALFS, AIBDWP, ASBUDC, AACCME, AARINF, AEXTST] .... [A1]

Equation [A1] shows water sector performance as a simple and direct function of 21 variables representing various legal, policy, and administrative aspects. Although this model is unrealistic as it fails to account for the performance implications of the inter-relationship among these institutional variables, we still specify it and also include it for evaluation essentially to provide contrast to the more realistic Model B that explicitly recognizes the performance effects of institutional synergy.

For enabling the specification of Model B more clearly, we need first to trace out the major institutional inter-linkages and their performance implications so as to identify the layers of linkages and the channels of impact transmission. Given figures 4.1 and 4.2 and the defined set of institutional and performance variables, these layers of linkages and channels of impact transmission can be traced as shown in Figure 4.3. To see how these layers and channels are traced in Figure 4.3, we note that of the 26 variables shown in the figure, five are performance variables—four related to water institution and its three components and one related to water sector. The rest are all institutional variables representing 21 institutional aspects. Only 16 of these 21 institutional variables are truly independent and are, therefore, distinguished by placing them within ovals or ellipsoids. The impact of these independent variables on institutional performance is channeled both directly (as indicated by the double-line arrows) as well as indirectly (as indicated by the single-lined arrows).

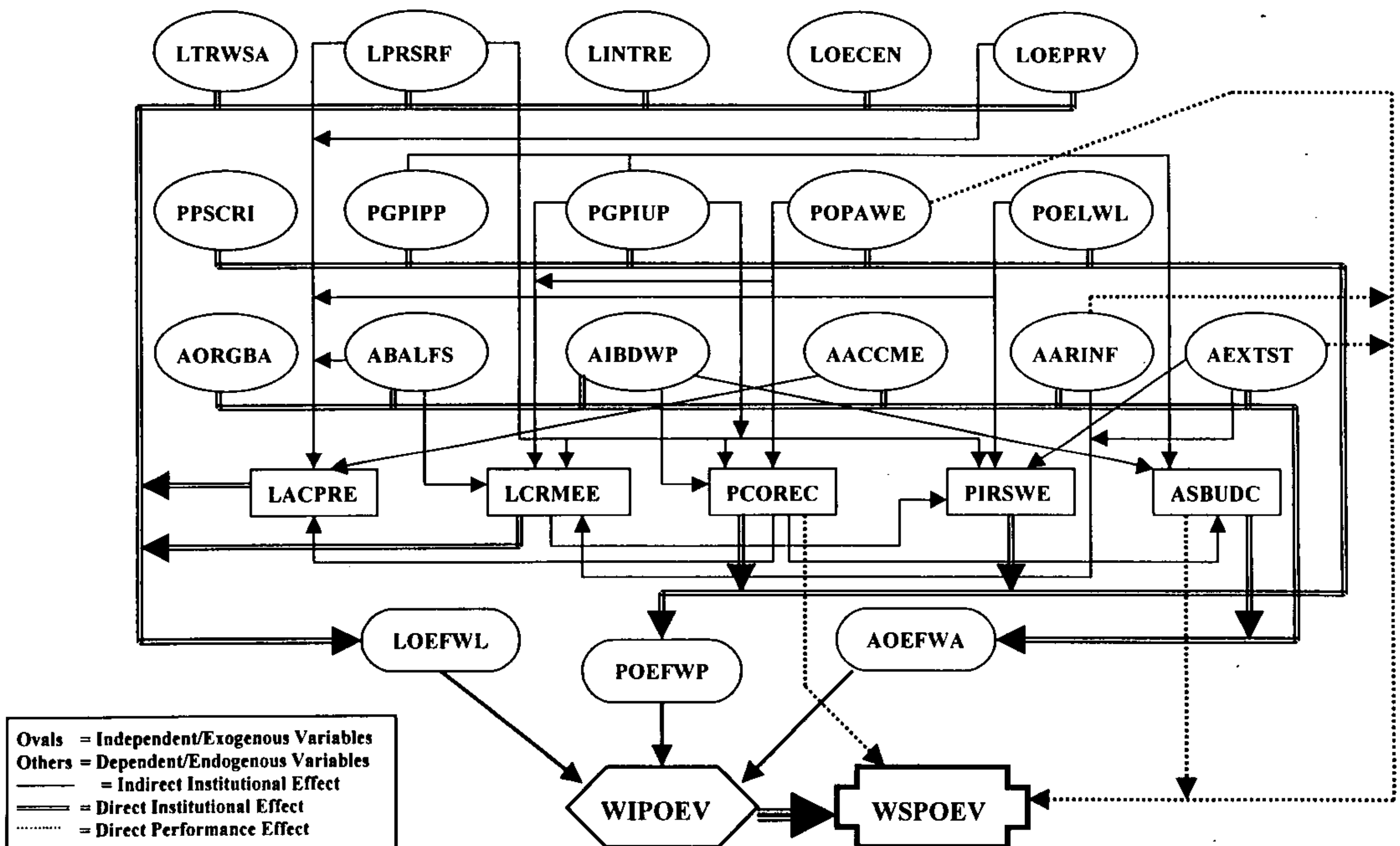

Figure 4.3.

Institution-Performance Interaction: Layers of Linkages and Channels of Impact Transmission.

The five institutional variables that are distinguished by placing them within rectangles are dependent as they are affected by different subsets of the 16 independent institutional variables. The institutional variables—both independent and dependent—affect the three variables representing the performance of three water institution components (placed within rounded rectangles) that together, in turn, affect the variable representing the overall performance of water institution (placed in hexagon). The variable representing water institution performance that captures the effects of the institutional variables affects ultimately the variable representing water sector performance (placed within cross), which is the ultimate dependent variable in the system. We also notice that in addition to their indirect effects on water sector performance via institutional performance, some of the institutional variables also have direct effects on water sector performance (indicated by dotted lines). These variables include both the independent ones (POPAWE, AARINF, and AXTST) as well as the dependent ones (PCOREC and ASBUDC). It is important to recognize that their indirect effects are in terms of their institutional influence whereas their direct effects are in terms their role as proxies for economy-wide policy, fiscal, information, and technology trends.[23] Thus, we can see that the effects of the variables representing both the institutional aspects and institutional performance on water sector performance are transmitted through various layers and multiple channels. With the identification of these layers of linkages and channels of impact transmission, it is rather straightforward to represent them as a set of interdependent equations. These equations that will together specify our Model B can be defined as follows:

LCRMEE = g_1(LPRSRF, PGPIUP, POPAWE, ABALFS, AARINF, AEXTST) .. [B1]

PIRSWE = g_2(LPRSRF, LCRMEE, PGPIUP, AEXTST) .... [B2]

PCOREC = g_3(LPRSRF, PGPIUP, POPAWE, AIBDWP) .... [B3]

ASBUDC = g_4(AIBDWP, PCOREC, PGPIPP, PGPIUP) .... [B4]

LACPRE = g_5(LPRSRF, LOEPRV, PCOREC, POELWL, AACCME) .... [B5]

LOEFWL = g_6(LTRWSA, LPRSRF, LCRMEE, LACPRE, LINTRE, LOECEN, LOEPRV) .... [B6]

POEFWP = g_7(PPSCRI, PCOREC, PIRSWE, PGPIPP, PGPIUP,

[23] In this respect, POPAWE representing the effect of other policies on water policy is considered as a proxy for the overall policy bias against water sector whereas AARINF and AEXTST representing respectively information adequacy and science & technology application are taken as indicators for the overall information and technology status. Similarly, PCORES and ASBUDC representing respectively cost recovery status and seriousness of budget constraint are considered as proxies for general cost recovery commitment and fiscal health of the government.

POPAWE, POELWL) .... [B7]

AOEFWA = g_8(AORGBA, ABALFS, AIBDWP, ASBUDC, AACCME, AARINF, AEXTST) .... [B8]

WIPOEV = g_9(LOEFWL, POEFWP, AOEFWA) .... [B9]

WSPOEV = g_{10}(WIPOEV, POPAWE, ASBUDC, PCOREC, AARINF, AEXTST) .... [B10]

Of these equations, the first five capture the institutional inter-linkages among some institutional aspects under the three institutional components. Hence, they are very important for capturing the performance effects of inter-dimensional synergy within water institution. Since these equations describe the way some of the institutional aspects are being influenced by other institutional aspects both within and across institutional components, they capture the institutional linkages that transcend individual institutional components. Equation [B1], for instance, considers the legal variable capturing the effectiveness of conflict resolution mechanism as a function of one legal variable (surface water rights format),[24] two policy variables (effectiveness of user participation policy and influence of other policies on water policy), and three administrative variables (balanced functional specialization, information adequacy, and science & technology application). Similarly, equation [B2] shows the policy variable representing the effectiveness of inter-sectoral/regional water transfers as a function of two legal variables (water rights format and effectiveness of conflict resolution mechanisms), one policy variable (effectiveness of user participation policy), and one administrative variable (extent of science & technology application).

Equation [B3] considers the policy aspect of cost recovery status as a function of one legal variable (water rights format), two policy variables (effectiveness of user participation policy and influence of other policies on water policy), and one administrative variable (existence of independent water pricing body). Equation [B4] postulates the administrative variable capturing the seriousness of budget constraint as a function of one administrative variable (existence of independent water pricing body) and three policy variables (cost recovery status, effectiveness of privatization policy, and effectiveness of user participation policy). Equation [B5], on the other hand, views the legal variable capturing the effectiveness of accountability provisions as dependent on two legal variables (water rights format and privatization provisions), two policy variables (cost recovery status and overall law-policy linkage), and one administrative variable (administrative accountability). In addition to their role in capturing the inter-dimensional institutional synergy, these five equations are also crucial in view of their structural linkages with the rest of the equations.

[24] The format of surface water rights is used here as well as in equations: [B2], [B4], [B5], and [B6] as a proxy for general format of water rights.

Having described the five equations that formally describe the institutional inter-linkages that transcend individual institutional components, now let us turn to the next three equations that capture the institutional linkages within each of the three institutional components. Equation [B6] postulates the overall performance of water law as a function of seven water law-related institutional aspects. These institutional aspects are: the legal treatment of water sources, the format of rights in surface water use (considered as a proxy for the general format of water rights), the effectiveness of conflict resolution mechanism, the effectiveness of accountability provisions, the level of internal consistency within water law, the degree of centralization tendency within water law, and the legal scope for private sector participation. Similarly, equation [B7] considers the overall performance of water policy as a function of seven water policy-related institutional aspects. These institutional aspects are: the project selection criteria, the cost recovery status, the effectiveness of inter-regional/sectoral water transfer policy, the extent of the impact of government policy towards private sector and user participation, the effects of other economic policies on water policy, and the extent of linkage between water law and water policy.

Likewise, equation [B8] specifies the overall performance of water administration as a function of seven administration-related institutional aspects. These institutional aspects are: the organizational basis of water administration, the level of balance in functional specialization, the existence of an independent body for water pricing, the severity of budget constraint, the effectiveness of administrative accountability, the adequacy/relevance of information, and the extent of science and technology application within water administration. While equations [B6], [B7], and [B8] are designed to capture the functional linkages within each of the three water institution components, equation [B9] shows how the overall performance of water institution is linked with the effectiveness of its three institutional components. Finally, equation [B10] postulates the performance of water sector as a function of that of water institution and five institutional variables taken as proxies respectively for policy bias against water sector (POPAWE), cost recovery commitment (PCOREC), overall fiscal health (ASBUDC), information level (AARINF) and technology application (AEXTST) in the country.

Taken together, these 10 equations—with different levels of detail and disaggregation—can help in evaluating some of the most important and policy-wise relevant layers in the process of institution-performance interaction. Looking at the equations, it is evident that they are nested with sequential relationships among them. Among the first five equations, the dependent variable in equation [B1] enters as an independent variable in equation [B2] and that in [B3] enters as an independent variable both in equations [B4] and [B5]. While all the dependent variables in first five equations also enter as independent variables in equations [B6], [B7], and [B8], those in the next three equations enter as independent variables in equation [B9]. The dependent variable of equation [B9] as well as those in equations [B3] and [B4] becomes the independent variable in equation [B10]. Thus, it is equation [B10] that captures the ultimate effects of various sequential relationships among all the other equations within the system.

The sequential feature of the equation system has major implications both for the choice of econometric technique as well as for the method of analysis. From an econometric perspective, since equations: [B1] to [B10] form an integrated system in view of their sequential relationships, they should also be estimated within the framework of a simultaneous system. Such an empirical approach will allow us to econometrically account for both the direct and indirect effects that the institutional aspects have on water sector performance. When these equations are estimated within an appropriate empirical context, the sign and size of their coefficients could provide valuable insights into the relative role that various institutional aspects play in determining the performance of both water institution as well as water sector. Given the sequential nature of the equation system and the estimated coefficients, it would also be possible to trace out the complete chains of effects (or, channels of impact transmission) between a marginal change in any institutional variable and its impact on water sector performance. Such an exercise could provide further insights into the relative performance impact of various configurations of institutional sequencing and packaging that is attempted in Chapter 9.

Models of Exogenous Variables

The models based on exogenous variables are specified to capture the effects of some factors that are exogenous to both water institution and water sector but are wielding a strong influence on both and hence, on the process of their interaction. Since we do not have any objectively observed measures for both the performance of water institution and water sector, the models that are specified below relate the actually observed exogenous variables with the subjectively derived variables capturing the performance of water institution, its three institutional components, and water sector. In this respect, these models differ from both models A and B that are based exclusively on subjectively derived institutional and performance variables. Recognizing this important difference, let us specify the set of equations representing Model C as follows:

LOEFWL = h_1(GNPPPC, POPDEN, DCPOUP, FWATWC, PWATAG, ALANDC, FPIIND, EXPEDU, GININD, AADFOR, NCNATW, ENVRRI, ININCR) .... [C1]

POEFWP = h_2(GNPPPC, POPDEN, DCPOUP, FWATWC, PWATAG, ALANDC, FPIIND, EXPEDU, GININD, AADFOR, NCNATW, ENVRRI, ININCR) .... [C2]

AOEFWA = h_3(GNPPPC, POPDEN, DCPOUP, FWATWC, PWATAG, ALANDC, FPIIND, EXPEDU, GININD, AADFOR, NCNATW, ENVRRI, ININCR) .... [C3]

WIPOEV = h_4(GNPPPC, POPDEN, DCPOUP, FWATWC, PWATAG, ALANDC, FPIIND, EXPEDU, GININD, AADFOR, NCNATW, ENVRRI, ININCR) .... [C4]

WSPPHY = h_5(GNPPPC, POPDEN, DCPOUP, FWATWC, PWATAG, ALANDC, FPIIND, EXPEDU, GININD, AADFOR, NCNATW, ENVRRI, ININCR) .... [C5]

WSPFIN = h_6(GNPPPC, POPDEN, DCPOUP, FWATWC, PWATAG, ALANDC, FPIIND, EXPEDU, GININD, AADFOR, NCNATW, ENVRRI, ININCR) .... [C6]

WSPECO = h_7(GNPPPC, POPDEN, DCPOUP, FWATWC, PWATAG, ALANDC, FPIIND, EXPEDU, GININD, AADFOR, NCNATW, ENVRRI, ININCR) .... [C7]

WSPEQU = h_8(GNPPPC, POPDEN, DCPOUP, FWATWC, PWATAG, ALANDC, FPIIND, EXPEDU, GININD, AADFOR, NCNATW, ENVRRI, ININCR) .... [C8]

WSPOEV = h_9(GNPPPC, POPDEN, DCPOUP, FWATWC, PWATAG, ALANDC, FPIIND, EXPEDU, GININD, AADFOR, NCNATW, ENVRRI, ININCR) .... [C9]

The independent variables in all nine equations are the 12 exogenous variables whereas the dependent variables are the subjectively derived performance levels of water institution and its three components (equations: [C1] to [C4]) as well as water sector and its four performance components (equations: [C5] to [C9]). While equations [C1] to [C4] capture the effects of the exogenous variables on the performance of water institution and its components, the equations [C5] to [C9] captures the same on water sector performance and its four components. As these exogenous variables capture the economic, social, demographic, resource, and institutional context within which the process of institution-performance interaction occurs, the equations [C1] to [C9] could help in understanding the relative level and direction of the influence of these contextual factors on institutional and sectoral performance. Since these equations relate only the subjective performance variables with the exogenous variables, it is important to note that they evaluate the effects of exogenous factors on institutional and sectoral performance not directly but only indirectly in terms of their effects only on the subjective process that generate these performance variables. But, the evaluation of these equations is still valuable partly to validate how the subjective evaluation are consistent with the objective nature of the general conditions surrounding water institution and water sector and partly to understand the relative role of exogenous factors in performance evaluation.

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Chapter 5

EMPIRICAL CONTEXT: DESCRIPTION AND JUSTIFICATION

The review of existing literature on institutional evaluation shows the importance of the present attempt in terms of its detailed modeling of the institution-performance interaction within water sector. It also demonstrates how serious are the information challenges involved in the empirical translation of such an interaction process. It is true that the issue can be quantitatively addressed by using either time series data for a country or cross-section data for a set of countries, or combining both the time-series and cross-section data within a panel analysis. Unfortunately, the task of obtaining actually observed and also internationally comparable time-series or cross-section data sufficient enough for an empirical estimation of models A, B, and C, though not impossible, is extremely costly in terms of both time and resources. Even if such data is available, there is still a problem as they represent the past situation and cannot, therefore, capture expectation and futuristic aspects. Since observed data can allow only an ex-post rather than an ex-ante analysis, their value for policy purposes is obviously limited.

EXECUTIVE PERCEPTION AS AN EMPIRICAL BASIS

To overcome the problems of both the non-availability and limitations of the observed data, the present study follows the empirical tradition of using the executive perception-based data for institutional analysis (e.g., Knack and Keefer, 1986; Cukierman, Web, and Neyapti, 1992; Gray and Kaufmann, 1998; Barret and Graddy, 2000; Chong and Calderon, 2000). Relying on this empirical approach, the information on all relevant institutional and performance variables can be obtained by administering a structured questionnaire to a sample of key water sector experts from a group of representative countries. Notably, the information, even on the variables capturing water sector performance, can also be obtained within the judgmental framework for following two reasons. First, observed data, though available on some of the aspects of water sector performance, is neither adequate to cover all performance aspects nor capable of capturing the ongoing as well as prospective performance changes. As a result, the information on all performance variables can also be obtained within the framework of judgmental evaluation. And, second, in addition to its role in solving the data problems, this approach also provides a consistent data set where each set of independent institutional observations has its own set of corresponding observations on water sector performance.

Besides its ability to overcome the constraint in obtaining observed data, the approach of using executive perception as an empirical basis also has a number of other advantages. First, it allows considerable freedom in the choice of institutional and performance variables and also enables the acquisition of all relevant information. Second, it can tap both the accumulated wisdom futuristic considerations that are not captured by observed data. Third, not only can it synthesize different types of information (i.e., objective data, subjective observation, and expected trend) but also internalize some of the complicated and difficult-to-measure concepts (e.g., performance, efficiency, and equity). And, finally, given its empirical reliance on a cross-section of countries and experts, it can capture the effects of the variations not only in the exogenous factors (e.g., political system, demographic condition, economic development, and resource endowment) but also in the individual-specific subjective factors (e.g., disciplinary background, experience, and ideological orientation).

Its empirical precedence and practical advantages apart, the use executive perception as an empirical basis for the evaluation of institution-performance interaction can also be justified in terms of some theoretical results from the institutional economics literature. Since institutions are not objective phenomenon but a human mental construct that think and act through the medium of individuals (Douglas, 1987; North, 1990; Stein, 1997; Ostrom, 1999), the approach of evaluating water institutions and their performance impact, based on the perception of water sector experts, remains theoretically consistent.[1] Similarly, since the subjective nature of institutions makes value judgments unavoidable in their evaluation (Bhaskar, 1997: 773), the subjective or judgmental evaluation of institutions is again justified. Apart from the justification in terms of the role of mental models in the process of institutional change, there is another way in which the judgmental values expressed by the respondents can be intuitively interpreted and justified. These values indicate in a sense the respondents' preference for a particular configuration of water institutions.

The consensus on the choice of institutional configurations can also be analyzed in terms of statistical analysis. In this sense, the survey procedure endogenizes institutions as well as their performance implications. What is to be noted here is that since the survey approach captures the role that the subjective perception plays in the process of institutional change, it is more realistic than the rational choice perspective of institutional change. Given the attention on the mental models of key individuals on the casual relationship between the institutions and performance from an overall macro level perspective, the influence of some of the informal aspects (especially non-economic factors such as ideology, conviction, and learning) can be broadly internalized into the evaluation process. For the evaluation of the potential for institutional change, 'perception' surveys to capture diversity of perspectives and casual models are an important diagnostic tool. They can help in capturing the direction of change and the areas of agreements (White, 1990: 89-90). Whether the diverse opinion is the outcome of

[1] North (1990: 5) makes this point still more effective when he says: "Institutions are a creation of human beings. They evolve and are altered by human beings; hence our theory must begin with the individual."

different values or the lack of information can also be ascertained, to some extent, by the way the survey is designed and translated.

SUBJECTIVE EVALUATION: RATIONALE AND CAVEATS

The main rationale for our reliance on subjective evaluation comes directly from our approach and evaluation methodology that are both based on the stage-based perspective of institutional change outlined in Chapter 3. While we may not claim that the stage-based perspective as such is unique, the three stages that we have identified, i.e., mind change, political crystallization, and actual institutional change, are definitely singular with no precedence. In contrast to the present literature that has almost an exclusive focus on the second and third stages of institutional change, the present study both highlights and elaborates on the central role that the mind change of key decision-makers plays in the whole process of institution-performance interaction. The mind change stage basically elaborates the way the institutional inter-linkages (i.e., linkages both within and across institutional components) and institution-performance linkages (i.e., the linkages that institutional components and aspects have with performance) are perceived but also how such a perception is affected by socio-economic factors.

Since it is the mental perception of these institution-performance relationships that is going to determine both the direction and effectiveness of actual institutional change, a careful evaluation of the first stage could also provide valuable insights into prospective future process in the other two stages of institutional change. Given the nature of the mind change process, it is obvious that objective data, even if at all it is available, will be of least value as it can capture only the past and static situation. The evaluation of the critical first stage of mind change has, therefore, to be based essentially on subjective or judgmental information derived from a carefully designed and conducted survey of a cross-section of relevant experts with different disciplinary background and geographic location. Since the information derived from the subjective perception and judgmental values of the respondents is central to our evaluation of institutional linkages and their performance implications, it is necessary to recognize the ramifications of three key ideas of institutional economics, i.e., bounded rationality, asset specificity, and information impactedness condition. While the implications of these conditions for contracts and organizational arrangements have been treated elaborately by Williamson (1975 and 1985), our concern for these conditions here is related to their implications for the appropriateness of the survey technique as well as for the quality of subjective information.

Taking the asset specificity condition first, it is related to the 'idiosyncratic employment' concept of Marshall (1948: 626) as well as the 'personal knowledge' idea of Polanyi (1962: 52-53). It refers to the special knowledge possessed by individuals in particular and the economically useful special attributes possessed by economic assets in general (Williamson, 1985: 52-54). Although these knowledge and attributes are very valuable, they may remain unrecognized, unrewarded, and underutilized. In many situations, there are difficulties in transferring and displaying such knowledge or attributes due to what is known as the information impactedness condition. Information impactedness refers to the condition where the "true underlying circumstances relevant to a transaction, or related set of transactions, are known to one or more parties but cannot be costlessly discerned by or displayed for others" (Williamson, 1975: 31). As can be seen, it is a derivative condition arising from uncertainty, opportunism, and bounded rationality. Bounded rationality refers to human behavior that is "*intentionally* rational but only *limitedly* so" (Simon, 1961: xxiv). This condition explicitly recognizes the cognitive and computational limitations of human mind especially relative to the size and complexity of the problem at hand (Simon, 1957: 198). As these limitations differ across individuals, there are bounded rationality differentials across individuals (Williamson, 1975: 47).

Reflecting these concepts in the context of our survey approach and information gathering technique or the survey instrument, we find that the survey approach helps to capture the special knowledge possessed by key water experts thanks to their practical experience, understanding, and proximity to various layers of decision-making apparatus. But, we need to recognize that our approach is not free from the cognitive and communication limitations imposed by the information impactedness and bounded rationality conditions. One way to minimize the consequences of these conditions on the evaluation process is to design the survey instrument in such a way as to facilitate a more efficient and less biased knowledge transfer. The institutional decomposition exercise where institutional components and institutional aspects are unpacked with finer details can do the job, provided the questionnaire is designed well to present the institutional alternatives and typologies in a simple and disaggregated manner.[2] This allows the respondents to focus their attention on each of the institutional detail and summon their knowledge and perception on that aspect so as to provide a more accurate response.

SAMPLE SELECTION AND CHARACTERISTICS

The key obstacle for the evaluation of the mind change is not the method but the empirical approach, especially the identification of the evaluation framework and the selection of the focus groups. Given a detailed, yet manageable, analytical framework based on institutional decomposition as described in Chapter 4, it is certainly possible to use a perception survey of various focus groups from different countries. While the choice of the countries can be made in such a way as to capture economic, social, physical, and historical diversity, the choice of the focus group is somewhat tricky. This

[2] Bounded rationality is manifested not just in terms of cognitive and computational limitations but also in terms of communication limitation (Williamson, 1975: 255). The limitations imposed by both bounded rationality and information impactedness can be minimized also through the use of simplified language and commonly used idioms.

is because the focus group should *simultaneously* have *all* the following four characteristics. First, the group under consideration should be directly related to water sector particularly with a major stake. Second, it should have a strong influence on the overall decision-making process affecting water sector. Third, it should have some basic understanding on the technical aspects of water institutional arrangements and their performance implications. And, finally, it should also have international exposure sufficient enough to have a relative perspective of institutional arrangements and water sector performance in more than one country.

Given the selection criteria, it is rather easy to identify the focus group for the survey. In the context of water sector, the three groups that satisfy one or more of the selection criteria are the water users, political decision-makers, and water experts. While water users have a larger and more direct stake in water institutions and their performance implications, their lack of technical knowledge on the structural features of water institutions as well as international exposure excludes them from being the focus group for our survey. Despite their influential status and considerable international exposure, the political decision-makers are also in the same predicament as they lack both technical knowledge and time necessary to provide the required level of institutional and performance details. Thus, in terms of the selection criteria, it is neither advisable to include the micro level water users nor feasible to select macro level political decision-makers. Unlike the water users and political decision-makers, a cross-section of carefully selected water experts—both subject specialists and sector executives—satisfying all the four criteria can be a more viable group to represent and capture the prevailing mindset towards water institutions and their performance. Moreover, the water experts—considered generally to be not as influential as the political decision-makers—do have considerable impact on the decision-making process both directly through their technical and policy advice to political actors and indirectly through their research and advocacy. In most contexts, they can also be considered as a pivotal group representing a critical interface between grassroots users and macro planners.

Sample Countries

The value and credibility of the subjective information needed for an evaluation of the models of institution-performance interaction depend clearly on the choice of the sample countries. Table 5.1 shows the sample countries along with some key information on their political arrangement, demographic condition, water resource potential and sectoral features, and socio-economic status. To have some first hand information on institutional arrangements, sector performance, and recent reforms, a representative sub-set of these 39 sample countries was also visited during October-December 1997.[3] In view of their

[3] The countries that were visited are: Australia, Brazil, Chile, China, India, Israel, Mexico, Morocco, South Africa, Spain, Sri Lanka, and the US.

Table 5.1a. Socio-economic Profile and Water Sector Features of Sample Countries.

Sl. No.	Sample Countries[a]	Political Regime[b]	Popu-Lation (miilion)	Area (million km2)	Annual Rainfall (cm)	Renewable Water Resources (bcum)	Annual Water Withdrawal Total (bcum)	Annual Water Withdrawal % of total Resources	Annual Water Withdrawal % used for Irrigation	Hydro Power as % of Total Power
		(1997)	(1999)	(1999)	(2000)	(Various Years)				(1998)
1	Argentina	1	37	2.78	5.0-500.0	1031.01	28.6	2.8	75.0	90.00
2	Australia	2	19	7.74	12.7-127.0	356.67	15.1	4.2	33.0	68.00
3	Bangladesh	1	128	0.14	101.6-203.2	1233.41	14.6	1.2	86.0	0.00
4	Bolivia	1	8	1.10	25.4-177.8	309.00	1.4	0.5	48.0	0.00
5	Brazil	3	168	8.55	60.0-360.0	7133.11	54.9	0.8	61.0	6.00
6	Cambodia	4	12	0.18	38.1-76.2	496.88	0.5	0.1	94.0	98.50
7	Canada	5	31	9.97	38.1-203.2	2856.40	45.1	1.6	9.0	62.40
8	Chile	1	15	0.76	5.0-125.0	480.11	21.4	4.5	84.0	18.00
9	China	6	1250	9.60	12.7-76.2	2856.25	525.5	18.4	77.0	17.40
10	Egypt	1	62	1.00	5.0-20.0	58.84	55.1	93.6	86.0	55.00
11	France	1	59	0.55	63.0-140.0	191.51	40.6	21.2	12.0	12.80
12	Germany	3	82	0.36	50.0-250.0	177.86	46.3	26.0	0.0	97.00
13	India	3	998	3.29	13.0-1100.0	1943.11	500.0	25.7	92.0	13.70
14	Indonesia	1	207	1.91	100.0-500.0	2613.38	74.3	2.8	93.0	12.90
15	Israel	1	6	0.02	2.5-35.5	1.10	1.7	154.0	64.0	18.60
16	Italy	1	58	0.30	76.2-127.0	168.72	57.5	34.1	45.0	2.00
17	Japan	7	127	0.38	76.2-203.2	432.05	91.4	21.2	64.0	1.00
18	Lao PDR	6	5	0.24	110.0-370.0	283.19	1.0	0.4	82.0	74.00
19	Mexico	8	97	1.96	15.0-170.0	463.56	77.8	16.8	78.0	19.30
20	Morocco	7	28	0.45	12.7-76.2	30.24	11.1	36.7	92.0	92.20
21	Myanmar	9	45	0.68	76.2-127.0	1058.18	4.0	0.4	90.0	90.10
22	Namibia	1	2	0.82	5.0-70.0	54.75	0.3	0.5	68.0	0.00
23	Nepal	10	23	0.15	100.0-400.0	211.58	29.0	13.7	99.0	0.20
24	Netherlands	3	16	0.04	62.5-92.5	92.75	7.8	8.4	34.0	0.09
25	New Zealand	10	4	0.27	60.0-150.0	344.21	2.0	0.6	44.0	25.00
26	Pakistan	1	135	0.80	30.5-162.5	261.63	155.6	59.5	97.0	77.60
27	Philippines	1	77	0.30	236.0	338.26	55.4	16.4	88.0	1.00
28	Poland	10	39	0.32	60.0-100.0	63.53	12.1	19.0	11.0	25.60
29	Portugal	1	10	0.09	50.0-100.0	72.23	7.3	10.1	48.0	20.00
30	South Africa	1	42	1.22	5.1-134.6	50.74	13.3	26.2	72.0	3.00
31	South Korea	1	47	0.10	130.0	70.55	23.7	33.6	63.0	20.00
32	Spain	11	39	0.51	15.2-139.7	111.03	35.5	32.0	62.0	94.00
33	Sri Lanka	1	19	0.07	30.4-233.7	44.25	9.8	22.1	96.0	71.00
34	Sudan	9	29	2.38	70.0-100.0	31.15	30.0	96.3	99.0	81.00
35	Thailand	4	62	0.51	127.0-230.0	415.28	33.1	8.0	91.0	12.00
36	Tunisia	1	9	0.16	10.0-25.0	3.95	2.8	70.9	86.0	41.00
37	United Kingdom	4	59	0.25	50.0-400.0	146.85	9.3	6.3	3.0	9.90
38	United States	3	273	9.36	17.8-213.4	2502.86	447.7	17.9	27.0	88.00
39	Vietnam	6	78	0.33	111.8-223.5	908.47	54.3	6.0	86.0	82.00

Sources: World Bank (2000), World Resource Institute (1999), IWMI (1998), and Gleick (1998).

Notes: [a]Data for Taiwan not available.

[b]Republic=1; Federal Parliamentary State=2; Federal Republic=3; Multiparty Liberal Democracy Under Constitutional Monarchy=4; Confedeeration with Parliamentary Democracy=5; Communist State=6; Consitituional Monarchy=7; Federal Republich operating under a centralized Govenemnt=8; Military Regime=9; Parlimentary Democracy=10; Parliamentary Monarchy=11.

Table 5.1b. Socio-economic Profile and Water Sector Features of Sample Countries.

Sl. No.	Sample Countries[a]	Net Irrigated Area: Total (mha)	Net Irrigated Area: As % of Arable Land	Annual Water Demand (bcum)	Groundwater Resources[b]: Annual Recharge (bcum)	Groundwater Resources[b]: Extraction Total (bcum)	Groundwater Resources[b]: Extraction As % of Recharge	GNP (PPP) Per Capita ('000 $)	Urban Popu-lation (%)	People Below Poverty Line (%)[b]
		(1994-97)		(1998)	(1975-95)			(1999)	(1999)	(1985-97)
1	Argentina	1.58	6.30	10.5	128	4.7	3.7	11.32	90.0	25.5
2	Australia	2.40	5.10	3.5	-	2.5	-	22.45	85.0	-
3	Bangladesh	3.67	43.40	6.9	34	3.4	10	1.48	24.0	42.7
4	Bolivia	0.09	4.10	0.5	130	-	-	2.19	62.0	65.0
5	Brazil	2.31	4.80	8.5	1874	-	-	6.32	81.0	17.4
6	Cambodia	0.27	7.10	0.2	30	-	-	1.29	16.0	39.0
7	Canada	0.73	1.60	1.4	369.6	1.1	0.3	23.73	77.0	-
8	Chile	2.16	54.30	6.3	140	-	-	8.37	85.0	21.6
9	China	34.69	37.70	181.2	870	74.6	8.6	3.29	32.0	6.0
10	Egypt	2.87	99.80	26.2	1.3	3.4	261.5	3.30	45.0	22.9
11	France	1.56	8.50	3.3	100	6.2	6.2	21.90	75.0	-
12	Germany	0.46	3.90	0.9	45.7	7.7	16.9	22.40	87.0	-
14	India	53.82	32.40	192.4	350	150	42.9	2.15	28.0	40.9
13	Indonesia	2.65	15.50	4.6	226	-	-	2.44	40.0	11.3
15	Israel	0.16	45.50	0.7	1.1	1.2	109.1	15.94	91.0	-
16	Italy	2.07	24.90	14.3	30	12	40	20.75	67.0	-
17	Japan	2.51	62.80	1.6	185	12.9	7	24.04	79.0	-
19	Lao PDR	0.16	18.60	0.2	50	-	-	1.73	23.0	46.1
21	Mexico	5.28	22.80	27.6	139	23.5	16.9	7.72	74.0	10.1
20	Morocco	1.13	13.10	4.7	7.5	3	40	3.19	55.0	13.1
22	Myanmar	1.47	15.40	1.5	156	-	-	0.70	27.0	-
23	Namibia	0.01	0.90	0	2.1	-	-	5.37	30.0	-
25	Nepal	1.03	38.20	1.6	-	-	-	1.22	12.0	42.0
24	Netherlands	0.54	61.00	1	4.5	1.1	25.3	23.05	89.0	-
26	New Zealand	0.13	8.70	0.5	198	-	-	16.57	86.0	-
28	Pakistan	16.94	80.80	72.6	55	45	81.8	1.76	36.0	34.0
27	Philippines	0.90	16.30	4.5	180	4	2.2	3.82	58.0	40.6
29	Poland	0.10	0.70	0.2	36	2.4	6.7	7.89	65.0	23.8
30	Portugal	0.49	21.80	1.5	5.1	3.1	60.1	15.15	63.0	-
31	South Africa	1.16	7.90	6.8	4.8	1.8	37.3	8.32	52.0	-
18	South Korea	1.12	60.60	2	-	1.2	-	14.64	81.0	-
34	Spain	2.83	18.10	10.9	20.7	5.5	26.6	16.73	77.0	-
33	Sri Lanka	0.28	30.70	3	17	-	-	3.06	23.0	40.6
32	Sudan	1.95	15.09	9.8	7	0.3	4	0.24	23.0	-
35	Thailand	4.08	23.90	9.5	43	0.7	1.6	5.60	21.0	18.0
36	Tunisia	0.22	7.60	1.4	1.2	1.2	101.7	5.48	65.0	19.9
37	United Kingdom	0.10	1.70	0.2	9.8	2.7	27.6	20.88	89.0	-
38	United States	22.29	12.00	105.9	1514	110	7.3	30.60	77.0	-
39	Vietnam	1.71	31.00	6.9	84	-	-	1.76	20.0	50.9

Sources: World Bank (2000), World Resource Institute (1999), IWMI (1998), and Gleick (1998).

Notes: [a]Data for Taiwan not available.

[b]'-' means data not available and in the particular case of people below poverty line, it also means the percentage is smaller than 5 percent.

variations in legal traditions, institutional arrangements, and water sector status, four states in the US (i.e., California, Colorado, Illinois, and Texas) are considered as separate regions for survey purpose. Taken together, it is these 43 countries/regions that provide the geographical context for the subjective evaluation of the process of institution-performance interaction within global water sector.

As can be seen from Table 5.1, these countries/regions jointly account for about 52 percent of the global land area, 68 percent of global population, 63 percent of global renewable water resources, and four-fifths of global freshwater withdrawal and irrigated area. From a continental perspective, the sample covers six African countries, 19 Asian countries, eight European countries, and 10 countries/regions from the Western Hemisphere. The sample is dominated by Asian countries including Israel for the understandable reason that it is in this continent there is a more acute mismatch between water demand and supply calling for urgent institutional reform. From a physical perspective, the sample covers countries/regions both in the tropical, sub-tropical, and temperate regions with differential rainfall pattern, water resource potential, and water demand. The sample also captures well the variations in water challenges facing different countries. For instance, Israel, Sudan, and Tunisia represent the problems of absolute water scarcity whereas Bangladesh, China, and Japan represent the problems of floods, drainage, and water quality. While California, Australia, and India represent the problems of sporadic droughts, most of the European countries represent water quality and environmental problems. From a development perspective, the sample covers 27 developing countries and 16 developed countries/regions. Although the data on people below the poverty line is not available for a number of countries, available data does indicate that the sample covers, at least, 60 percent of global population suffering from poverty.

Equally important is also the political diversity represented by the sample. As can be seen, the coverage includes dictatorship (e.g., Myanmar), kingdom (e.g., Morocco), communist arrangements (e.g., China), and democratic system—both parliamentary and presidential (as represented by many other countries). The form of government arrangements also varies from unitary to federal arrangements. These variations in political and government arrangements as well as in legal traditions are important as they affect the legal, policy, and administrative aspects of water sector. Since the sample covers different continents, historical backgrounds, political systems, development stages, demographic trends, water law traditions, and, more importantly, levels of water scarcity, it can represent well the reality of global water sector in all its relevant physical, economic, and institutional dimensions. The representative character of the sample is enhanced further by the fact that it also covers the full spectrum of recently observed institutional changes in the global water sector both in terms of their coverage, depth, and effectiveness (Saleth and Dinar, 1999a and 2000). Of the 43 countries/regions, 15 have undertaken a series of recent initiatives to reform their water institution in particular and water sector in general.[4] Thus, looking from any perspective, the sample countries provide a very rich contextual background for obtaining information on the subjective perception of institution-performance interaction within water sector.

Sample of Experts and Survey Process

Just like the choice of the sample countries is purposive to ensure diversity of situation and context, the list of water experts was also prepared with a deliberate purpose of representing various regions, disciplinary backgrounds, professional specialization, experience levels, and organizational affiliations. Special attention was also given to ensure that the water experts have the required level of knowledge and international exposure. In this sense, the initial list of water experts forming the prospective sample for the perception survey is certainly purposive. Considering this list of experts as a preliminary sample, an exhaustive but pre-tested questionnaire (see Appendix-A) was either personally handed over or mailed to them with detailed explanation as to the objective and scope of the exercise. The final sample includes only those experts who have actually responded with a completed questionnaire, providing all the required information. In this sense, the actual sample that constitutes the information basis our study is *almost* random, though more by chance than by design. The alphabetical list of the respondents who constituted our final sample of experts as well as other experts who supported with logistics, information, and materials is given in Appendix-B.

The survey was conducted in three phases between October 1997 and May 2001. In the first phase that spanned during October 1997-March 1998, a total of 98 key water sector experts—with a diverse disciplinary orientation, wider experience, and international exposure—were identified from 12 countries. These countries are: Australia, Brazil, Chile, China, India, Israel, Mexico, Morocco, South Africa, Spain, Sri Lanka, and the US (Illinois, California, Colorado, and Texas). Of the 98 experts contacted in the first stage of the survey, only 48 have actually responded with a completed questionnaire. Even among these responses, only 43 turned out to be complete to give comparable information on all the variables and the rest could not be used in view of large gaps or partial responses.[5] In the second phase of the survey conducted during April 1998-November 1999, another 164 water experts in 27 additional countries were approached with questionnaires for information. Of them as well as some of those who were contacted in seven of the countries covered in the first phase, 73 responded with full information.

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[4] Chapter 6 gives a comparative account of these institutional reforms and their performance linkages.

[5] These 43 questionnaires received in the first phase of the survey represented only 10 of the 12 countries as the experts contacted in Morocco as well as in the four states of the US, i.e., California, Illinois, Colorado, and Texas have not responded in time. As a result, their responses were subsequently included with the questionnaires received in the second phase of the survey.

Table 5.2. Country and Survey-wise Distribution of Sample Experts.

Countries/ Regions	Code		Recent Reform[a]	Questionnaires Obtained (1997-2000)			
	Number	Letter		Survey-1	Survey-2	Survey-3	Total
Argentina	1	AR	No	-	1	-	1
Australia	2	AU	Yes	3	3	-	6
Bangladesh	3	BD	No	-	4	-	4
Bolivia	4	BO	No	-	1	-	1
Brazil	5	BR	Yes	4	2	-	6
California	6	CA	Yes	-	3	-	3
Canada	7	CD	No	-	4	-	4
Chile	8	CL	Yes	5	1	-	6
Combodia	9	CM	No	-	1	-	1
China	10	CN	Yes	3	2	-	5
Colorado	11	CO	Yes	2	-	-	2
England	12	ED	Yes	-	1	1	2
Egypt	13	EG	No	-	2	-	2
France	14	FR	Yes	-	-	1	1
Germany	15	GM	No	-	-	2	2
Indonesia	16	IA	No	-	4	-	4
Illinois	17	IL	No	1	-	-	1
India	18	IN	Yes	5	4	-	9
Israel	19	IS	Yes	4	-	-	4
Italy	20	IT	No	-	-	3	3
Japan	21	JP	No	-	4	-	4
South Korea	22	KR	No	-	1	-	1
Laos PDR	23	LP	No	-	1	-	1
Morocco	24	MO	Yes	-	6	-	6
Mexico	25	MX	Yes	6	-	-	6
Myanmar	26	MY	No	-	1	-	1
Namibia	27	NB	No	-	1	-	1
Netherlands	28	ND	No	-	2	-	2
Nepal	29	NP	No	-	2	-	2
New Zealand	30	NZ	No	-	1	-	1
Philippines	31	PH	No	-	3	-	3
Pakistan	32	PK	No	-	3	-	3
Poland	33	PO	No	-	-	3	3
Portugal	34	PT	No	-	1	1	2
South Africa	35	SA	Yes	2	4	-	6
Sudan	36	SD	No	-	2	-	2
Sri Lanka	37	SL	Yes	3	-	-	3
Spain	38	SP	Yes	5	1	-	6
Thailand	39	TL	No	-	1	-	1
Tunisia	40	TU	No	-	2	-	2
Taiwan	41	TW	No	-	1	-	1
Texas	42	TX	No	-	1	-	1
Vietnam	43	VN	No	-	2	-	2
Total			15	43	73	11	127

Note: [a]The recent reform status of the countries is based not only on literature review but also on authors' subjective considerations as to the extent and depth of the recently observed reform initiatives.

In the third phase of the survey covering the period of December 1999-May 2000, 16 water experts were approached from some of the same countries covered in the second phase as well as from four additional countries (France, Germany, Italy, and Poland). Of them, 11 responded with a completed questionnaire. All in all, the final sample consists of 127 water experts from 43 countries/regions implying a reasonable response rate of about 46 percent. It is the information derived from the responses of these 127 experts that forms the database for the quantitative evaluation of the subjective perception of institution-performance interaction within water sector.

The country and survey-wise distribution of these experts are shown in Table 5.2. As can be seen, we have single response from 13 countries/regions but multiple responses from 30 countries/regions. Thus, the number of responses varies from one to nine. The continental pattern of country coverage and survey response can be seen in Figure 5.1.

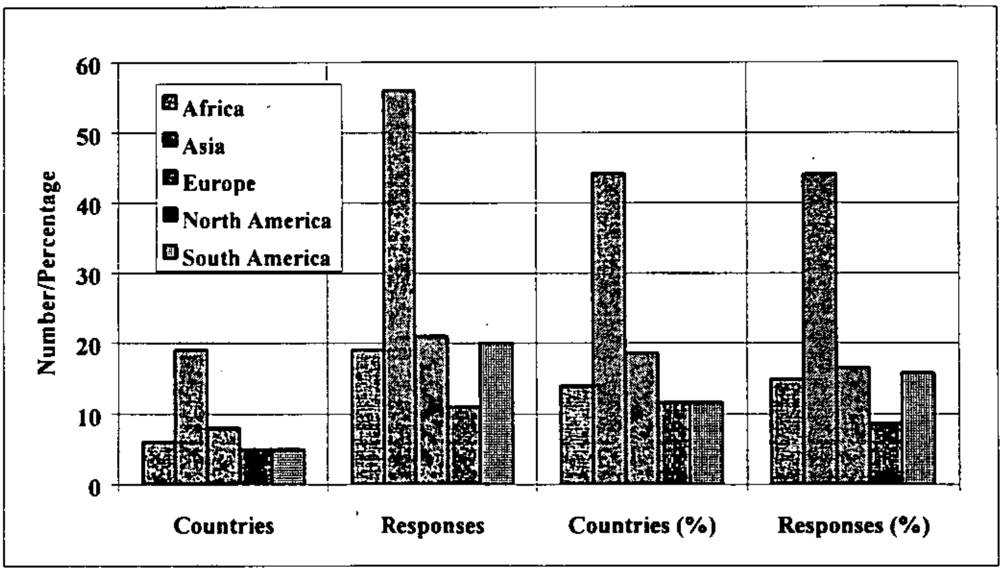

Figure 5.1

Continental Break-up of Sample Countries and Sample Experts

Asia accounting for 44 percent both in country coverage and survey response dominates other regions. As noted already, since this region accounts for the largest share in global population, poverty, and irrigated agriculture, it has to be represented well in the sample. While both the Western Hemisphere and Europe are represented relatively well, Africa comes last with a share of around 15 percent both in country coverage and survey response.[6] Except for this fact, the sample both in terms of its country coverage and survey response is, more or less, consistent with the continental pattern of demographic, resource, and institutional potentials.

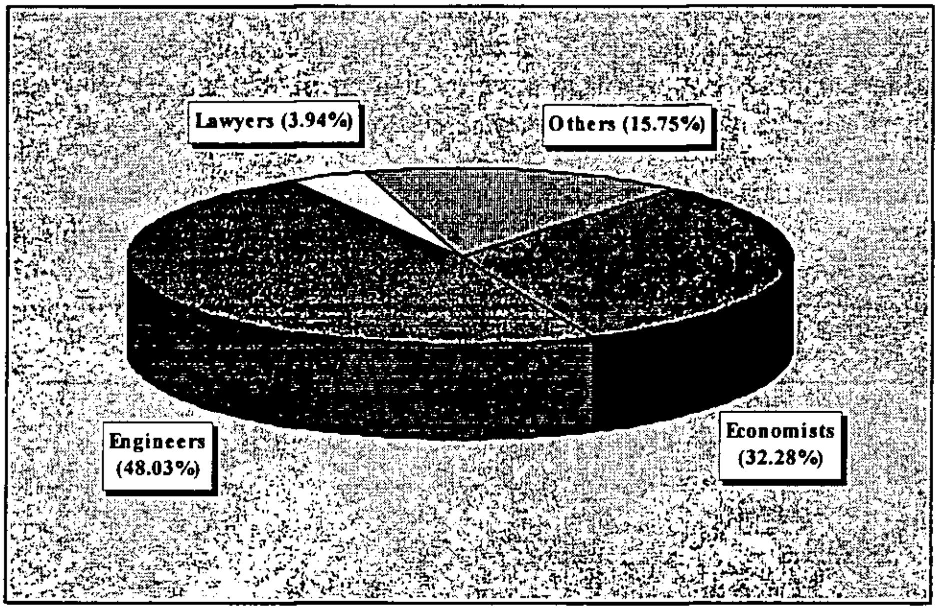

Figure 5.2

Disciplinary Background of Sample Experts

Figure 5.2 depicts the disciplinary background of the 127 experts who are included in our final sample. The majority of the respondents are engineers (48 percent) and economists (32 percent). The rest of the respondents are either lawyers or represent other social science disciplines such as management and sociology. This pattern is somewhat consistent with the existing disciplinary composition found in the water sector of most countries. We do recognize that this strict disciplinary characterization of experts does not, however, reflect fully their vast trans-disciplinary knowledge either gained from experience or learned through interaction. The fact that they were able to provide complete answers to all the legal, policy, administrative, performance issues covered in our exhaustive questionnaire is by itself an ample testimony for their wider knowledge base that extends much beyond their strict disciplinary background.

[6] While we did try to cover more countries in Africa, especially Ghana, Kenya, Nigeria, Tanzania, and Zimbabwe, the questionnaires sent to these countries have not been returned. Despite a lower coverage of countries in terms of numbers, the survey did cover other important countries of the continent, such as Egypt, Morocco, Namibia, Sudan, Tunisia, and South Africa.

Another relevant aspect related to the sample composition is that the sample also covers experts from both the government and non-governmental sectors. While experts within government are officials at the highest echelon of water administration in the respective countries, others include retired officials, academics, and international consultants. As noted already, since international exposure is one of the major criteria for their selection, the experts included in the sample do have considerable knowledge on the water sector and its institutional arrangements in other countries. Overall, the sample displays a wider diversity not only in terms of the background and experience of experts but also in terms of the development status, political arrangements, and resource endowments of the countries. It can, therefore, provide a broader spectrum of both country-specific as well as cross-country perspectives on the subjective perception of the linkages evident both within and between water institution and water sector performance.

PERCEPTIONAL INFORMATION: EMPIRICAL VALIDITY AND INTERPRETATION

As noted already, the evaluation mind change that forms the logical first stage of institutional change specifically requires perceptional information. The use of executive perception as an empirical basis for institutional analysis does have empirical precedence, theoretical justification, and practical advantages. While the empirical approach is certainly legitimate, there are still questions as to the nature of the perception-based information, its interpretation, and its amenability for a regression-based analysis. Since the validity of the results and the credibility of their policy implications are predicated ultimately on the appropriateness of the empirical context and the quality of the information, some of the most important among these questions have to be addressed prior to the analysis of the regression results.

Is the Perception-based Information Comparable?

The comparability of information is a precondition for its use in a regression context. The question over comparability arises from both the perceptional basis of the information and as well as the structure of the sample with different countries and different experts from the same country. Since water institutions and water sector issues differ both within and across countries, the responses of the experts are considered to reflect their subjective evaluation of different and apparently distinct institutional arrangements and performance conditions. But, this argument for the non-comparability of the responses ignores both the basic conceptual framework as well as the quality of sample experts involved in the evaluation process.

Conceptually speaking, water institution of each country can be considered as a set containing all of its legal, policy, and administrative features. For visual purpose, let us consider this as a circle. Although water institutions differ across countries, they do share certain common features. To reflect this reality, the water institutional arrangements at the global level can be represented by a larger circle that contains the set of intersecting circles representing both country-specific as well as common institutional aspects. A similar analogy can also be extended to conceptualize the water sector at the global level. Given their international experience, it is reasonable to consider that they evaluate only these larger sets—representing respectively the institutional arrangements and performance levels of the global water sector—that are being evaluated by them. Since the experts evaluate their country-specific situation with reference to global situation, their observations pertain to different parts of the larger entities of global water institution and global water sector. On this logic, it is legitimate to consider the independent observations of the sample experts as comparable.

While the conceptual basis of evaluation ensures the general comparability of information, a few additional aspects of comparability are to be noted in the context of both factual and judgmental information. For instance, the factual information on an institutional feature provided by an expert from of a given country becomes also relevant and comparable with that provided by experts from other countries with a similar institutional feature. The judgmental information obtained on a 0-10 scale implies that the values reported by experts are an outcome of a comparison of the current situation with an ideal situation that lies at the back of their mind. Such information can be compared only when the 'ideal situation' is the same (or, at least, closer) across experts. Since the ideal situation can either be the one existing in some other countries or be the one existing in theory, it is likely to be same across experts having substantial international experience and subject knowledge.[7]

Does Institutional Diversity Inhibit the Evaluation?

Although the present study aims to evaluate the effects of institutional variations on the performance of both water institution and water sector performance, such an evaluation is in terms of variations that are observed in major institutional typologies rather than in micro level details. Thus, the micro level institutional details—certainly an important concern for studies dealing with the institutional diversity at national and regional level, are not pertinent for the main purpose of this study. This can be illustrated by considering the legal format of water rights. While the format of water rights displays wider variations across countries, regions, and water sources, it is still possible to identify a generic set of key typologies of water rights format such as the common property rights, riparian rights, appropriative rights, correlative rights, and water permits. Since this study requires only the evaluation of the relative effects of these broad categories rather than

[7] Even if the ideal situation is not exactly the same, the independently reported judgmental values can be shown to be comparable—both within and across countries—in the sense as consumption expenditure or poverty level is being compared across individuals and countries with different utility for money and living standard norms. Again, from another perspective, the values are conceptually not much different from the one obtained from willingness-to-pay or contingent valuation surveys among individuals with different socio-economic background and other subjective characteristics.

their micro level variants, the evaluation is not constrained by the micro level institutional diversity.

How to Interpret the Variations in Experts' Responses?

When water institutions are effective in the sense that they are powerful enough to pervade the minds of the decision-makers and influence, thereby, their water allocation and use decisions, the variations in the responses of experts are likely to be lower. Otherwise, the variations will be larger among the responses due to the role of disciplinary background, differential interpretation, and other subjective factors. If the subjective factors are powerful enough to disorient perception, then, water institutions have failed in their basic role of providing a transparent framework for human-water interaction. Intuitively speaking, the magnitude of these variations can be considered as a measure of institutional ineffectiveness. For instance, the variations in factual information (e.g., the format of water rights or conflict resolution mechanism) among experts from the same country represent the degree of ignorance or uncertainty which can, in fact, be considered more as a measure of institutional ineffectiveness than as a limitation of sample experts.

Similarly, since the variations in the judgmental information of experts from the same country will be greater when institutions are ineffective and subjective factors like bias and expectations are dominant, the magnitude of such variations can also be considered as a measure of institutional ineffectiveness. While inter-country variations in both kinds of information can be considered as an indication of cross-country variations in performance of both water institutions and water sector, their intra-country variations can be interpreted as an indicator of the level of uncertainty over the features of water institutions and their performance impacts. Since the main function of institutions is to reduce uncertainty and increase transparency, the extent of uncertainty or ambiguity evaluated in this manner can also provide comparative insights on the relative efficacy and performance of water institutions in different contexts.

Can the Perception-based Data be used in a Regression Context?

The comparability of information, though necessary, is not sufficient to justify its use within a regression framework. The sufficient condition for the use of perception-based information in a regression context, however, comes from the following observation that forms the very foundation of the evaluation methodology outlined above. Experts are often observed to say that the water sector performance of a given country/region is low because of poor institutional arrangements. This is not a casual statement but based on a mental process of evaluation that compresses both the observed data as well as subjective information on water institution and water sector performance.

It is reasonable, therefore, to magnify and elaborate the mental process of evaluation to ask how low is water sector performance and how poor is the operation of water institution and use such information to see the linkages between water institutions and water sector performance. This is exactly what our evaluation methodology is doing when it attempts to obtain all the relevant information from a sample of international experts and so does our system model when it attempts to evaluate the linkages between water institution with water sector performance. Since the regression exercise actually mimics the process of evaluation that occurs in the minds of experts relying on the same set of information used in such a process, the use of the perception-based information within a regression framework is intuitively consistent and justified.

Do the Regression Results Reflect Only the Expected Linkages?

While it is true that the responses of experts is an outcome of not only their observations of reality but also their expectations of desirable situation, the regression results cannot be considered to reflect only the expected linkages. As long as the responses are truthful and are based on observed information, the results do reflect the actual linkages. Given the fact that the sample covers internationally known experts with a considerable stake on their reputation when revealing their knowledge and judgment, it is unreasonable either to question the integrity and objectivity of their responses or to consider the evaluation as a hypothetical exercise for making self-fulfilling prophecy. Even when the regression results reflect only the expected linkages, they are still valid because they are not used here to prove the already known fact that institutions matters but to evaluate the relative impact of institutional aspects on the performance of water institutions and water sector performance. In this sense, the regression results can be considered as a means for finding an international consensus in the relative importance of various institutional components and aspects in addressing water sector problems.

Can the Presence of an Institutional Aspect Ensure Better Performance?

Some of the equations in the model of institution-performance interaction postulate that the presence of an institutional aspect can improve performance on the reasoning that the performance of both water institution and water sector is likely to be better than otherwise. This does not mean any mixing up of 'cause' and 'effect'. Since there are sequential linkages and synergy among institutional components, institutional components that are considered as a means to induce changes in the institutional and water sector spheres are themselves an outcome of prior changes in other institutional components. Considering water rights system as an example, the presence of such a system implies also the presence of a related set of legal, policy, and administrative arrangements that are necessary to support its operation. While water rights system is certainly a means for improving water sector performance, it is also an end from the viewpoint of institution building. Similarly, financial self-sufficiency or cost recovery, which is an end from the financial angle, is also a means for improving the physical health and operational efficiency of water projects. Thus, the cause-effect categorization is path dependent in the sense that a 'cause' can be an 'effect' and *vice versa* depending upon the objective with which the evaluation proceeds.

DATABASE

The database for the study includes both the survey data obtained through our questionnaire from the 127 sample experts as well as secondary data pertaining to the sample countries. Given the three sets of models specified and described in Chapter 4, it goes without saying that the survey data provides the basis for estimating models A and B whereas both the survey as well as secondary data provide the basis for estimating Model C. Since models A and B are based exclusively on survey information, they are estimated with a sample consisting of the individual responses from all the 127 experts. In contrast, Model C with a hybrid information base is estimated with a sample consisting of 39 countries. This is because comparable secondary information on all the exogenous variables that form the independent variables of the model can be obtained mostly at the national level. In view of this fact and the attendant need to ensure cross-sectional consistency, all the performance variables that form the dependent variables in all the nine equations of Model C are obtained by taking the average of individual responses from each of these 39 countries. In the case of US where we considered four of its states (California, Colorado, Illinois, and Texas) as separate regions for survey purpose, the performance variables for these four regions were also averaged to represent the overall performance at the national level. With these facts in mind, let us have a brief description of both the survey and secondary database.

Survey Data

Given the elaborate and detailed nature of the questionnaire and the meticulous nature of the information provided by the respondents, our survey enables us to generate, at least, a total of 75 variables. This list includes 17 legal variables, 25 policy variables, 27 administrative variables, five water sector performance variables, and a water institution performance variable.[8] Of these 75 variables, we have selected, however, only 26 variables to build the models A and B as specified in Chapter 4. These variables include 21 institutional variables (seven each of the legal, policy, and administrative variables), four institutional performance variables, and a water sector performance variable. As could be seen from the model specification, the selected institutional variables are those representing some of the most important institutional aspects which are receiving considerable attention in the currently ongoing policy debate worldwide. The coverage of institutional aspects include, among other things, water rights, conflict resolution,

[8] The full data set containing the 127 observations on these 75 variables can be obtained from the authors upon request with an understanding that the information will be used for academic, policy, and non-commercial purposes.

accountability, privatization, user participation, decentralization, project selection and cost recovery, water transfers, balance in functional specialization, information adequacy, and science & technology application. The descriptive statistics for the 26 institutional and performance variables included in models A and B are given in Table 5.3.

Secondary Data

The objective of collecting secondary data is to develop variables to capture the role of physical, demographic, socio-economic, and institutional factors that are exogenous to both water institution and water sector but have a strong influence on their performance. While these exogenous factors are many, the attention is focused on the following crucial aspects. They are the development status, demographic condition, resource scarcity, sectoral orientation of the water economy, food production, social sector investment, distributional equity, ecological status, overall institutional effectiveness, and external perception of the credit worthiness of the country. Given these aspects that form part of the overall environment within which institution-performance interaction occurs within water sector, a set of variables is selected to represent them. The result is a selection of 12 variables that form the independent variables in all the nine equations of Model C as specified in Chapter 4. Since it is more meaningful and also easier to obtain information on these variables at the national level, they are collected for the 39 countries covered in our country/regional sample.

Table 5.4 shows the descriptive statistics for the 12 exogenous variables obtained from secondary sources as well as the nine institutional and water sector performance variables obtained from our survey. As noted already, the nine performance variables for each country are obtained by averaging the corresponding responses from all the experts from that country. This is true for all countries except the 13 countries for which there is only one response. While the secondary information for most of the exogenous variable is obtained from World Bank (1998, 1999, and 2000), the information on the share of natural capital in national wealth and environmental regulatory regime index is obtained respectively from Kunte, et al. (1998) and Esty and Porter (2000).

While the objective and rationale for the selection of the set of exogenous variables are obvious, we find two difficulties in getting comparable information for all the 39 countries in the sample. First is the difficulty in getting data on all variables for the time period that coincides with that of the survey information. As a result, the time period of the data differs across variables as shown in Table 5.4. Although this problem is difficult to overcome, we tried to collect data for periods that are as close to the survey period as possible subject, of course, to data constraint. The second difficulty is related to the non-availability of data on few variables for one or more countries. In the case of these variables and countries, we used the corresponding data from similarly placed other

Table 5.3. Descriptive Statistics for Perception-Based Institutional and Performance Variables.

Sl. No.	Variables			Mean Values	Standard Deviation	Range	
	Names	Acronyms	Types			Min	Max
1	Treatment of Surface and Sub-surface Water	LTRWSA	Dummy	0.331	0.472	0.00	1.00
2	Format of Surface Water Right	LPRSRF	Category	2.606	1.470	0.00	7.00
3	Effectiveness of Conflict Resolution Provisions	LCRMEE	Scale	5.235	2.566	0.00	10.00
4	Effectiveness of Accountability Provisions	LACPRE	Scale	4.427	2.684	0.00	10.00
5	Degree of Integration Within Water Law	LINTRE	Scale	3.622	3.326	0.00	10.00
6	Tendency for Centralization in Water Law	LOECEN	Scale	5.063	2.878	0.00	10.00
7	Scope for Privatization in Water Law	LOEPRV	Scale	4.662	2.601	0.00	10.00
8	Overall Effectiveness of Water Law	LOEFWL	Scale	5.361	2.059	0.00	10.00
9	Project Selection Criteria	PPSCRI	Category	3.530	1.561	0.00	6.00
10	Level of Cost Recovery	PCOREC	Category	2.230	0.712	0.00	4.00
11	Effectiveness of Water Transfer Policy	PIRSWE	Scale	3.277	2.384	0.00	8.75
12	Impact of Private Sector Participation Policy	PGPIPP	Scale	4.284	3.105	0.00	10.00
13	Impact of User Participation Policy	PGPIUP	Scale	3.654	2.844	0.00	10.00
14	Impact of Other Policies on Water Policy	POPAWE	Scale	5.622	1.715	0.00	7.00
15	Overall Linkage Between Law and Policy	POELWL	Scale	5.660	2.429	0.00	10.00
16	Overall Effectiveness of Water Policy	POEFWP	Scale	4.615	2.003	0.00	8.67
17	Organizational Basis of Water Administration	AORGBA	Category	2.504	1.463	0.00	5.00
18	Balance in Functional Specialization	ABALFS	Dummy	0.472	0.501	0.00	1.00
19	Existence of Independent Water Pricing Body	AIBDWP	Dummy	0.252	0.436	0.00	1.00
20	Seriousness of Budget Constraint	ASBUDC	Scale	3.381	3.289	0.00	10.00
21	Effectiveness of Administrative Accountability	AACCME	Scale	4.364	2.518	0.00	10.00
22	Adequacy of Information	AARINF	Scale	6.217	2.190	0.00	10.00
23	Extent of Science/Technology Application	AEXTST	Scale	4.463	1.989	0.00	10.00
24	Overall Effectiveness of Water Administration	AOEFWA	Scale	4.828	2.050	0.00	9.00
25	Overall Evaluation of Water Institution Performance	WIPOEV	Scale	5.499	2.033	0.00	10.00
26	Overall Evaluation of Water Sector Performance	WSPOEV	Scale	5.165	1.583	0.00	8.67

Table 5.4. Descriptive Statistics for Perceptional and Observed Variables Used in Hybrid Models.

Sl. No.	Variables				Mean Values	Standard Deviation	Range	
	Names	Units	Periods	Acronyms			Min	Max
1	Overall Effectiveness of Water Law	Scale	1998-00	LOEFWL	5.42	1.62	1.55	10.00
2	Overall Effectiveness of Water Policy	Scale	1998-00	POEFWP	4.30	1.73	0.00	7.12
3	Overall Effectiveness of Water Administrn.	Scale	1998-00	AOEFWA	4.84	1.72	0.00	8.75
4	Overall Evaluation of Water Institution	Scale	1998-00	WIPOEV	5.43	1.73	0.00	8.50
5	Overall Evaln.: Physical Performance	Scale	1998-00	WSPPHY	5.32	1.57	0.00	8.30
6	Overall Evaln.: Financial Performance	Scale	1998-00	WSPFIN	5.17	1.80	0.00	8.25
7	Overall Evaln.: Economic Performance	Scale	1998-00	WSPECO	4.41	1.93	0.00	8.75
8	Overall Evaln.: Equity Performance	Scale	1998-00	WSPEQU	5.53	1.90	0.00	9.33
9	Overall Evaln.: Water Sector Performance	Scale	1998-00	WSPOEV	5.11	1.58	0.00	8.66
10	GNP(PPP)/Capita	($)	1999	GNPPPC	9.97	8.80	0.24	30.60
11	Population Density	(People/km^2)	1999	POPDEN	154.95	186.49	2.00	981.00
12	Decadal Change in Urban Population	(%)	1980-90	DCPOUP	7.15	7.48	-1.00	34.00
13	Freshwater Withdrawal/Year /Capita	M^3	1980-98	FWATWC	614.34	400.50	41.67	1639.90
14	Agricultural Share in Total Withdrawal	(%)	1987-98	PWATAG	65.10	29.87	0.00	99.00
15	Arable land/Capita	(ha)	1995-97	ALANDC	0.33	0.48	0.03	2.75
16	Food Production Index (1989-91 = 100)	(Index)	1996-98	FPIIND	117.92	14.93	88.20	153.50
17	Public Expenditure on Education	(% of GNP)	1997	EXPEDU	4.73	1.95	1.20	9.10
18	Gini Index	(Index)	1985-97	GININD	37.64	8.20	24.90	60.00
19	Share of Natural Capital in Total Wealth	(%)	1990-94	NCNATW	8.08	6.30	1.00	22.00
20	Environmental Regulatory Regime Index	Score	??????	ENVRRI	-0.06	0.81	-1.52	2.71
21	Institutional Investor Credit Rating	(Index)	2000	ININCR	55.99	24.36	16.90	92.90

countries as surrogate information following the approach used by Kunte, et al. (1998). The variables and the countries for which the surrogate approach is used are shown in Table 5.5. As can be seen from this table, the surrogate information is used more heavily in the case of the two variables representing respectively the share of natural capital in national wealth and the environmental regulatory regime index as these information are not available for many countries.

Table 5.5. Details on the Use of Surrogate Data.

Sl. No.	Variables	Countries	Surrogates
1	GININD	Sudan	Tunisia
2	EXPEDU	Sudan	Tunisia
3	ALANDC	Sudan	Tunisia
4	FPIIND	Sudan	Tunisia
5	ININCR	Sudan	Tunisia
		Combodia	Vietnam
		Laos PDR	Vietnam
6	NCNATW	Sudan	Tunisia
		Combodia	Vietnam
		Laos PDR	Vietnam
		Poland	Netherlands
		Bolivia	Chile
		Israel	Jordan
		Myanmar	Thailand
7	ENVRRI	Sudan	Zimbabwe
		Tunisia	Zimbabwe
		Morocco	Zimbabwe
		Nambia	Zimbabwe
		Bangladesh	India
		Pakistan	India
		Sri Lanka	India
		Nepal	India
		Myanmar	Thailand

In any case, these two problems related to the secondary data on the exogenous variables are not expected to affect the results of Model C in any serious manner. This is due to the following reasons. First, we note again that these exogenous variables are used essentially as indicators of the overall environment within which the process of institution-performance interaction occurs within water sector in different countries. As a result, differential time period of the variables is not going to have any serious effect. Second, since the surrogate approach is used mostly in the case of variables that take into account some of the qualitative and relative magnitudes, we expect that this approach will not have much effect on the overall results. Both tables 5.3 and 5.4 are instructive not only to give a flavor of the kind of survey and secondary information underlying the estimation process but also as a necessary background for the interpretation of estimation results of various models to be presented in Chapter 7.

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Chapter 6

INSTITUTIONAL CHANGES IN WATER SECTOR: A CROSS-COUNTRY REVIEW

Institutional arrangements governing water sector are undergoing remarkable changes worldwide in recent years. Even though the extent and depth of these changes vary by country-specific economic, political, and resource realities, they do evince notable commonalities. What are the nature and direction of these institutional changes? Which are the factors that prompt and sustain such changes? How pronounced are the common trends and patterns? Are there 'best practice' cases? How relevant are they for universal application? The purpose of this chapter is to provide some answers these and related questions based on review of institutional changes in our sample countries. Given the scope of our study and purpose of this chapter, the cross-country review attempted here is rather brief concentrating on key institutional features and main thrust of recent reforms.

Even though the review is neither complete nor comprehensive, it is significant on four counts. First, since the review highlights the relative influence of exogenous factors (e.g., socio-economic, demographic, political, and resource-related aspects), it provides cross-country anecdotal evidences for the effects of the overall institutional environment both on institution-performance interaction (see Figure 4.2) and on the perception of sectoral performance (see Model C). Second, since the review is performed within an analytical framework rooted in institutional transaction cost theory, it is possible to understand and explain the occurrence and depth of reforms across countries as a direct outcome of transaction cost-opportunity cost calculus. Third, despite its brevity, the review can place sample countries in the four stages of our perception-based conception of institutional change. And, finally, the review provides a political economy background and context for the quantitative analysis of institution-performance interaction within water sector being attempted in the ensuing chapters.

WATER INSTITUTIONAL CHANGE: AN ANALYTICAL FRAMEWORK

The cross-country review can be more illuminating when performed within the analytical framework based on institutional transaction cost theory. Institutional transaction cost approach, as developed by North (1990a), is more general than the original transaction cost approach as it can also incorporate the real costs associated with many non-economic and non-market aspects. As such, this approach can capture the individual and interactive effects of both economic and non-economic factors within a common analytical framework. In the particular context of water sector, the factors affecting water institutions are many with a diverse origin and varying impact. For analytical convenience, they can be grouped into endogenous factors that are internal to water sector and exogenous factors that are outside the confines of both water institution and water sector.[1] Since the exogenous and endogenous factors are interrelated and their relative impacts differ by context, it is difficult either to isolate their individual roles or to generalize the direction of their effects. But, their effects can be tracked within the institutional transaction cost framework by conceptualizing them as part of either the transaction costs or the opportunity costs of institutional change. For water institutions, the transaction costs cover both the real and monetary costs of instituting the regulatory, monitoring, and enforcement mechanisms related to water development, allocation, and management. Similarly, the opportunity costs cover both the real and economic value of opportunities foregone or the net social costs of '*status quo*'. Since the theory asserts that institutional change occurs when the opportunity costs exceed the transaction costs to trigger a political thrust for reform, it is consistent both with the welfare-theoretic logic as well as with the political economy argument.

As noted in Chapter 3, although the opportunity and transaction costs are difficult to quantify exactly, they can be identified and approximated. Unfortunately, the prevailing approaches for the estimation of the opportunity and transactions costs of institutional change are static and partial, as they do not account either for the dynamics of institutional inter-linkages or for the impact of exogenous factors. Since institutional inter-linkages and exogenous factors often play a powerful role in influencing the nature, direction, and speed of the process of institutional change, their exclusion leads to an underestimation of the true potential for institutional change in a given context. Institutional change is not a one-time event but rather a continuum that moves in line with the changing resource realities, socio-economic needs, and political power structure. As the reforms initiated in the early stages brighten the prospects for downstream reforms, there are intricate and functional linkages between the transaction costs of subsequent reforms and the opportunity costs of earlier reforms.[2] Similarly, since the institutional changes within water sector derive considerable synergy from exogenous factors reflecting changes elsewhere in the economy, the transaction costs of water sector reforms can also decline due to scale economies in institutional change.[3]

The opportunity and transactions costs of institutional changes are not static but change continuously due to the effects of institutional inter-linkages as well as the impacts of endogenous and exogenous factors. For instance, water scarcity becomes

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[1] The endogenous factors include water scarcity, water conflicts, financial and physical deterioration of water infrastructure, and operational inefficiency of water institutions. The exogenous factors include economic development, demographic growth, technical progress, economic and political reforms, international commitments, social values and ethos, and natural disasters such as floods and droughts.

[2] For instance, with the institution of transferable water rights, the prospects for other institutional aspects such as conflict resolution and water markets increase due to the linkages that the transactions costs of the latter two institutional aspects have with those of the water rights system.

[3] The scale economies in transaction costs emerge from the fact that the cost of transacting water institutional changes is lower when water sector reform forms part of an overall country-wide economic reform and political reconstruction than otherwise. It also shows how institutional changes within water sector are linked to exogenous changes elsewhere in the economy.

acute due to economic development and population growth, the real and economic costs of inappropriate water institutions tend to rise creating, thereby, both an economic and political urge for change. Similarly, the economic reforms magnify the fiscal implications whereas natural calamities such as droughts and floods aggravate the political implications of the opportunity costs of inappropriate institutions. Political reforms involving nation-wide institutional changes, on the other hand, reduce the transaction costs of water sector reforms directly because the institutional changes within water sector form only a small part of the overall reform process. Likewise, technical progress (e.g., satellite and information technologies, and computer-based water control structures) can also reduce the transaction costs of institutional changes. As the exogenous factors tend to magnify the opportunity costs of water crisis and reduce the transaction costs of water sector reforms, they often provide a powerful economic urge and political thrust for institutional changes within water sector.

The analytical framework based on the transaction cost theory captures not only the role of factors both within and outside the water sector but also the strategic significance of certain dynamic aspects of institutional change such as institutional inter-linkages and scale economies. Although the set of factors affecting institutional changes does not vary much across countries, their relative significance in the opportunity and transaction costs calculus vary by county-specific contexts. It is the contextual nature of these variations that, in fact, explain why countries differ in terms of the extent and depth of water institutional reform. As the transaction cost theory provides a unified framework to track and account for the effects of myriad factors affecting institutional changes, it can be used as a theoretical basis for explaining both the country-specific as well as cross-country variations in the nature and direction of water institutional changes.

WATER INSTITUTIONAL CHANGES: A CROSS-COUNTRY REVIEW[4]

Before attempting a review of recent institutional changes in the sample countries, it is necessary to recognize the following aspects. First, we need to keep in mind (a) the institutional transaction cost framework discussed above, (b) the stage-based conception institutional change (see Chapter 3), and (c) the socio-economic profile and water sector feature of sample countries (see tables 5.1a and 5.2). Since these aspects provide the framework and context, they can enhance our understanding of the 'why' and 'how' of the observed institutional changes. Second, from an analytical perspective, the review can be organized by either on a country-by-country basis or by classifying the sample countries in terms of their reform status, resource situation, development status, or geographic location. We opt to organize the review in terms of nine geographic regions, i.e., North America, Latin America, Europe, Middle East, Africa, South Asia, South East Asia, and Oceanic. As we can see, this framework also reflect the regional variations in development status, water resource realities, and reform initiatives. And, finally, the

[4] Country summaries for Japan, Pakistan, and the US (covering mainly California, Colorado, Illinois, and Texas) are yet to be incorporated.

review has a varied focus and coverage of country-specific situation partly for the need to give more attention to countries with recent reforms and partly due to a lack of comparable information. With these words, let us now present a quick review of water institutional changes.

North American Region

Water quality and environment are the major concerns facing the water sector in **Canada**. As a results, the recently observed legal and policy initiatives a dominant focus on these concerns [see International Commission on Irrigation and Drainage (ICID), 2000a; Canadian National Committee on Irrigation and Drainage (CNCID), 2000]. The Federal Water Act and Federal Water Policy that was formulated in mid 1980s provide a national framework for protecting water quality and enabling sustainable water management. While the federal-provincial body, i.e., the Canadian Council of Ministers of the Environment, has a policy and oversight role at the national level, regional interests and locational aspects have led to notable changes in provincial water laws and policies. For instance, the Federal Irrigation Act has undergone changes in Ontario and Quebec. Ontario is currently preparing the Water Resources and the Environmental Protection Act as well as the Pesticides Act to address its water quality and environmental problems. Similarly, Quebec is currently preparing a new Water Management Policy with an integrated approach to water resources management. Since several trans-boundary rivers and water bodies with the US, water management in Canada also has an international dimension. The water implication of climatic change is a major long-term issue facing Canadian water sector.

Latin American Region

Prompted by the macro-economic crisis of the late 1980s, **Mexico** has initiated unprecedented reforms in the water sector beginning first with its irrigation segment in 1988. The irrigation sector reform involved a transfer of 2.9 mha—representing 87 percent of the area under major and medium irrigation and 46 percent of the total area under all irrigation—to 386 WUAs. On legal front, the National Water Law in 1992 and the Federal Law of Regulations in Water Matters in 1994 were enacted. On policy front, there is a clear accent on decentralization and privatization. While water supply functions are being moved to provinces and municipalities, financially self-dependent utilities and private companies are being created in urban areas (see Hazin, 1998). With the success of Llerma Basin Council (1989), basin approach is now extended to Rio Bravo (1994) and Valley of Mexico (1996) basins. For encouraging private irrigation investment, the New Agrarian Act has relaxed land ceiling for irrigated land from 20 to 100 ha. The legal and policy changes coupled with the irrigation management transfer (IMT) have also led to some notable changes in water administration. The Commision Nacional del Agua (CNA), the key organ of water administration, was moved from the Ministry of Agriculture to the Secretariat of Environment, Natural Resources, and Fishing.

Chile has a well developed institutional arrangements quite favorable for market-based water allocation, decentralized management, and private sector participation. As per the 1981 Water Code and the 1988 Constitution, water use right is treated as a private property independent of land that can be traded, used as collateral, and treated as assets for tax purposes (see Gazmuri and Rosegrant, 1994). Chilean water administration also has a better demarcation of responsibilities. While the state grants quantified water rights to users, active water markets reallocate such rights both within and across sectors, WUAs distribute water, collect fees, and maintain the system; and WUAs and courts resolve conflicts (see Gazmuri and Rosegrant, 1994; Herne and Easter, 1995). In the urban sector, the corporatization and privatization of state-owned water supply agencies and the consequent entry of private water companies have improved both the coverage and quality of water and sanitation services (Gazmuri and Rosegrant, 1994:25). In order to avoid speculation and discourage large-scale water rights transfer from agriculture to power and urban sectors, there is a legislative proposal to allow forfeiture of water rights for non-use for five years and to create sector-specific water rights. The Environmental Law of 1994 not only mandates water supply agencies to treat wastewater but also stipulates minimum in-stream flow for ecological purposes.

The adoption of a new Constitution in 1988 marks the beginning of water sector reforms in **Brazil.** By distinguishing 'federal waters' from 'state waters', the Constitution makes both the federal and state governments responsible for water management. The National Water Resource Policy Law, though delayed since 1991 due to federal-state disagreements, was finally passed in 1997. Eight major states have also passed their own water laws. While law precludes ownership rights, it does allow private use rights. On water administration front, the long domination of the power sector in national water policy finally ended in 1995 with the transfer of water from the Ministry of Mining and Energy to the newly created Ministry of Environment, Water Resources, and Legal Amazon. Despite the attempt to consolidate water issues within a single administrative apparatus, there are many water-related functions (e.g., irrigation, extension, urban water supply, and water quality) that remain still administratively dispersed. There are also notable trends towards administrative decentralization and privatization of urban systems. The creation of National Water Resource Management System and the establishment of national, basin, and state level water councils is expected to improve coordination.

Although water sector reforms in **Argentina** are not as extensive as in Mexico, Chile, and Brazil, there are also some notable institutional initiatives (See Artana, et al., 1999; World Bank, 2000a and 2000b). Argentina has undertaken several significant reforms and is also planning for more changes. While water scarcity, salinity and drainage problems, water quality and pollution issues, and floods are creating a constant pressure for reforms, the immediate prompt for reform came from the financial and performance crises of irrigation and water supply systems and the severe fiscal problems facing both national and provincial governments. The reforms had a major focus on decentralization and privatization. Most of the irrigation districts under federal administration were transferred to the provinces with the eventual plan for management transfer to WUAs. About 100 major dams with a total capacity of 160 bcum are being operated by private sector. Buenos Aires concession of 1993 and similar arrangements in the province of Corrientes are the notable instances for privatization of water supply and sanitation systems. Currently, efforts are afoot to create a common regulatory framework for all provinces, prepare a national water master plan, and modernize water sector in general and irrigation sector in particular.

European Region

The major features of water sector and its management systems in **United Kingdom** (UK)[5] are an urban orientation, quality-induced scarcity, and a centralized regulation with decentralized service provision by private companies [see Rees and Zabel, 1998a and 1998b; Office of Water Services (OFWAT), 1999a and 1999b; Department of Environment, Transport and the Regions (DETR), 1998a, 1999b, and 1999]. Water is a shared resource with private use rights and public management rights. Although there is not any exclusive water law, the legal principles for water management are derived from the common and the case laws. Apart from water rights, some of the long-standing institutions of UK include regional water authorities, private involvement, and charging system for water use and pollution. Although privatization of water services started in the late 1970s, the process gained momentum in 1985 till its completion in 1989. The Regional Water Authorities have become Water and Sewerage Companies and are being regulated by OFWAT and by the Drinking Water Inspectorate. While the Department of Environment is responsible for water planning, the National River authority is responsible for planning coordination. Even though the planning and implementation processes are participatory, there are also several avenues for dispute resolution. Like other European countries, the EC water directives also have their effects on the water policies of UK. While the separation of regulatory functions from operational functions and public-private partnership have contributed to effective to management and improved services, aspects like rigid price regulations and mixed payment systems are having some negative efficiency and equity effects.

The water sector and its institutional arrangements in **France** have undergone significant changes in resent years (see Barraque et al., 1998a and 1998b; Betlem, 1998a and 1998b; Rees, et al., 1998; Rees and Zabel, 1998a and 1998b; Santos and Rodrigues, 1998; Zabel, 1998; Agence Loire-Bretange, 1998). These changes have created and strengthened a basin-based and participatory framework for water management in France. In 1964, basin-based institutional arrangements were created with 6 basin agencies and 25 departments. The new water law of 1992 has sharpened further their managerial, regulatory, and monitoring functions. Since the basin agencies lack enforcement power, the 'river contract'—an institution based on voluntary collective action—and *Police de l'Eau*—an institution responsible for monitoring water withdrawal and discharge—have

[5] The summary reflects essentially the features of water management system in England and Wales, though some features are common to the same in Scotland and Northern Ireland.

evolved to strengthen monitoring and enforcement. Since basin committees are more representative, state power in these committees have declined from 1/2 to 1/5. A new reform prepared in 1998 aims to improve the financial means for water law enforcement and charging for agricultural pollution and flood risk aggravation. Latest policy trends include the introduction of catchment planning agencies in basin and sub-basins levels, partial trans-versalization of water services in large cities, and the creation of municipality-owned water companies in other urban areas. EC also has substantial effects on water sector reforms in France. In fact, legal changes are being introduced since 1989 to comply with EC directives water subsidy, water quality, and environment.

The water sector in **Spain** is spatially organized into 14 river basin organizations (RBOs) known as 'Confederaciones Hidrograficas'. These RBOs, though operate under the Ministerio de Obras Publicas Y Transportes (MOPT), are the real executive arm of water administration responsible for water development, bulk allocation, pricing, and monitoring and enforcement. Operating below the RBOs are the municipalities and irrigation communities that distribute water, collect charges, and resolve conflicts at local levels. The 1985 water law allows users to obtain use and source-specific water and discharge permits from the RBOs. As mandated by this law, a comprehensive National Water Plan together with Basin Water Plans has been prepared in 1993 (MOPT, 1993). Since Spain is a member of the European Community (EC), its water policies—especially those related to water subsidy and water quality—are strongly influenced by EC's agricultural and environmental policies. As per the EC directives, Spain has prepared during 1994-95 a plan for time-bound improvement in water quality. Apart from the subsidy and water quality targets, EC also requires Spain to reduce its irrigated area by 10 percent.[6] The notable among some of the recent initiatives include the proposals to introduce transferable use rights, grant financial autonomy to RBOs, construct new projects only with users' prior agreement to pay full costs, and encourage private sector participation in construction, distribution, sewerage treatment, and pollution control.

The major water problems of **Portugal** are regional water disparity, heavy evapotranspiration (50 percent of available water), and substantial trans-boundaray flow (a third originating from Spain). Responding to these and other problems, Portuguese water institutions are changing significantly (see Correia, et al., 1998; Nunes, et al., 1998; Maia, 2000). As per law, surface water is largely public whereas groundwater is private subject public regulation. Legal changes in 1990 have reoriented the legal framework from agency and sector-specific regulations to an integrated approach to water management. In 1993, notable changes were initiated both in policy principles and administrative structure. The policy principles are: (a) to prepare water plans at the national, basin, and sub-basin levels; (b) implement them through the national and basin level water councils; (c) license water use rights; and (d) introduce polluter/user-pay principles in all sectors between 1993 and 2004. The Ministry of Environment was

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[6] The crop diversification programs alone cannot meet this challenge. As water markets can be a part of the solution in such situations (Garrido, 1997), deliberate policies and legal provisions are needed to facilitate their emergence and growth.

restructured to create the Secretariat for Natural Resources with a national mandate and 5 regional directorates with basin level mandate for water management. Notably, since present river basin management structures are created by dismantling previous basin structures, they need time for articulation and maturity. Following the 1993-94 legislation, privatization of urban water supply has been initiated in five metro regions including Lisbon whereas corporatization initiative has created 12 state-owned water companies in other urban centers. While environmental auditing/inspection and public-private partnership are the main vehicles used for meeting EC's water directives, the relatively old water treatment technologies continue to limit progress.

Apart from the internal pressure from water quality and scarcity problems, the water sector in **Germany** is also affected by the political aspect of German unification as well as by the international aspects of EC directives related to water sector and water sharing agreements. Although the legislative framework for water management in Germany is quite recent, the regulatory regime is based both on planning instruments, permitting and licensing procedures, and economic instruments (see Kraemer and Jager, 1998; Rees et al., 1998; Rees and Zabel, 1998b). The principle that water should be managed as part of the environment is maintained both in law and policy. The three-tiered political arrangement of Germany also has its reflection on the water administration. With the unification, the centralized administrative structure in East Germany is being gradually reformed. The multiple organizational arrangements at the federal, provincial, and local levels create coordination and enforcement difficulties. Although a centrally coordinated research and education system is absent, there are successful private sector initiatives in this important arena. While German water institution has several merits (e.g., separation of managerial and operational functions and integration of direct regulation with economic incentives), its main weaknesses are the lack of coordination and insufficient articulation of water quality and environment in water policy.

The evolution of water management institutions in **Netherlands** is dictated not only by factors such as economic development and population expansion but also by two geographical features of country (see Perdock and Wessel, 1998). With a significant area (30 percent) and population (60 percent) are below mean sea level, Netherlands face the problems of both water scarcity and water excess. Since nearly three-quarters of the water inflow originates outside the border—with two-thirds of inflow from the Rhine along, there is also an inescapable international dimension. Both these features also create water quality and drainage-related problems. The most important legislation is the 'Organic law' that consists of constitutional rules for various organizations involved in water management such as the state, provinces, municipalities, and water boards. Besides this law, there are the State Act (1971) stipulating the water tasks of the state and the Water Boards Act (1992) specifying the operational rules for water boards. As per the legal framework, water management is mainly the task of public administration with the state, province, and local and regional bodies sharing the management responsibilities, though the planning and management process is highly participatory and transparent. There is a well-established system of water rights under which users can acquire water rights by property transfer, acquisition, inheritance, or reallocation subject to public regulatory rights. Despite its institutional maturity and resilience, the Dutch waster sector still faces major challenges in managing floods, controlling non-point pollution, ensuring the financial viability of water boards, and meeting the EC water directives. Recently, many provinces adopted the National Water Policy, but it is not yet fully operationalized.

Irregular water distribution, weak water retention (only 5 percent of annual precipitation), pollution and nitrate contamination, and extreme dependence on Wisa and Odra river basins (with 80 percent of available water) are the major features of water sector in **Poland**. The legal system is weak and water management issues are approached essentially from an environmental perspective [see Berbeka, 2000; Lorek, 2000; Poland National Committee on Irrigation and Drainage (PNCID), 2000]. As such, the Ministry of Environment, the apex body responsible for water management at the national level, has a broader mandate including environmental protection and pollution prevention and control. The national policies are being implemented by corresponding agencies at the provincial and local levels. Each province (voivodship) has a Department for Environmental Protection having both management and regulatory functions including issuing of permits and setting discharge standards. The main responsibilities of gminas, the local governments in Poland include water supply and wastewater treatment. There are also agencies outside the structure of the Ministry of Environment (e.g., the state and provincial level Inspectorate for Environmental Protection and the National Fund for Environmental Protection and Water Management) that play important roles in areas such as enforcement, data gathering, and financial support.

Pressed by an increasing water scarcity and the EC directives on water and environment, the water sector and its institutions in **Italy** are now witnessing notable changes [see Massarutto, 1999 and 2000; Italian National Committee on Irrigation and Drainage (INCID), 2000; United Nations, 2000]. Although Italian legal and institutional frameworks of water policy went major reforms lately to conform to EC directives, implementation and enforcement still lack behind. It is only with the Law 36/1994 that the government could establish that all water uses need license. But, licensing is difficult to implement and enforce as it is implemented by the peripheral administration of the Ministry of Public Works through its regional organs. Besides, regional autonomy and diverse management structures (e.g., almost an exclusive reliance on public irrigation in the south but heavy involvement of private water users in the north) also create their own constraints. Water issues concerning more than two regions are dealt within relevant Basin Authorities with the involvement of some State ministries. Although the Italy has made a significant progress in the last 20 years, there are still many areas needing urgent reform. These include the framing of a comprehensive water policy applicable across uses and regions, enhancing the coverage and effectiveness of economic instruments, and strengthening of administrative coordination among public agencies at various levels.

African Region

The radical changes witnessed in the water sector of **South Africa** are part of the ongoing process of post-Apartheid economic and political reconstruction. The water law enacted in 1998 defines a modern legal system conducive for management decentralization, market-based water allocation, full cost recovery, and integrated water resource management. As per the law, private and tradable use rights can be obtained from the Department of Water Affairs and Forestry (DWAF). Natural Resources Courts are created to resolve water conflicts. The White Paper on National Water Policy (DWAF, 1997) gives top priority for capacity building, information needs, and human resource development. Water charges—applicable only in public irrigation system—will be extended to all irrigation systems. Similarly, the WUAs—currently operating mostly in sugarcane zones—are to be extended to other areas. On administration front, it is proposed to create a National Public Water Utility to finance, develop, and operate all water infrastructures (DWAF, 1997: 29). Basin entities—known as the Catchment Management Agencies—are being created to involve farmers, irrigation boards, and municipalities as stakeholders. The relative success of water boards—the regional public utilities for bulk water supply—is paving way for the creation of new regional water organizations (e.g., Lesotho Highlands Water Project and Komati Basin Water Authority).

Despite a centralized political structure, water administration in **Morocco** evinces remarkable decentralization tendencies. The water law of 1995 has led to significant changes both in the spheres of water policy and water administration. It makes the Supreme Water Council (involving all major water sector stakeholders) as the key organ for national level water policy and the RBOs—each covering one or more Regional Authorities for Agricultural Development—as the regional nodes of water administration. The national and basin water plans mandated under the law are to provide technical framework for formulating both national and regional water management strategies. By advocating users pay principle and full cost recovery, the law requires water abstraction and pollution taxes. Recent ministerial reorganization has brought together agriculture, water, and environment under the Ministry of Agriculture, Equipment, and Environment. The ongoing programs for canal lining, pressurized supply of canal water, and the application of sprinkler and drip systems aim to enhance water use efficiency in irrigation. The urban water conservation in Rabat achieved through demand-side management and that in Casablanca attained through a privatized system of water supply suggest new avenues for reforming the urban water sector.

The water sector in **Sudan** is characterized by acute regional variations (drought in north but floods in south), heavy dependence on shared Nile water (79 percent), meager share of groundwater (16 percent), high evapotranspiration, and extreme irrigation orientation (91 percent). Although water issues are on top of policy agenda, actual reforms are rather disproportionate to intentions and requirements (see Adam, 1997; World Bank, 2000; The Economist Intelligence Unit, 2000c; Government of Sudan, 2001). The legal framework of water sector saw a major change since the enactment of Water Resources Act in 1995 that, in fact, updated and consolidated all previous water-related acts. The Ministry of Irrigation and Water Resources (MIWR) handles nearly all water resources under the overall policy guidance and coordination of the National Council for Water Resources. While the National Water Corporation is responsible for drinking water supply, the Irrigation Water Corporation—established under the MIWR in 1995—is responsible for managing irrigation sector. But, the Gezira irrigation scheme—accounting for 35 percent of Nile supply—is under the Sudan Gezira Board. On the policy front, pricing mechanisms remain weak as the proposed pricing reform including a 15-20 percent increase in water rates is being resisted. Polices are also need to create additional supplies (by increasing storage in Roseires dam and by managing the wetlands areas[7] in the Nile basin) and improve allocation of existing supply. Current dialogue is dominated by issues such as National Water Policy and reorientation of water administration for improving coordination, transparency, and capacity building.

The water sector in **Namibia** is marked by water scarcity due to poor rain and regular droughts, dominance of domestic and livestock needs (50 percent), dispersed population settlement, and international nature of all rivers. These features obviously have an effect on the water institutional structure and its direction of change (see Heyns, 1997 and 1998; The Economic Intelligence Unit, 2000b). The legal framework of water sector is based on the Water Act of 1954 that is largely outdated. The Department of Water Affairs located in the Ministry of Agriculture, Water, and Rural Development is main nodal agency for water management. Last decade witnessed notable changes both on the policy and administrative fronts. A 1993 policy for water supply and sanitation sector calls for cost sharing and community management. While water tariffs are fixed to cover mainly the O & M costs, they witness an annual increase of 17 to 30 percent during 1993-98. The Water Supply and Sanitation Coordination Committees were established to ensure functional and operational integration. The Namibia Water Corporation Limited (NamWater)—a state owned autonomous body—was established in 1998 to manage bulk water supply and create/maintain water infrastructure. The comprehensive sector review conducted in 1996 with World Bank assistance calls for major reforms in the spheres of capacity building, economic incentive, and law and regulation. Regional cooperation is another critical area for meeting Namibia's growing water needs. [8]

The water sector in **Egypt** has an extreme irrigation orientation and almost an exclusive reliance on Nile water that is shared with other Nile riparians—Sudan and Ethiopia—under an international agreement. As such, water institutional arrangements in Egypt essentially revolve around the Nile System and its agriculture (World Bank, 1994 and 2000; Amer, 2000; Saghir, et al., 2000). The Nile-based canal system is operated by the Irrigation Department located in the Ministry of Public Works and Water Resources that is the apex body for water management as per the 1982 Law No. 48 and 1984 Law No. 12. The National Water Research Center supports the Ministry in its management

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[7] It is estimated that if this wetland area is managed appropriately, 10 bcum—representing about 40 percent of the present total water potential—can be annually added to the water resource of Sudan.

[8] For instance, the ambitious project for diverting water from the Okavango—a river shared with Angola and Botswana—to avert water shortage in Namibian capital Windhoek, has to be due to Botswana's objection. Now, Namibia is in final stages of awarding a contract for the desalinization plant in South Africa for meeting the water needs of its coastal towns.

tasks. Egyptian water sector is also influenced by other agencies (e.g., Environmental Affairs Agency) and ministries (e.g., Health; Housing, Public Utilities, and New Communities; and Agriculture and Land Reclamation). Besides the external pressures from population growth and economic development, the Egyptian water sector with a small resource base is also facing the mounting pressures from problems of salinity, lower water productivity, and poor financial and system performance. As a result, the water policies are slowly moving away from the Nile system to focus on groundwater development, water harvesting from flash floods, and desalinization. Besides, there are also successful efforts in water conservation and drainage water reuse.

Water sector in **Tunisia** is noted for its meager resource base due to rainfall, vulnerability to droughts, susceptibility of aquifers to seawater intrusion, dominant share of irrigation (79 percent), user involvement, and increasing reliance on water reuse (see World Bank, 1993 and 2000; Zekri, 1997, and Saghir, et al., 2000). Laws 58-63, 60-6, 63-18, and 71-9 provide early legislation for government management and users' cost sharing obligations. Besides its refinements to the overall legal framework, the 1975 Water Code has also transformed the concept of 'water rights' from ownership rights to use rights. In 1989, Tunisian parliament approved the law 89-44 to allow the creation of an independent public institution with financial autonomy, responsible for managing and maintaining the irrigation infrastructure. While the government finances most water and irrigation development schemes, there is a long tradition of user involvement in operation, maintenance, and management functions even since the law of 1933 passed by French colonial administration. Of the 2450 WUAs in Tunisia at present, 800 are in irrigation schemes, 1500 are in water supply schemes, and 150 are in irrigation-cum-water supply schemes. There are efforts to further reduce state involvement, improve finance and administration, strengthen private sector involvement, and implement demand management strategies.

Middle East Region

The 1959 water law remains the foundation for both the water policy and water administration in **Israel**. The Water Commission (WC), previously under the Ministry of Agriculture but now under the Ministry of Infrastructure, is the implementing organ of water law. At the operational level, the WC relies on Mekorot,[9] a state-owned water company accounting for 70 percent of the water supply in Israel. The WC receives technical support from Tahal.[10] Despite the political overtones, economic factors have a decisive impact on water use due to metered allocation and volumetric pricing. While politics favors water allocation towards domestic sectors, urban water prices cover the full supply cost. Even though irrigation water is subsidized, the subsidy has declined

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[9] It operates the National Water Carrier—the pipeline system moving water from Lake Galilee to Negev desert. It is now entering in areas such as urban water retail, sewerage treatment, and desalination.

[10] This firm that remained the official water planner for the past 20 years has been privatized as an engineering consulting outfit.

from 75 to 50 percent since the progressive block rate pricing introduced in 1987 to penalize large and fresh water consumers (Yaron, 1997).[11] The 1997 report of the Public Commission on Water Sector has proposed several changes to improve the institutional basis of Israel's water sector (Arlosoroff, 1997). The heart of the reform proposal involves market-based approach and privatization within a strong framework of public regulation. A legislative proposal, which is still before Israeli parliament, aims to enhance private sector role in urban water distribution, O&M, and sewerage treatment.

South Asian Region

After the 1987 constitutional amendment in **Sri Lanka**, water sector responsibilities were divided between the union and provincial governments. Sri Lanka, like India, does not have either an exclusive water law or declared water policy but 50 or so acts influence the water sector in varying degrees. However, a draft Water Resources Bill, being discussed since the early 1980s, has all ingredients for a modern water law such as water permit systems, full cost pricing, inter-ministerial coordination mechanism, and water courts for conflict resolution (see World Bank, 1992:168). Although 40 or so government agencies influence the water sector, only a few form the core of national water administration (see Nanni, 1996). A new institutional structure as conceived in the Action Plan for Comprehensive Water Resources Management [Water Resources Secretariat (WRS), 1997:3], though delayed since 1998, is currently being put in place. Besides these macro changes, Sri Lanka is also notable for its IMT program followed since 1989. Under this progam, 757 WUAs have been registered with an operating area of 85700 ha [Mahaweli Economic Authority (MEA), 1997].[12] Although Sri Lanka has a long experience with basin organizations, the dissolution of basin organizations like Gal Oya and the recent conversion of Mahaweli Development Authority into a Ministry are viewed as a reversal of its declared policy of decentralization. However, as a part of its policy of promoting privatization, in 1997, the government has piloted a water company with shares owned by farmers in the Ridi Bendi Ela area.

India does not have any exclusive water law but many water-related and irrigation laws most of which are passed during colonial times. But, the drought of 1987 and the macro economic crisis of the late 1980s have led to some notable policy changes. While the drought led to the National Water Policy (NWP) of 1987,[13] the economic crisis of the 1980s has forced many states to raise internal resources through better cost

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[11] After the introduction of the block rate system, water wastage has declined in all sectors and water productivity has increased by more than 250 percent in agriculture and 80 percent in industry.

[12] Notably, thanks to the government policy of promoting women WUAs pursued since 1995, there are now 249 women WUAs excluding 149 other women organizations in rural areas (MEA, 1997).

[13] There is now a new NWP due for approval. Although this policy is almost a repeat of the earlier policy, it adds a new thrust on private sector participation in irrigation financing and management.

recovery and external resources through the mobilization of private funds.[14] The 1992 Committee on Pricing of Irrigation Water advocates higher water rates and group-based volumetric water distribution [Government of India (GOI), 1992]. The 1992 Model Groundwater Bill, though not adopted by any state so far, advocates well permits, water metering, and withdrawal limits. A high level national committee has advocated the promotion of private investments in water sector (GOI, 1995). Few states are already trying to obtain private funds directly by inviting bids for project construction and indirectly by issuing water bonds for tapping public funds for irrigation development (Saleth, 1999). Water sector reforms are substantial in few states (e.g., Andhra Pradesh, Madhya Pradesh, and Tamil Nadu) that have undertaken IMT as well as reorganized their water administration. While changes are visible especially in the policy and administrative spheres, India requires a radical restructuring of its water institutions based on the reform blueprint (see World Bank, 1998) developed jointly by the GOI and the World Bank.

The water sector of **Nepal**—the land-locked kingdom in the Himalayas—is notable for its poverty reduction role, higher share in public expenditure (37 percent), scarcity-floods syndrome, gross underutilization of power potential (one percent), and trans-boundary resource base. Recently, there are notable changes in Nepalese water sector and its management institutions (see Nepalese Delegation, 1996; World Bank. 1997; Economic and Social Commission for Asia and the Pacific (ESCAP), 1997; Regmi, et al., 1998; Upadhyay and Regmi, 1999; Easter, 2000; Royds Consulting, et al., 2000; Sharma, 2000). The legal framework of the water sector is defined essentially by four acts: Water Resources Act (1992), Electricity Act (1992), and Nepal Water Supply Corporation Act (1989), and Environmental Protection Act (1996). The former Act makes water a state resource and allow its private use through license. The agencies directly responsible for water sector are the two departments (hydrology and meteorology and irrigation) in the Ministry of Water Resources and one department (water supply and sewerage) in the Ministry of Housing and Physical Planning. The 1993 and 1997 amendments to the 1992 Irrigation Policy were introduced to promote stakeholder participation, decentralization, and privatization, and economic pricing. While notable progress is seen in IMT, development of micro water rights, and water pricing, reform tasks still outstanding are many more including the regional cooperation with India to harness its irrigation hydropower potential.

The water institutional reform in **Bangladesh** has several challenges, given especially the poverty reduction role of water sector, frequent flood-related damages, and health hazards of arsenic water and poor drainage (see Alam, 1997; Rahman, 1998; Nishat and Faisal, 2000; Bangladesh Water Development Board, 2000). Although the recent legal initiatives (e.g., the Environmental Conservation Act of 1995 and the Environmental Pollution Control Ordinance of 1997) are related more to water quality

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[14] Public funds are mobilized through state guaranteed long-term water bonds issued by semi-autonomous agencies. Examples for such agencies include the Narmada Valley Development Authority created by Gujarat state and the Krishna Valley Development Corporation floated by Karnataka state.

and floods than to water allocation and management, those on the policy and administrative fronts addresses the allocational and management aspects. For instance, the National Water Management Policy of 1999 takes inter-sectoral perspective and streamlines water administration. While National Water Council is the apex body for policy, the Ministry of Water Resources is the main executive agency for water resources management and the Water Resources Planning Organization prepares and updates water sector plans. Since the country is located in the drainage basin of several international rivers, its institutional reform initiatives also entail an international dimension. The 1996 Ganges water sharing agreement between India and Bangladesh has provided a partial framework for joint water management between these two countries. With this agreement, the Joint Rivers Commission that dealt with water sharing problems between the two countries in the past has become still more important in dealing with daily problem solving, data sharing, and overall coordination.

South East Asian Region

Water sector reforms in **China** is closely linked to the economic liberalization programs initiated especially since the early 1980s. The 1988 water law, passed after a decade-long consultation, has strengthened both water administration and water policy [see Peoples Republic of China (PRC), 1988]. Considering water as people's property, the law distinguishes the management and allocation rights of the state from the use rights of the people. It advocates water permits and full cost recovery, stipulates basin as the basic management unit, and mandates the formulation of national, regional, and sectoral water plans. Despite a centralized political system, water sector shows a considerable degree of management decentralization.[15] The 1997 Law of Flood Control and National Policy on Pollution Control and Aquatic Protection aim at addressing the flood and pollution problems.[16]. The State Water Industry Policy of 1997 is unique for a socialist country as it allows private investors in water sector (PRC, 1997: 1). To create the institutional framework needed for translating these policies, the MOWR has already prepared the Master Plan of the Water Law and Regulation System as well as the Water Legal System Construction (see Ke Lidan, 1997: 642&645). While the issuing of water drawing permits is already in progress, the institutional structures needed to support permit-based water allocation are expected to be in place by 2010.

The water sector and its institutional arrangements in **Cambodia** has to be viewed in the light three aspects: its recovery from war and related political disturbances,

[15] For instance, 77 percent of the total water projects in China are managed at the county level and only the remaining (inter-country and inter-provincial) projects are managed either at provincial levels or by the Ministry of Water Resources or its regional organs, the Water Conservancy Commissions (Ke Lidan, 1997: 655).

[16] While a tenth of the country—with a half of population and two-thirds of agricultural and industrial output—suffers from periodic floods, over 600 cities—located mostly in the economically important northern China—suffer from perpetual water shortage. Water pollution and its health hazards threaten 436 of the 532 monitored rivers in the country.

transition from a command economy to a market-based economy, and its location within the Mekong River Basin, the dominant international basin in South-East Asia. For obvious political economy reasons, the outdated water institutional arrangements in Cambodia are changing rather slowly (see Royal Government of Cambodia, 1966, Sisovann, 1997; Sina, 1998 and 1999). The Environmental Protection and Natural Resources Law of 1996 is only tangentially related to main water sector concerns. As to the water administration, the Ministry of Environment—established in the aftermath of 1993 elections—has the primary responsibility for water resources management. But, with the creation of new investment laws and the initiation of five-year development plans, the reform prospects are bright both in general and in water sector contexts. Since water-related objectives are the focus of 1996-2000 plan, there are efforts to develop water law and water policy, and strengthen water administration. Since the water-related decisions of up-stream countries of the Mekong River affect its water sector, Cambodia needs regional cooperation to better utilize its water resources potential. Given the critical role of the regional institution Mekong River Committee, institutional reforms in Cambodia are to be crafted within the basin-based institutional arrangements.

Although water management in **Thailand** is constrained by a heavy dose of centralization, supply-driven approach, subsidy syndrome, and outdated institutions, the situation is changing, at least, since 1992 (see The Thai Deligation, 1996; Jarayabhand, et al., 1998; Aekaraj and Chevaprasert, 1999; Pattannee, 2000; Molle, 2000). While Thailand lacks a comprehensive water law, a draft water law is currently under preparation by the National Water Resources Committee being chaired by the Prime Minister. This law is expected to rectify the weak spots in existing legal framework for water management. Government policy lacks clear guidance in many areas including water pricing, demand management, investment priorities, and information and technology application. The situation gets further complicated as 9 national committees and more than 30 government agencies in 9 ministries work in the policy and administrative arenas. Despite a somewhat bleak situation on water quantity management, there is some progress on water quality both at the macro and micro levels since the enactment of National Environmental Quality Act (1992) and the establishment of the Wastewater Management Authority (1995). Recently, there is a notable shift of policy towards basin approach, demand management strategies including allocation and pricing, and decentralization including user participation and private sector involvement.

While its archipelago nature complicates water management problems, **Indonesia** has undertaken notable reforms to strengthen its water sector and management institutions (see Indonesian Delegation, 1996; Sutardi, 1997; Ismaji, 1998; Sosongko, 1999; World Bank, 1999; Soeparmono, 2000). Since it is estimated that water can a limiting factor when withdrawals exceed 20 percent of water potential, there is a constant challenge of allocation and management. During the first water development plan (1969-1993), water policies were formulated within the framework of water law 11/1974. As part of cost recovery policy, Indonesia also promoted IMT in public irrigation systems. The initiatives undertaken to address water quality in 1982 include the Water Quality Management and Regulation Policy, the Clean River Program, and the creation of

National Environmental Agency. For administration purposes, 5600 river basins of the country are grouped into 73 river territories. The second water development plan (1994-2019) aims to strengthen water resources infrastructure and institutions. It adopted an integrated approach for water planning and management, especially within a basin framework. But, Indonesia still faces outstanding reform tasks such as the need to streamline water administration including the creation of river basin structures, promote private participation, and strengthen allocation mechanisms including the use of economic instruments and creation of water rights.

South Korea, like many countries South East Asian countries, is facing sever water shortage and floods due to uneven rainfall pattern and water quality due to sedimentation and industrial pollution. As response to these problems, water management institutions of South Korea is changing though not at the expected pace (see Shim and Lee, 1996; Ham, 1997; Hee, 1998; Kwun, 2000). The legal framework for water management is defined the River Act, Multipurpose Dam Act, Natural Disaster Prevention Act, Public Water Surface Area Management Act, and Water Quality Preservation Act. The Ministry of Construction and Transportation is the apex body for water management. While the Water Resources Bureau is responsible both for policy preparation and coordination, it is the Water Resources Corporation that actually plan, develop, manage and regulate dams in Korea. The Ministry of Environment manages water quality aspects through direct control as well as economic instruments. The Ministry of Home Affaires that is responsible for water supply has recently launched a 5-year comprehensive Plan for Clean Water Supply in collaboration with other ministries noted above. Recently, South Korea has prepared plans for creating the institutional structures needed for managing both surface and sub-surface water and promoting water conservation through water pricing, water reuse, and water saving technologies.

The water sector in **Laos** is marked by its monsoon dependence, linkages with forest management, underutilization of power and irrigation potential (less than 2 and 20 percent respectively), significance to Mekong River basin (with 38 percent share in total basin flow), and quality problems from sedimentation. Although water institutional reforms remain more as proposals than actual initiatives, there are few notable steps in this direction (see Rasphone, 1996; Souvannabouth, 1997; Souk, 1998 and 1999). Although water-related policies at sub-sectoral and regional levels can be found, Laos does not have a national water resources policy. Similarly, while water-related provisions are scattered in the 1991 Constitution, exclusive water legislation was absent till a draft Water Law was adopted in 1996. This law provides a framework for basin-based inter-sectoral approach to water management and applies water quality criteria for ecosystem protection. But, the law still needs clarification through appropriate decrees from relevant ministries. On the policy front, issues such as water licensing, water pricing, community participation, private sector, and regional cooperation figure prominently in the legal and policy dialogue. On the administrative front, multiplicity of administrative entities and absence of national water master plan creates serious problems of administrative and technical coordination. Laos being a member of the Mekong River Committee, its water sector can also benefit from international cooperation.

The water sector and its institutional arrangements in **Vietnam** are affected both by problems common to the Indochina Peninsula as well as those that are specific to the country's own political past and present and future requirements. These include the syndrome of scarcity-flood-water quality, monsoon pattern and topography, and past political events involving prolonged war and internal conflicts, and peoples' economic aspirations (see World Bank, 1995 and 1999; World Bank, et al., 1996; Su, 1996 and 1998; Num, 1997; Nguyen, 1999; Tu, 2000). While the 1992 Constitution provides the overall legislative and administrative framework for water resource management, the Water Resources Law of 1999 defines more specific legal provisions including the license and permit systems as well as monitoring and enforcement mechanisms. For water quality, the National Law on Environmental Protection of 1993 was enacted. Notably, the Ministry of Water Resources was dismantled and its functions are now with the Ministry of Agriculture and Rural Development and Ministry of Planning. Other ministries related to construction and urban development, planning and investment, environment, and energy also have an influence on the water sector. Water management at the local level shows significant decentralization as local committees of users maintain and manage both irrigation and water supply schemes. But, extensive reforms are still needed both on the policy and administrative fronts as the legal provision both on water quantity and quality are yet to be translated into operational policies and fragmented regulatory and enforcement mechanisms impede actual implementation.

The water sector in **Myanmar**, a country under Junta military council, is not only facing the physical challenges—seasonal and spatial water scarcity, periodic floods, and sediment-induced water quality problems—but also by underdeveloped institutional arrangements (see Myint, 1996 and 1997; Wei and Thein, 1998; The Economist Intelligence Unit, 2000a). The stronger linkage between water resources and forest require an environmental perspective of water management. The irrigation, flood, and drainage related acts neither prove effective in addressing the emerging concerns nor articulate an integrated perspective. It is on with the formation of the National Commission of Environmental Affairs in 1990 that the environmental and water quality legislation came into being. On the policy front, subsidy, absence of economic instruments, and top-down approaches remain the predominant features. The main government agencies involved in water resource management include the Irrigation Department, Utilization Department (lift irrigation), General Affairs Department (water supply and sanitation), and Myanmar Electric Power Enterprise (hydropower generation), and Inland Water Transport (river navigation). Although Irrigation Department takes leading role in the water sector, it does not have the mechanisms to coordinate the rest of the agencies. Besides, water sector also lacks skilled personnel and suffers from unbalanced functional specialization and disciplinary background of available personnel.

Oceanic Region

Although the water institutions in **Australia** are more mature than most other countries, they are still undergoing changes partly to reflect changing resource realities and partly through deliberate reforms effected since the late 1980s (Musgrave, 1997: 17). The

Water Reform Agreement signed by the Council of Australian Governments (COAG) proposes additional institutional initiatives to improve water quality, refine water rights system and water allocation procedures, institute independent review of water prices, and promote community participation. Since compliance with these policies entails attractive federal money, most states have already prepared time-bound action plans for implementing these aspects. The agreement reached by the Murray-Darling Basin Ministerial Council in 1995 for establishing a collective cap on water extraction represents an unique inter-state initiative to control water stress and water salinity within the basin.[17] Apart from national, state, and regional attempts, there are also notable developments at sub-sectoral levels. The corporatization and privatization tendencies are observed both in urban sector (e.g., Hunter Water in 1991 and Sydney Water in 1994) as well as in irrigation sector (e.g., in the Murray Irrigation Area and Coleambally and Murrumbidgee Irrigation Area since 1997) [Department of Land and Water Conservation (DLWC), 1997: 8]. These changes can enhance further the role of economic instruments and market-based water allocation procedures even while improving the physical health and sustainability of the water sector in Australia.

The evolution of water institutions in **New Zealand** reflects the four phases of its water sector development, i.e., flood control in the 1940s, pollution control in the 1950s, irrigation and power development in the 1960s and 1970s, and environmental aspects in the 1980s (see Farley and Simon, 1996; Scrimgeour, 1997). The legal framework for water management in New Zealand is defined largely by the Soil Conservation and Rivers Control Act (1941), Water and Soil Conservation Act (1967), and Resource Management Act (1991). On the administrative side, water management responsibilities were shifted from the Ministry of Works and Development to the Ministry for the Environment in the early 1990s. A recent change with a fundamental effect on irrigation sector is the selling of 52 public irrigation projects to private owners during 1998-2000. While New Zealand does not have water problems as serious as those found in other countries of Asia and Africa, its still has it own challenges, especially related to inter-sectoral allocation between economic and ecological needs, groundwater quantity/quality, political economy of water management, and application of science & technology. The National Agenda for Sustainable Water Management agreed in 1999 has suggested the necessary processes and mechanisms for tackling many of the challenges (see New Zealand Ministry for the Environment 1999).

The water sector and its institutional arrangement in the **Philippines**—an archipelago like Indonesia—is evincing some notable changes (Philippines Delegation, 1996; World Bank, 1996; Sosa, 1997; Rivera and Sosa, 1998; Baltazar, 1999; United Nations, 1999a). The Water Code of 1976, as enforced by the National Water Resources Board, provides the guiding framework for about 20 public agencies and 10 government departments dealing with water. The National Irrigation Administration is a key agency

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[17] While it is normally difficult to reverse current water use to its 1993-94 level, the high degree of political commitment and the existing system of volumetric water allocation across regions, sectors, and individuals enhance the prospects of realizing the target.

as it mobilizes about 80 percent of total water resources to irrigation districts. Water quality monitoring and groundwater regulations are the responsibility of the Department of Environment and Natural Resources. For ensuring coordination among various agencies dealing with water quality, the Water Crisis Commission was created under the National Water Crisis Act of 1995. For management purpose, the country is divided into 12 hydrology-based water regions. Apart from notable progress in IMT policy, the privatization of water supply systems in Manila and other urban areas has been quite successful due to both legislative (Executive Order 311; Republic Act 7718) and financial (Presidential Decree 198) support. These sub-sectoral initiatives, though succeeded as a process, are yet to yield appreciable performance gains. Besides, from an overall management perspective, many gaps (e.g., information system, weak enforcement, and operational coordination) still persist in Philippine water sector.

SELECTED BEST PRACTICES

Before unraveling the common trends and general patterns underlying the nature and direction of institutional changes observed across countries, it is useful to identify some of the best practice cases noticed in few countries. The best practice cases, though isolated and context-specific, are healthy practices that can strengthen the institutional basis for a better water allocation, financing, and management. These cases have a policy value as they help in unraveling the general principles underlying success stories.

Mexico offers three best practices, i.e., the IMT, the formation of RBOs, and the water permit registry. The IMT in Mexico is notable both for its speed and coverage as well as for the extent of other supportive legal and administrative changes effected both during and after IMT. While the Mexican case supports the big-bang approach to IMT, it also underlines the critical roles of other factors such as the macro economic compulsion, political will, and farmers' cooperation. Unlike the IMT program that was initiated by the national government, the initiatives for basin organizations came from the provincial governments facing an unprecedented threat of pollution and groundwater depletion within the concerned basins. Since the registry of water permits, which is maintained at all levels, keeps the records of quantified permits for surface and sub-surface water, it forms the technical basis for the emergence and growth of water markets.

Chile offers three major sets of best practices. The first set consists of practices that facilitate market-based water allocation such as transferable water use rights, registry of water rights, multi-tiered WUAs, and the administratively enforced third-party protection. The second set that supports project viability consists of a clear demarcation of responsibility between water administration and users, project construction being conditional on users' prior payment commitment (also seen in few other countries such as Nepal), and the mandatory formation of WUAs right up to the project level. The third set that improves the performance of urban water sector consists of debureaucratization and privatization of urban water supply agencies, full-cost pricing with protection of poor consumers through demand rather than supply-side subsidy, and the mandatory requirement to treat urban sewerage to protect water quality.

The most notable among the best practices in **Brazil** is the region and sector-specific water strategy that prioritizes regions and sectors in terms of their relative susceptibility to water quantity and quality problems. Other best practices include the program of 'water democratization' that aims to promote user participation as well as the basin level organizations such as the Watershed Committees and inter-state mechanisms such as the Water Resources Councils that aim to promote federal-state coordination in water management. The best practices in **Spain** are observed both at the macro and micro levels. At the macro level, the most notable one is the role that RBOs play both in inter-regional water transfers and inter-sectoral water allocations. This practice demonstrates that RBOs can function as a potential administrative framework for promoting market-based solutions to inter-regional and inter-sectoral water allocation problems. At the sub-sectoral level is the practice of encouraging urban water supply agencies to be autonomous and financially self-dependent (e.g., Canal Isabel II in Madrid). The local level best practices include the traditional community-based water allocation systems operating in Valencia and the water markets in Canary Islands.[18]

The best practices in **Morocco**—observed mostly at the sub-sectoral levels—include the granting of autonomy to public urban water supply agencies and the privatization of urban water supply in cities like Casablanca. Similarly, the use of a revolving fund for providing loans to urban users both for water meter installation and for retrofitting water appliances is also an innovative way of making users to self-finance urban water conservation. The RBOs in Morocco are unique as they are based more on projects than on the river systems and hence, their boundaries are defined both by hydrology and demand areas. Besides, since they are managed by agricultural agencies, they serve as an organizational means for integrating water delivery with the provision of farm inputs.

Notable best practice cases of water reuse and involvement of user groups in the operation of domestic supply are seen in **Tunisia**. Being one among the pioneering countries in wastewater reuse, Tunisia is presently using some 100 mcum of treated wastewater for irrigation and it is expected that this amount will triple by 2010. Tunisia is also notable for the extensive involvement of user associations in the operation and management of local level drinking water schemes. In fact, these associations account for over 60 percent of all WUAs in Tunisia at present. **Egypt** also has a notable water reuse-related best practice as about 30 percent of the irrigation water in the Nile Delta area are reused. While this practice improves use efficiency and minimizes drainage problems, its also has all the negative consequences of increased salinity and other water quality problems. The moral of this case is that since the practices that are good need not be the best from every angle, there is need for care while generalizing. **Israel** is known

[18] The Valencia system, evolved since the Arab invasion of Spain, is known for an almost quantitative inter-farm water allocation effected without any water meters. Although institutions and technologies are complementary, the Valencia case where social organization is being substituted for water measuring technology suggests that there is an economically relevant margin within which institutions and technologies can be substitutes.

for its extensive application of water saving technologies and judicious choice of water conserving cropping systems. The three-part progressive tariff for irrigation water observed in Israel is also unique as a water pricing practice. Other best practices include the proposal for a selective privatization of water administration and the unmistakable tendency towards water recycling and reuse.

The most notable among the best practices of **South Africa** relates to its water law as it creates a modern legal framework for a market-oriented water sector. The water pricing policy is also notable for its intention to cover not only the O&M and capital costs but also the costs of water management, conservation, and research. Other best practices include the importance attached to catchment management, conflict resolution through natural resource courts, and an extensive application of sprinkler and drip technologies. The Vaal River basin—with extensively inter-connected storage and both-way water movement facilities—is an interesting case of an engineering basis for balancing demand and supply over time and space. The best practices in urban sector include the reliance on demand management techniques including a multi-tiered water pricing, retrofitting, and water education (e.g., Hermanus, a coastal tourist town in Western Cape).

The best practices of **Sri Lanka** include its IMT program, the recent piloting of a share-based and farmer managed irrigation water company, and the cascade system of water use. Although the IMT in Sri Lanka is less extensive than in Mexico, it is notable for promoting WUAs as multi-purpose agencies involved not only in water allocation and cost recovery but also in farm input delivery. The piloting of water company concept is in line with the declared policy of irrigation privatization and management decentralization. The cascade system of water use, where the unused water flowing from the upper reaches of the system is used and reused several times before the water reaches the sea, leads to a system level physical water use efficiency of up to 80 percent.

Despite the limited institutional initiatives at the national level, **India** does have notable best practices especially at the state and local levels. The notable among them are the institutional reforms initiated under the WRCPs in states such as Andhra Pradesh, Orissa, and Tamil Nadu. Other best practices include the creation of autonomous corporations in Gujarat, Karnataka, and Maharashtra for mobilizing public funds as well as the initiative of Andhra Pradesh and Maharashtra for soliciting corporate investments in water sector. The best practices observed at the local level cover the community-managed *Pani Panchayat* (Water Council) system and the cooperative river-based lift irrigation schemes in Maharashtra, and the groundwater markets in Gujarat, Uttar Pradesh, Tamil Nadu, and West Bengal (see Saleth, 1998).

The best practices of **Australia** include the permit-based volumetric water allocation, transferable permits, and user-oriented public agencies but with effective regulatory capabilities. It is these practices that provide the necessary institutional framework for realizing the cap program that aims to reduce water extraction to its 1993-94 level in the Murray-Darling basin. The Murray-Darling RBO also represents one of the most successful inter-state water management organizations in the world. Another unique feature is the role played by the Independent Pricing and Regulatory Tribunal in setting both urban and rural water prices. In the urban sector, the best practices take the form of granting autonomy to water supply agencies (e.g., Sydney Waters) as well as involving privates companies in water provision (e.g., Adelaide, Southern Australia).

The legal distinction both between the regulatory and allocative functions of the state as well as between the use rights and payment obligations of the users is an important legal best practice in **China**. While such a distinction is also found in the water laws of Chile, Brazil, Israel, Mexico, South Africa, and Spain, it is much clear in the Chinese law. This legal feature and the policy level demarcation of the operational spheres for public and commercial entities within the water sector that is made explicit in the 1997 Water Industry Policy are the key ingredients for an efficient water institution. Despite their bureaucratic linkages with the MOWR, the WCCs are also an interesting form of RBOs to promote further administrative decentralization within the water sector.

Privatization can also be considered a best practice, especially when viewed purely from an economic rather than an ideological perspective. In this context, there are many countries that have initiated privatization both in urban sector (e.g., Argentina, Brazil, Mexico, Morocco, Philippines, Portugal, and UK) and in irrigation sector (e.g., Argentina, Autralia, and New Zealand).[19] While privatization policies, espeically in the urban sector, are common in many countries, **UK** is the only country that has developed systematic framework for regulating private supply agencies and ensuring, thereby, some balance between private incentives and public interests. Apart from the US, UK is also notable for its effective arrangements for public hearing and conflict resolutions.

An interesting legal best Practice observed in the **Italy** relates to the legal provisions for the identification and protection of environmentally vulnerable zones (e.g., nitrate vulnerable areas and sensitive areas for eutrophication). In fact, this provision was made to comply with the water directives of EC. Another legal best practice observed in **Portugal** relates to the legal definition of 'water domain' and its implication for integrated resource management. Since the 'water domain' is defined as water bodies taken with the strips of land along their borders, this concept can facilitate an integrated approach to both water and land resources management. Another best practice seen in Portugal relates to the stipulation that the proceeds from water and pollution charges has to remains in water sector and should be used for river basin development plans. Since this practice can enable the users to see the direct linkage between payment and service, it has a bearing on willingness to pay and comply among users.

Few best practice cases on water quality management are seen in the **Philippines**. With the creation of the Water Crisis Commission as well as the River Rehabilitation Secretariats in each of the 40 most polluted rivers and with the active involvement of the all stakeholders, there has been a marked improvement in their water quality. The most noted instance in this respect is the rehabilitation of the Pasig River. A somewhat similar

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[19] The extent of irrigation privatization is significant both in Argentina and New Zealand. In Argentina, private companies now operate 100 multipurpose dams with a total storage capacity of about 160 bcum under long-term license. In New Zealand, private groups operate now 52 irrigation projects.

best practice is also seen in **Thailand** where a major long-term project aiming at improving the deteriorated water quality in 359 rivers of major importance has made substantial impacts. Although the full impacts of the project are yet to be measured, the case of Chao Phraya Basin shows what can be achieved with a comprehensive and participatory approach to water quality management.

COMMON TRENDS AND PATTERNS

Even though the country-specific review of water sector features, institutional arrangements, and recent reform initiatives are very brief, a cross-country comparison does give a feel for the nature, status, and direction of ongoing changes in the global water sector. As the physical, financial, and ecological constraints tend to limit the relevance of supply-side solutions, countries are now trying their best, within their political economy constraints, to set right the institutional foundation necessary for promoting demand-side solutions. While institutional reforms differ across countries in terms of their coverage and effectiveness, they evince a remarkable similarity in terms of their thrust and direction. These similarities include the increasing importance attached to market-based allocation, decentralization and privatization, integrated water resource management, and economic viability and physical sustainability.

From Water Development to Water Allocation

The paradigmatic shift from water development to water allocation requires a radical reorientation of water institutions. The challenge lies not so much in having allocation-oriented water laws and policies as in building an allocation-oriented organizational structure out of an existing water administration with insufficient skills and resources. Unlike the development era characterized by bureaucratic and closed-loop decision structure with a domination of political and engineering considerations, the allocation era demands an open and participatory decision process with a priority for economic issues and a premium for consensual procedures and outcomes. Some countries (e.g., Australia and Chile as well as regions like California and Colorado in the US) already have the capability for meeting the challenges of the allocation paradigm. They have not only the tradition of distinguishing allocation functions from development functions within water administration but also the institutional ingredients for supporting water markets as an allocation mechanism. Similarly, despite their focus on water quality and other environmental dimensions, countries such as UK and France have also developed relatively more sophisticated institutional arrangements to manage their water sector. Others (e.g., Spain and China) can develop the institutional potential faster whereas the remaining countries are to go a long way in creating the necessary institutions for ushering their water sector into the allocation paradigm.

Towards Decentralization and Privatization

The dominant trend towards decentralization—a key factor to catalyze a faster transition to the allocation paradigm—is an unmistakable feature of water sector worldwide.

Countries have begun to recognize the functional distinction between decentralized arrangements needed for user participation and centralized mechanisms needed for coordination and enforcement. The key features of the ongoing process of decentralization evident both at sectoral and sub-sectoral levels are an increasing importance attached to RBOs, IMT, and utility-type bodies in urban water sector. While the RBOs are called differently in different countries (e.g., Watershed Committees in Brazil, Water Conservancy Commissions in China, Basin Councils in Mexico, and Hydro-geological Federations in Spain), they share a common conceptual basis.

In the context of RBOs and other regionally decentralized arrangements, it is necessary to recognize two caveats. First, regionalization need automatically ensure a decentralized system of decision-making as some RBOs of the past (e.g., the Tennessee Valley Authority) are often considered as centralized organizations. And, second, regional decentralization also requires some form of centralized mechanisms for ensuring both coordination and conflict resolution. The key to this centralization-decentralization dilemma lies in carefully crafting the institutional arrangements at different geographical levels so as to achieve both local flexibility and regional coordination in water use decisions. It is only within such a framework that the RBOs and other regionally decentralized management mechanisms can function as an effective organizational basis both for pursuing integrated water resource management as well as for resolving inter-regional and inter-sectoral water conflicts.

The IMT, the program for transferring the managerial responsibilities including cost recovery and system maintenance to legalized WUAs, is the main mode of decentralization within the irrigation sector. The IMT is quite extensive in Mexico and Sri Lanka (as well as in Turkey and Philippines) and also picking up in countries like India and Morocco (also in Indonesia and Pakistan). While China has a tradition of involving communities in lower level irrigation management, Australia (as well as the western parts of US) have arrangements such as irrigation districts wherein farmers have far greater managerial and financial responsibilities. In Spain, the proposal to grant full autonomy to basin organizations is likely to advance the process of decentralization still further.

Decentralization within the urban water sector occurs via the emergence of the autonomous and financially self-dependent utility-type organizations for the provision of urban water services. Instances for such companies can be found in all countries except India, Sri Lanka, and China. Although there are no such utilities in China at present, the 1997 Water Industry Policy aims to create them in future. In Australia, Chile, Mexico, and Morocco (and also in Philippines and Argentina), urban water sector decentralization has also taken the form of privatization. While privatization and decentralization are obviously in an advanced stage in countries with a relatively privatized water sector (e.g., Australia, Chile, UK, Argentina, and New Zealand), even countries with a bureaucratic water sector (e.g., China and India) are now actively exploring the ways to tap private financial, managerial, and technical resources for water development and management.

Although there are notable instances for privatization initiatives in the irrigation sector (e.g., England, Australia, Argentina, and New Zealand), those initiatives observed in the water sector of the sample countries confine mainly to the economically attractive and technically feasible segments of water sector such as urban water supply, sanitation, and desalinization. Since private sector cannot be expected to take up water activities of public value (e.g., flood control), the public sector will continue to be important in these water-related activities. Thus, the privatization and other decentralization initiatives, though minimize the role of bureaucracy, cannot, however, eliminate the role of government altogether. Such elimination is neither possible nor desirable in view of the need for both the regulatory as well as the enabling functions that the state apparatus has to perform in the new context. Since the privatization process can be instrumental not only in strengthening the complementarity but also in rekindling a spirit of healthy competition between the public and private sectors, it adds a new institutional dimension to water resource management.

Towards Integrated Water Resource Management

Although all countries are committed to integrated water resource management, they differ considerably in terms of the institutional arrangements to underpin this approach. Most countries have policy organs (e.g., water resource councils or stakeholder bodies) for facilitating an integrated perspective on water sector. But, not all of them have developed the regionally and sectorally disaggregated national water plan. While some countries (e.g., Australia, Israel, Mexico, and Spain) already have a national water plan, others (China, Brazil, Morocco, South Africa, and Sri Lanka) have the mandate to develop such a plan under their recently enacted/proposed water laws. India will also have soon a national water plan. Although these water plans neither require nor lead to any institutional changes, they provide a technical framework needed for promoting an integrated perspective on water sector issues. The practical translation of such an integrated perspective does entail significant institutional changes.

In an effort to eliminate prevailing sectoral bias and to incorporate environmental issues within water management, many countries are making administrative reorganization to move water from the agriculture and power ministries to the environment or natural resources ministries.[20] Countries like Australia have water within the overall portfolio of natural resources from the start whereas others (e.g., Brazil, Mexico, Spain, and Morocco) have only recently moved water matters to the environment ministry. Another administrative attempt is the integration of most water-related functions within one organization (e.g., Brazil and Indian states such as Tamil Nadu and Orissa). There is also an increasing tendency among countries (e.g., China,

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[20] There is an emerging feeling among few experts that the movement of water into environment and other related ministries itself causes a new bias due to the increasingly constraining role of environmental concerns leading not to an integrated approach but a single purpose planning centered around environment and ecology.

South Africa, and Sri Lanka) to incorporate watershed and catchment management considerations within basin management plans.

Towards Financial Viability and Physical Sustainability

There is unanimity among countries that a phased improvement in cost recovery is the first step to salvage the water sector from both financial crisis and physical degeneration. While the full recovery of O&M costs is the stated objective in all countries, countries like Australia and Chile have gone a step ahead of others by trying also at an annuity-based capital cost recovery. Notably, South Africa is attempting to recover the costs involved in water conservation, management, and research as well. But, the basic problem still remains as subsidies continue even in countries such as Australia, Chile, and Israel. While a better financial health can facilitate the physical health of water distribution and drainage infrastructures, the physical sustainability of water sector cannot be ensured without controlling the pollution and water quality problems. The common approach in this respect involves water quality grading, quality standards, and pollution control regulations. All the sample countries grade their water in terms of quality categorization defined by chemical properties and usability status of water. Although most countries have provisions for pollution permit system, they differ in terms of its practical translation and effective implementation. While Australia and Israel enforce strict quality standards, others lack the necessary institutional mechanisms and political will to make much headway on the pollution front. But, the policy level awareness of water pollution and its health and environmental effects can be seen in all countries.

FACTORS MOTIVATING INSTITUTIONAL CHANGE

While the institutional initiatives observed in global water sector have a similarity of thrust and direction, they differ not only in terms of their origin and motivation but also in terms of their ability to initiate and sustain the actual reform process. The cross-country review suggests that institutional changes within water sector occur due to the role of both endogenous factors (e.g., water scarcity, performance deterioration, and financial non-viability) as well as exogenous factors (e.g., macro economic crisis, political reform, natural calamities, and technological progress).

While water crisis remained as the fundamental factor motivating reforms in most contexts, the proximate or immediate factors triggering institutional changes came from elsewhere in the economy. For instance, the macro economic crisis of the late 1980s has been the motive force for IMT in Mexico and the current reform debates in India. In South Africa, water sector reform forms an important part of the ongoing process of economic and political reconstruction. Similarly, in the case of Chile, China, and Brazil, since water sector reforms have benefited from the synergetic influences of their political and economic liberalization policies, they actually form part of an economy-wide liberalization program. In Spain and Portugal, on the other hand, the water sector reforms form a key component of the country's transition from a controlled system to a liberalized one and its subsequent obligations as an EC member. In countries like Sri Lanka, India, Pakistan, and Morocco, international lending agencies (e.g., World Bank and ADB) and technical organizations (e.g., IWMI and FAO) are also catalyzing institutional changes within water sector.

While all countries are committed to reform their water institutions, they are obviously at different stages in terms of the extent and effectiveness of institutional reforms. This is an outcome of the gap between their intentions and requirements on the one hand and willingness and capabilities on the other hand. Political economy constraints and inability to have the confidence and cooperation of users also limit the impact of even the already undertaken reforms. As a result, except few countries where there is powerful economic pressure and political urge for reforms, the institutional reforms in most countries are essentially in the form of intentional statements or, at most, ceremonial changes and cosmetic adjustment.

The comparative review, despite its brevity and conciseness, does allow a tentative placement of countries within the spectrum of water institutional change as visualized in our stage-based conception of the process of institutional change. Countries such as Australia, Chile, UK, and France as well as regions such as California and Colorado in the US are obviously in an advanced, though not an ideal, stage where the already undertaken institutional change have already began yielding substantial performance gains. In these countries and regions, the institutional reforms are also irreversible and sustainable. Israel, with its technologically advanced and economically sensitive water sector, could very well be ahead of most countries when its reform proposals take practical shape. While Mexico, Sri Lanka, Portugal, and New Zealand have made notable progress in reforming their irrigation sector, they are yet to make similar progress in other water sub-sectors. These and other similarly placed countries can be considered in the third stage where institutional reforms of both procedural and substantive nature are gradually reaching maturity. As a result, the performance gains of perceptible magnitude are yet to be realized.

Spain, followed by China, also has the organizational potential as well as the water law and water sector reform proposals to strengthen its water institutions. Morocco is also favorably placed in terms of its national level institutional reforms and its partial success in reforming urban water sector as well as in promoting a basin-based integrated approach in the irrigation sector. Although Brazil shows considerable political commitment followed by concrete actions in the form of water law enactment and administrative reorganization, it is still constrained by the present constitutional division of water sector responsibilities between the federal and state governments. Although India exhibits slow progress in terms of water sector reform at the national level, it does show notable progress at the state and local levels. Most of the remaining countries, despite the sector-specific progress made in some of them (e.g., Thailand, Philippines, and Tunisia) are still in the interface between the first and second phase where perceptional changes towards reforms are either getting more pronounced or being articulated on the political sphere. Obviously, there is no country in the world that is contemplating water institutional reform in one form or the another.

IMPLICATIONS FOR INSTITUTIONAL TRANSACTION COST THEORY

Even though the present evaluation of institutional changes in the global water sector is based on a small cross-country sample, it does have notable implications both for institutional economics theory as well as for national and international strategies for promoting institutional change within water sector. The mere occurrence of institutional changes in most countries can be taken as an observational evidence for the fact that the opportunity costs of institutional change are increasing to surpass the corresponding transaction costs in the context of many countries. But, the fact that institutional changes are uniform neither across institutional components nor across water sub-sectors suggests that both the opportunity and transaction costs vary considerably by context.

The variations in the extent and coverage of institutional reform across countries provide evidence for the powerful effects that both factors both endogenous and exogenous to water sector have on the opportunity and transaction costs of institutional change within water sector. These factors act together to raise the opportunity costs of institutional change, reduce the corresponding transaction costs, and create a pro-reform climate. Since some of these factors also capture the political economy imperatives, in all cases where the opportunity cost is high enough to counter the political transaction costs as well as path dependency constraints, actual institutional changes occur or get initiated. Depending upon the endurance of such costs in the reckoning of policy-makes and general public as well as the administrative capabilities and public support, the initiated changes are sustained and gets translated in observable performance improvement. When this happen, institutional changes reach the take off state as performance gains can silence the remaining opposition and provide resource stream to deepen the reform process while path dependency will work in favor of reform by ensuring the irreversibility of the reform process.

There are also certain notable features to the internal dynamics of institutional change. Our cross-country review provides inkling for some of them. The experience of Australia, California, Chile, UK, and France also points to the fact that the earlier reforms tend to reduce the transaction costs of subsequent reforms. Though not reported in our country-specific review, there are also evidences for strong institutional linkages. For instance, the effects that the creation of financially independent corporate entities (e.g., Tunisia, Namibia, and Portugal) has on pricing policy provide an instance for the linkage between administrative reform and policy reform. The synergy effects from exogenous factors and the scale-related effects of institutional inter-linkages clearly suggest that countries with only partial reforms at present could deepen their institutional reforms fairly at a faster pace, that too, with lesser financial costs and political opposition.

As the transaction cost declines and political balance improves as one moves on the institutional change continuum, it is prudent to pursue a logically linked sequential reform strategy wherein water sub-sectors and institutional components are prioritized in terms of their performance impact, facilitative roles for downstream reforms, and political acceptability. Such a strategy also has a political economic advantage as it can be used to create a pro-reform political coalition so necessary to support and sustain the reform process. Since such a strategy can exploit better the synergies both from institutional inter-linkages and from exogenous factors with proper timing, packaging, and sequencing, it has a better chance of success with the least cost and political opposition. While the rationale and need for such a reform strategy is clear, the main policy question, i.e., how to identify an effective strategy for institutional reform complete with all the design principles including institutional prioritization, sequencing, packaging, and timing, is yet to be answered. We will try to provide some answers to this and related questions—both from an analytical and empirical perspective--in the ensuing chapters.

Chapter 7

INSTITUTION-PERFORMANCE LINKAGES: EVIDENCE AND EVALUATION

Chapter 6 has provided anecdotal and descriptive evidences only for some of the more explicit linkages among institutional aspects and their performance implications as observed in one or more sample countries. Although the more subtle linkages evident in the process of institution-performance interaction are not covered, Chapter 6 did provide ample theoretical reasoning and observational evidence for the relative role of endogenous and exogenous factors in water institutional reforms within a transaction cost framework. These evidences as well as the discussion on country-specific and cross-country trends and patterns in water challenges and institutional responses provide the necessary background for the interpretation of results and analysis that are attempted in the present chapter. This chapter represents the most critical part of the study as it brings together the theoretical issues and observational evidences to bear upon the empirical results so as to highlight their strategic value and policy implications.

EMPIRICAL EVALUATION: APPROACH AND FRAMEWORK

For a better analysis of the results and appreciation of their implications, it is instructive to first clarify ourselves of the approach and framework within which the three sets of models specified in Chapter 4 are empirically estimated and evaluated. The approach allows us to identify the estimation techniques/procedures that are appropriate for different models whereas the evaluation framework enables us to indicate the way the models are estimated and their results are presented and evaluated. As to the approach underlying the estimation of the three models, we have adopted two approaches. They are the single equation approach involving the Ordinary Least Squares (OLS) technique and the system or the simultaneous equation approach involving the 3-Stage Least Squares (3-SLS) technique. Since these estimation techniques/procedures vary across models, it is necessary to know the implications of their assumptions for our analysis. Equally important is also an understanding of the way the models are estimated and evaluated. These aspects are discussed below.

Econometric Approaches

As we know, the two approaches used for the estimation of the models have different assumptions regarding the nature of the econometric relationships evident or postulated among the equations being estimated. The single equation approach assumes that the equations are separate with no linkages among them whereas the system approach assumes that the equations are structurally nested either with sequential or simultaneous linkages. The two approaches also suggest different econometric techniques and estimation procedures. While single equation approach requires the reliance on the

Ordinary Least Squares (OLS) technique, the system approach underlines the need for advanced econometric techniques involving either instrumental variable, 2-Stage Least Squares (2-SLS), or 3-SLS techniques. Of three techniques that can be used for estimation under the system approach, we opted to use the 3-SLS in view of its superior econometric features.[1] Given these approaches and the nature of the three sets of models specified in Chapter 4, it is natural for the econometric approaches and hence, the estimation techniques/procedures, to vary across models.

Since Model A has just a single equation, it is estimated obviously with the single equation approach and its underlying OLS technique. In contrast, in view of the sequential linkages evident among the 10 equations in Model B, it will be more realistic if they are estimated as a single system using the 3-SLS technique. Purposively, however, these equations are also estimated with the single equation approach and the OLS technique. The specific reason for the estimation of Model B under both approaches is to contrast its performance and provide, thereby, some econometric evidence for the existence of sequential linkages among institutional and performance variables that have so far been demonstrated only analytically (see Figure 5.3). To extend the comparative analysis of model performance under different estimation techniques, the performances of Model B under the OLS and 3-SLS techniques are also compared with the performance of Model A. In this case, the comparison is confined to three equations, i.e., [B6], [B7], and [B8] as Model A does not have counterparts for the remaining equations of Model B that characterize different layers of institutional inter-linkages and institution-performance linkages.

Evaluation Framework

Having described the approaches used for the estimation of different models, let us also note few relevant aspects pertaining to the estimation, presentation, and evaluation of the empirical results. All the equations of the three models specified in Chapter 4 are only generic in that they just show the relationship between their respective dependent and independent variables without any explicit indication of the exact functional form of the relationships. Although these equations can be estimated with a variety of functional forms, in our estimation exercise, we have adopted only a simple linear form for all the equations.[2] With a simple linear form, all the equations are also estimated with a constant

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[1] When there are sequential linkages among equations, as is the case in the present context, the 3-SLS technique provides unbiased and consistent estimates with Maximum Likelihood Estimation (MLE) characteristics. Moreover, this technique is also more convenient for tracing how the effects of a marginal change in one variable in an equation spread throughout the system.

[2] While it is certainly possible and also desirable to experiment with quadratic and other non-linear forms, either with logarithmic transformation or with interactive terms, the problems such as the existence of large number of zero values and the difficulty of including many but countable interactive variables present serious technical constraints.

term for the express purpose of capturing the important effects of excluded variables, especially those capturing exogenous factors such as the socio-economic, political, demographic, and ecological factors.[3] Given such a functional specification for their equations, all the models are estimated with the applicable techniques/procedures using the latest version of the popularly used econometric software package known as SHAZAM (Version 8.0).

It is also necessary to add few words on the presentation and evaluation of the results. Since all the models that we are estimating are large either in terms of the number of variables or equations, or in terms of both, it is not feasible to legibly present them in a single table. Thus, for presentational convenience, the estimated results for all the models are reported in two related tables. As to the evaluation of results, although we use only the normally used econometric tests, it is still useful to state them explicitly for additional clarity. Specifically, the relative statistical significance of the estimated coefficients of the variables is evaluated based on their t-ratios at the significance levels of both 10 and 20 percent. Although it is a convention to use the significance level of 10 percent, we relax it to 20 percent to identify the relatively more significant among the insignificant variables at the conventional level.

The explanatory power of the OLS equations is evaluated using the R-Square (R^2) and that of 3-SLS is evaluated both in terms of System R^2 as well as the Likelihood Ratio test.[4] Since our data set is based on cross-sectional information, there is a potential for the econometric problem of heteroskedasticity.[5] To make sure that this problem does not lead to biased estimates, we use the Breusch-Pagan test statistic. Although this statistic is reported only for the 3-SLS results, since it pertains to the econometric properties of the data set, it applies equally to other contexts including the OLS results as well. To add clarity to our discussion on the institution-performance linkages, it is very useful to recall

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[3] As we can see, the effects that some of these factors have on performance evaluation can also be evaluated more explicitly with the help of the nine equations in Model C. The constant terms in the equations of this model could, in fact, capture the effects of other exogenous factors that are not included in view of data limitations.

[4] While R^2 shows the explanatory power of all the variables within an equation, the System R^2 evaluates the explanatory power of all the equations estimated together as a system. The Likelihood Ratio test is also an index of the explanatory power of the model as it is based on the difference between the maximum likelihood that is estimated with the restriction that all coefficients in the model are zero and the same estimated without that restriction (Kennedy, 1987: 58-59).

[5] Simply put, this problem is due to the relationship between the magnitude of the independent variables and their residuals (i.e., the difference between their actual and estimated values). Specifically, it exists whenever the absolute magnitude of the residuals is related to the independent variable such that the former is small (large) for lower (higher) values of the latter. If, in contrast, the absolute magnitude of the residuals is, more or less, the same regardless of the vales of the independent variables, the problem is, of course, absent. This can be econometrically verified with the Breusch-Pagan test statistics having a chi-square (χ^2) distribution for large sample (Kennedy, 1987: 96-98).

at this stage the analytical categorization of various layers of institution-performance interaction that we have made in Chapter 4. For analytical convenience, the linkages among institutional aspects within each of the three institutional components are denoted as intra-institutional linkages whereas the same among those across institutional components are denoted as inter-institutional linkages. Of course, both the intra and inter-institutional linkages form part of institutional linkages. The other layers pertain to performance linkages where the performance of water institution is related to the performance of its three components and that of water sector is related to the performance of water institution. These institutional and performance layers are sequentially nested and form part of the process of institution-performance interaction. With these explanatory and technical preliminaries on the approach and evaluation framework, we are now ready to present and analyze the empirical results of the models, focusing especially on the evidence they provide for the existence and significance of the institutional and performance linkages.

EVIDENCE FOR INSTITUTION-PERFORMANCE LINKAGES

We have been discussing all along the strategic significance and performance implications of the institutional inter-linkages and institution-performance linkages that are inherent in the process of institution-performance interaction both in general and in water sector contexts. While the theoretical and conceptual basis for these linkages were provided in chapters 2 and 3, a detailed analytical exposition of the same was shown in Chapter 4 (see Figure 4.3). Some descriptive and anecdotal evidences for some of these linkages as observed in one or more of our sample countries were also given in Chapter 6. Thanks to the empirical information and the identified sets of models, we are now able to provide the most direct evidence—both for existence of these linkages as well as for their performance implications—that is feasible within the current state of information. The evidence for institutional and performance linkages can be shown from a comparison of the OLS results of both models A and B with the 3-SLS results of Model B as shown in tables 7.1a and 7.1b.

For understanding the rationale and basis for these comparisons, it is useful to recall here the different assumptions and modeling properties on which the three sets of results are based. Model A with a single equation presents the conventional conception of institution-performance interaction by postulating water sector performance as a simple and direct function of a set of 21 variables representing various law, policy, and administration-related institutional aspects. Thus, unlike Model B, neither does it recognize the institutional and performance linkages as represented by equations [B1] to [B5] nor does it distinguish the direct effects of institutional aspects from their indirect effects that are channeled through water institution and its components as characterized by equations [B9] and [B10]. As a result, Model A does not have these seven critical equations characterizing various layers of linkages within the process of institution-performance interaction. Although Model B that includes these seven equations clearly recognizes the institutional and performance linkages, when it is estimated with the OLS

Table 7.1a. Comparing Estimates for Models A and B with Differential Assumptions on the Nature of Institution-Performance Interaction in Water Sector.

Equa-tions	Dependt. Variables	Independt. Variables	Model A (One Single OLS)		Model B			
					As Separate OLS		As 3-SLS	
			Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio
[1]	LCRMEE	LPRSRF	-	-	0.047	0.314	0.079	0.556
		PGPIUP	-	-	**0.252**	3.287	**0.246**	3.481
		POPAWE	-	-	-0.015	-0.120	0.096	0.880
		ABALFS	-	-	**0.793**	1.763	**0.822**	2.212
		AARINF	-	-	***0.169***	1.601	***0.122***	1.408
		AEXTST	-	-	0.124	1.054	***0.141***	1.303
		Constant	-	-	**2.305**	2.383	**1.818**	2.085
[2]	PIRSWE	LPRSRF	-	-	**0.225**	1.636	**0.209**	1.686
		LCRMEE	-	-	**0.200**	2.367	**0.698**	3.633
		PGPIUP	-	-	-0.003	-0.040	***-0.139***	-1.557
		AEXTST	-	-	**0.260**	2.506	**0.299**	3.025
		Constant	-	-	0.495	0.729	**-1.750**	-2.025
[3]	PCOREC	LPRSRF	-	-	***-0.063***	-1.457	**-0.070**	-1.833
		PGPIUP	-	-	0.024	1.084	***0.024***	1.297
		POPAWE	-	-	0.013	0.364	-0.018	-0.593
		AIBDWP	-	-	**0.386**	2.675	**0.265**	2.153
		Constant	-	-	**2.132**	9.124	**2.358**	11.750
[4]	ASBUDC	AIBDWP	-	-	0.588	0.840	**1.485**	2.008
		PCOREC	-	-	-0.310	-0.722	**-3.426**	-3.590
		PGPIPP	-	-	-0.061	-0.619	-0.022	-0.233
		PGPIUP	-	-	0.117	1.086	***0.155***	1.463
		Constant	-	-	**3.760**	3.634	**10.178**	5.111
[5]	LACPRE	LPRSRF	-	-	-0.073	-0.494	***0.200***	1.292
		LOEPRV	-	-	**0.349**	3.976	**0.289**	3.600
		PCOREC	-	-	**0.538**	1.801	**3.814**	6.499
		POELWL	-	-	**0.247**	2.591	**0.208**	2.486
		AACCME	-	-	0.043	0.495	-0.021	-0.278
		Constant	-	-	0.200	0.215	**-7.036**	-4.769

Note: [a]Bolded coefficients are significant at 10 percent or better whereas bolded and italicized coefficients are significant at 20 percent. Since Model A does not recognize institutional inter-linkages, it does not have coefficients for the five equations [1] to [5].

Table 7.1b. Comparing Estimates for Models A and B with Differential Assumptions on the Nature of Institution-Performance Interaction in Water Sector.

Equa-Tions	Dependt. Variables	Independt. Variables	Model A (One Single OLS)		Model B			
					As Separated OLS		As 3-SLS	
			Coefficient[a]	t-Ratio	Coefficient[a]	t-Ratio	Coefficient[a]	t-Ratio
[6]	LOEFWL	LTRWSA	**0.472**	1.713	***0.476***	1.366	0.259	0.730
		LPRSRF	-0.006	-0.066	0.097	0.906	0.095	0.853
		LCRMEE	-0.008	-0.151	**0.242**	3.518	***0.321***	1.489
		LACPRE	-0.006	-0.106	-0.012	-0.164	0.241	1.173
		LINTRE	-0.008	-0.216	**0.125**	2.490	**0.093**	1.779
		LOECEN	-0.039	-0.948	**0.122**	2.211	***0.076***	1.462
		LOEPRV	0.030	0.571	**0.184**	2.711	0.066	0.790
		Constant	-	-	**1.809**	3.152	***1.256***	1.556
[7]	POEFWP	PPSCRI	***-0.122***	-1.565	***-0.159***	-1.603	-0.107	-1.189
		PCOREC	0.184	1.053	**0.675**	3.182	**1.523**	3.241
		PIRSWE	**0.120**	2.205	0.040	0.616	**0.783**	5.278
		PGPIPP	-0.020	-0.480	**-0.086**	-1.730	**-0.103**	-2.265
		PGPIUP	-0.043	-0.993	**0.096**	1.744	0.062	0.977
		POPAWE	-0.013	-0.182	0.075	0.833	0.053	0.590
		POELWL	**0.093**	1.631	**0.389**	5.754	**0.179**	2.605
		Constant	-	-	***0.934***	1.262	**-2.067**	-1.977
[8]	AOEFWA	AORGBA	-0.074	-0.909	-0.033	-0.330	0.035	0.359
		ABALFS	**0.718**	2.924	**1.046**	3.514	**1.062**	3.827
		AIBDWP	0.273	1.003	0.141	0.423	0.121	0.383
		ASBUDC	***-0.054***	-1.476	-0.015	-0.339	0.149	1.098
		AACCME	-0.062	-1.239	-0.018	-0.294	-0.030	-0.481
		AARINF	**0.205**	3.463	**0.252**	3.538	**0.226**	3.126
		AEXTST	**0.171**	2.372	**0.403**	4.975	**0.356**	4.661
		Constant	-	-	**1.142**	2.099	0.841	1.188
[9]	WIOPEV	LOEFWL	-	-	**0.148**	1.767	**0.371**	2.484
		POEFWP	-	-	**0.217**	2.420	-0.072	-0.415
		AOEFWA	-	-	**0.377**	4.568	**0.622**	4.188
		Constant	-	-	**1.881**	4.020	***0.840***	1.304
[10]	WSPOEV	WIPOEV	-	-	**0.383**	6.737	**0.843**	7.355
		POPAWE	-	-	-0.053	-0.888	-0.063	-1.149
		ASBUDC	-	-	**-0.062**	-2.015	**-0.132**	-1.570
		PCOREC	-	-	-0.067	-0.437	***-0.450***	-1.278
		AARINF	-	-	**0.183**	3.588	**0.098**	1.934
		AEXTST	-	-	**0.155**	2.717	0.041	0.672
		Constant	**2.783**	4.427	**1.886**	3.630	**1.537**	1.972
R^2/System R^2		Constant	0.517		-[b]		0.765	

Notes: [a]Bolded coefficients are significant at 10 percent or better whereas bolded and italicized coefficients are significant at 20 percent. Since Model A does not recognize either the performance linkages among institutional components or the direct effect of some institutional factors on water sector performance, it does not have the coefficients for equations [9] and [10].

[b]The R^2 for the OLS estimation of equations [1] to [10] are respectively: 0.14, 0.10, 0.10, 0.26, 0.19, 0.33, 0.36, 0.43, 0.37, and 0.52.

technique, it assumes away the sequentially nested nature of the 10 equations. As a result, the OLS version of Model B, unlike its 3-SLS version, could neither capture the performance implications of the institutional linkages nor distinguish their direct effects from their indirect effects.

Clearly, the performance differences between Model A and the OLS and 3-SLS versions of Model B are directly linked to their varying assumptions regarding the nature of institutional linkages and their performance implications. A carefully performed comparison of their results could, therefore, indicate which model/version is consistent with our empirical information. This can, then, be the basis for establishing the evidence for both the existence and performance contributions of the linkages. Let us note that the comparison proceeds in two stages. In the first stage, the OLS results of models A and B are compared to show the importance of explicitly recognizing and modeling some of the most important institutional and performance linkages. In the second stage, the OLS and 3-SLS results of Model B are compared to show the necessity of estimating the equations together as a system when institutional and performance synergies are present and the direct effects of institutional factors are to distinguished from their indirect effects. While the comparison in the first stage provides the necessary evidence for the existence of institutional and performance linkages, that in the second stage adds evidence for their performance contributions.

Evidence for the Existence of Linkages

To provide evidence for the existence of institutional and performance linkages, we first exploit the particular feature that distinguishes Model A from Model B, i.e., the absence of the seven linkage equations ([B1] to [B5], [B9], and [B10]) in the former but their presence in the latter. Thus, when the estimates for these equations are significant in the OLS results of Model B, we can take that as empirical evidence for the existence of the linkages represented by them. At the same time, we also compare the relative significance of the 21 variables (in equations [6] to [8]) that are common to both models. It is clear that in the first stage of comparison involving the OLS results of both models, we focus on two aspects. The first aspect of comparison is related to the significance of the variables in the seven linkage equations that are excluded in Model A but included in Model B. And, the second aspect of comparison is related to the number of statistically significant variables among the ones that are common to both models. Thus, we can empirically establish the existence of the institutional and performance linkages when the following two conditions are satisfied. First, the statistical significance of the variables in equations [B1] to [B5], [B9], and [B10] is stronger. And, second, the number of statistically significant variables (excluding the constant term) in equations [6], [7], and [8] is greater for the OLS results for Model B than that for Model A. Let us also recognize that the first condition is both necessary and sufficient for establishing the existence of institutional and performance linkages. In contrast, the second condition is only a part of the necessary condition as it just aims to show that the OLS performance of Model B is as good as that of Model A.

As we reflect these two conditions with the OLS results of both models presented in tables 7.1a and 7.1b, we can easily verify that both these conditions are indeed satisfied but with two notable exceptions. First, since none of the variables is significant in equation [4], the institutional linkage postulated here seems to be unimportant. And, second, contrary to the second condition, the number of significant variables identified by the OLS results of Model A exceeds that of Model B. But, these exceptions are not serious as we consider the following facts. First, as can be seen from Table 7.1a, the insignificance of equation [4] is only so when it is estimated as a separate OLS equations but not so when estimated as a part of the 3-SLS equation system. Second, the second condition that failed in equation [8] is not so critical as it forms only a part of the necessary condition. Third, as we take all the 21 variables together, the total number of statistically significant variables identified by the OLS results of Model B (12) is still larger than that of Model A (8). And, finally, as we compare the absolute magnitude of the coefficients of the statistically significant variables common to both models, we find those associated with Model B to be larger in almost all cases.[6] In view of these facts, we can safely conclude that all the linkages postulated are very important and, as we will see below, they also have significant contributions to the overall performance of both water institution and water sector.

Evidence for the Performance Implications of Linkages

The second stage of comparison that involves the OLS and 3-SLS results of Model B is still more important as it enables us to provide evidence for the significant performance implications of the institutional and performance linkages. As noted already, although Model B explicitly recognizes these critical linkages, when its equations are estimated as separate relations within an OLS framework, it also fails equally to capture the performance implications of institutional and performance synergies flowing among the equations both directly and indirectly. Since such a failure means an underestimation of the performance impact of the institutional and performance variables, the OLS results cannot reveal the full and realistic picture of the process of institution-performance interaction. But, in contrast, when Model B is estimated by considering all its ten equations together within a system framework, the results will be more realistic and reliable as they capture the sequentially nested characteristics of the equations. As a result, it is possible not only to have a more accurate evaluation of the performance

[6] We note that the comparison of both the number and magnitude of the coefficients of the 21 variables common to both models looks apparently unrealistic because the dependent variables with which they are related in the two models are different. But, our conclusion as to the number and magnitude of the statistically significant variables is still very much valid as we compare the same set of coefficients with those obtained in the 3-SLS results of Model B that captures both the direct and indirect effects.

implications of the institutional linkages but also to make a clear distinction between the direct and indirect effects of institutional variables on water sector performance.

The second stage comparison of the OLS and 3-SLS results for Model B also focuses on some of the same aspects considered in the first stage comparison, especially the relative size and significance of the coefficients of both the institutional and performance variables in the system. There is, however, an additional aspect pertaining to the relative explanatory power of the OLS and 3-SLS versions of the model in question. Specifically, the evidence for both the existence as well as the significant performance contributions of the institutional and performance linkages can be established when the following three conditions are satisfied. First, the number of statistically significant variables (excluding, of course, the constant) identified by the 3-SLS results is the same or larger than that identified by the OLS results in the case of each or, at least, most equations. Second, the absolute magnitude of the coefficients of the linkage variables (i.e., the dependent variables in equations [1] to [9] that enter as independent variables in other equations) obtained in the case of 3-SLS results is larger than that obtained in the OLS results. And, finally, when the explanatory power of the 3-SLS results, as indicated by its R^2 is larger than that of the OLS results.

By applying these conditions to the results in tables 7.1a and 7.1b, we find that the total number of statistically significant variables identified by the 3-SLS results of Model B (34) exceeds that identified by its OLS counterpart (31). What is notable the most is the fact that in the case of the first five equations representing institutional inter-linkages, the 3-SLS results not only identify the same set of variables (11) identified as significant by the OLS results but also identify seven additional variables as significant. This result taken along with the fact that equation [4], which is shown to be insignificant by the OLS results, has turned out to be significant under the 3-SLS results, shows, in fact, the effects of the nested structure among all the equations. For instance, even though the linkages variable ASBUDC (seriousness of budget constraint) is not significant in equation [8], it is very significant in equation [10]. This suggests that its indirect effect on water sector performance via AOEFWA (overall performance of water administration) is insignificant, its direct effects on the ultimate performance variable WSPOEV (overall performance of water sector) is rather very important. But, the linkage variables PCOREC (cost recovery status), despite the dissipation of its effects due to the insignificance of other variables in the linkage chain (e.g., POEFWP [overall performance of water policy] in equation [9]), has significant effects on WSPOEV both indirectly through its effects on ASBUDC (via equation [4]) as well as directly in equation [10]. Similarly, the linkage variable LCRMEE (effectiveness of the legal provisions for conflict resolution), though does not have any direct effects, has substantial indirect effects on water sector performance via LOEFWL (overall performance of water law).

We can also see many instances for the multifarious effects of even non-linkage variables such as PGPIUP (effectiveness of user participation policy), ABALFS (balance in functional specialization), AARINF (information adequacy), and AEXTST (extensiveness of science & technology application). While the effects of PGPIUP are channeled only indirectly through the direct and indirect effects of the linkage variables LCRMEE, PCOREC, and ASBUDC, those of AARINF and AEXTST are channeled both indirectly via the linkage variables LCRMEE and AOEFWA as well as directly in equation [10]. We also note, however, that some of the effects of the linkage variables as well as others in the linkage equations get dissipated mainly due to the insignificance of POEFWP in equation [9]. Even though the POEFWP is insignificant, a number of policy-related institutional variables (e.g., PCOREC and PGPIUP) do have substantial effects on water institutional and water sector performance both directly and indirectly. This means, among other things, that the effects of some of the policy-related institutional variables are channeled more through other variables than through POEFWP. In this sense, it is more accurate to say that it is the transmission of the effects of policy variables via other variables that lead to the insignificance of POEFWP rather than the latter as a cause for the dissipation of the effects of the former.[7]

In view of their sequential linkages as well as the multifarious nature of both their direct and indirect effects, it is natural that the significance of some variables differs across the estimation procedures. Since the 3-SLS estimation aims to maximize the performance of the total system rather than that of any single equation, it is usual for some variables with significant effects at the context of one equation becoming insignificant from the perspective of the system. As the effects of some variables are either captured, moderated, or even preempted by some other variables within the system, the difference in the number of significant variables identified by the two versions of Model B is itself an indication of the significance of institutional and performance linkages. From this perspective, therefore, the lesser number of significant variables identified by the 3-SLS results in equations [6], [7], and [9] does not represent a serious repudiation of the performance implications of the linkages.

While the number of significant variables is only a necessary condition in the context of present comparison, the sufficient condition for demonstrating the performance contributions of institutional linkages is related to the absolute magnitude of the coefficients of the significant variables. The rationale for this condition as an evidence for the performance implications of institutional linkages comes from the following simple fact. In the presence of strong institution-performance linkages, the coefficients of most variables, especially those capturing the linkages, are likely to be large if they either benefit from positive institutional and performance synergy or remain strong enough to withstand the negative effects of other related variables in the system. Otherwise, for reasons contrary to those stated above, either the size of the coefficient will be smaller or the variable itself becomes insignificant. As can be verified from tables 7.1a and 7.1b,

[7] Dissipation only means that the effects are not captured by any other variables. It does not mean that the effects are lost because they are implicitly captured by the system. In this sense, a variable is insignificant only in the context of a given equation but not so in the context of the total system.

among the 34 statistically significant variables under the 3-SLS results, 21 variables have coefficients that are substantially larger/more significant than their OLS counterparts. In contrast, among the 31 statistically significant variables under the OLS results, only 17 variables have coefficients that are larger/more significant than their 3-SLS counterparts.

What is more important from the perspective of the performance significance of institutional linkages is the size of the coefficients associated with the linkage variables, i.e., the dependent variables in the first nine equations that enter as independent variables in other equation. As can be seen, all linkage variables indeed have a larger and more significant coefficient. Instances in this respect can be seen by comparing the coefficients of LCRMEE in equations [2] and [3] and PCOREC in equations [4], [5], [7], and [10]. But, the coefficient of WIPOEV—the most important among all the linkage variable that captures the overall effects of institutional linkages and transmits ultimately on water sector performance—provides the most dramatic instances of all that are evident in tables 7.1a and 7.1b. While the size of the coefficient for this important linkage variable is 0.843 in the 3-SLS results, it is only 0.383 in the OLS results. This is the most direct evidence that one can provide for the consistency of the system version of Model B within our empirical context. This evidence also supports the existence and significant performance contributions of the institutional and performance linkages in reality. This is supported further by the fact that the system R^2 for the 3-SLS results is far higher than that obtained for the OLS results suggesting that the 3-SLS version of Model B fits the empirical data far better than its OLS counterpart.

EVALUATION OF INSTITUTION-PERFORMANCE LINKAGES

Providing the evidence for existence and performance implications of institutional linkages, though very important from the perspectives of our objectives, is only a part of the story. The other but critical part of the story pertains to the evaluation of the relative importance of institutional variables and identification of the most significant institutional aspects in terms of the magnitude of their performance impact. In this evaluation, our focus is obviously on the system version of Model B that has been shown to be consistent not only with our theoretical discussion and analytical description but also with our empirical data. Thus, our evaluation confines to the 3-SLS results reported in tables 7.1a and 7.1b and focuses on the relative role and policy implications of institutional aspects in different equations representing various layers of the process of institution-performance interaction. Obviously, the analysis of the relative role of institutional aspects is based on the size, direction, and statistical significance of the coefficients for the variables represented by them in different equations.

It is useful to recall at this stage the distinctions as well as the structural linkages evident among the four subsets of equations within Model B. The first subset—containing equations [1] to [5]—captures the institutional linkages across institutional components. That is, they capture the relationships that some of the law-related institutional aspects have with policy and administration-related institutional aspects and *vice versa.* In contrast, the second subset containing equations [6] to [8] captures the linkages only within each of the three institutional components. That is, they characterize the relationship that the legal, policy, and administrative components of water institution have with their respective institutional aspects. The third subset containing just equation [9] represents the relationship that water institution performance has with the performance of its three institutional components. It captures the effects transmitted not only by equations [6] to [8] but also by the first five equations. The last subset containing equation [10] captures the relationship that water sector performance, the ultimate dependent variable in the system, has with water institution performance as well as with some other institutional variables entering as proxies capturing certain economy-wide conditions and policy trends.

Even though the four subsets of the equations are distinct as they capture different facets of the process of institution-performance interaction, they do have a sequentially nested structure. Thus, when they are estimated together as a system, as we actually did so with the system version of Model B, the effect of institutional inter-linkages captured by the first set of five equations ([1] to [5]) are transmitted to the next set of three equations ([6] to [8]). The second set of equations, in turn, transmits both their own effects as well as the effects of the first set of equations to equation [9], which, then, captures these effects of institutional components and institutional aspects transmitting ultimately to water sector performance in equation [10]. Besides their indirect effects routed through water institution performance, some of the institutional aspects also have direct effects on water sector performance, though as proxies for some general condition related to policy, financial, information, and technology aspects.

The distinctions and structural linkages among the four subsets of equations are made not only to facilitate a better understanding of the relative role and significance of the institutional factors but also to provide an analytical framework useful for a more organized evaluation of the institutional and performance linkages. This framework structures our ensuing evaluation into three parts, i.e., inter-institutional linkages (equations [1] to [5]), intra-institutional linkages (equations [6] to [8]), and institution-performance linkages (equations [9] and [10]). Although both the first and second subsets of equations focus only on institutional linkages, it is useful to distinguish them. For, the first subset deals with institutional linkages across three water institutional components (inter-institutional linkages) whereas the second subset deals with the institutional linkages within each of the three institutional components (intra-institutional linkages). However, in view of the structural linkages among all the equations within the system, their categorization into subsets is made just for analytical convenience. Thus, as we evaluate the relative role of institutional aspects in all the three subsets of equations, we will highlight their sequentially nested structure by distinguishing the direct and indirect effects of these aspects on the performance of water institution, its components, and water sector.

Inter-institutional Linkages

The relative role of institutional aspects in various layers of inter-institutional linkages can be evaluated from the 3-SLS results for the first five equations reported in tables 7.1a and 7.1b. Taking the first among these five linkages, we find that the effectiveness of legal provisions on conflict resolution mechanisms (LCRMEE) is strongly influenced by the positive and statistically significant effects of the four of the six variables specified in the equation to represent various legal, policy, and administrative aspects. The significant variables are the policy variable representing the effectiveness of user participation policy (PGPIUP) and the three administrative variable representing respectively balance in functional specialization (ABALFS), information adequacy (AARINF), and extensiveness of science & technology application (AEXTST). Of these four institutional aspects, ABALFS, followed by PGPIUP, have a more dominant effect than the other two. In any case, the results are understandable for the reason that a functionally balanced water administration and an active user participation policy coupled with a better technology and information could considerably improve the effectiveness the legal provisions for conflict resolution.

Equation [2] represents the institutional inter-linkage that the effectiveness of inter-sectoral/regional water transfer policy (PIRSWE) has with two legal variables and one each of policy and administrative variables. The results show that all the four variables are statistically significant, suggesting clearly the dependence of the effectiveness of the policy-related institutional aspect on other legal, policy, and administrative aspects. These variables listed in terms of their relative significance are: LCRMEE, AEXTST, the legally specified water rights format (LPRSRF), and PGPIUP. All of them except PGPIUP also have positive effects. The dominant positive effect of LCRMEE is very significant from the perspective of institutional linkages. Since it is a variable linking equation [1] with [2], it transmits the effects of all the significant variables that affected it in equation [1]. As such, both AEXTST and PGPIUP affect the water transfer policy both directly due to their effects in equation [2] but also indirectly through their effects on LCRMEE.

Interestingly, in the case of PGPIUP, its indirect effect is positive whereas its direct effect is negative. This opposing effects of this institutional aspect is, of course, consistent with intuition as an effective user participation policy and, hence, user participation, could lead to the effectiveness of water transfer policy through its contribution to conflict resolution. But, user participation could also have a constraining influence on water transfer policy as the latter could favor the users in one sector/region against the others.[8] The significant positive effects of LCRMEE and LPRSRF, however,

[8] Since it is the irrigation sector that has a dominant share in water use in most contexts, inter-sectoral water transfers are likely to adversely affect the share of irrigation sector and inter-regional water transfers have a similar effect in the region from where water is transferred. Given the fact that the user

suggest that more effective legal arrangements for conflict resolution and property rights in water could considerably improve the effectiveness of water transfer policy. These two legal institutional aspects can also be used to counter the negative effects of PGPIUP as user opposition is less likely if there exists an effective water rights system to protect individual water shares and conflict resolution arrangement to compensate for any loss caused by water transfer.

Equation [3] shows the nature of relationship that the policy-related institutional aspect of cost recovery status (PCOREC) has with one law-related institutional aspect, two policy-related institutional aspects and one administration-related institutional aspect. These variables are: LPRSRF, PGPIUP, effects of other policies on water policy (POPAWE), and the existence of independent water pricing body (AIBDWP). As per the estimated results, all variables with the exception of POPAWE are significant. Among the three significant variables, AIBDWP and PGPIUP have positive effects whereas LPRSRF has a negative effect. The positive effect of both AIBDWP and PGPIUP on cost recovery status is understandable as the existence of an independent water pricing body can imply the likelihood of frequent revisions in water rates and user participation can contribute to a better recovery of water charges. We also note, among these two, however, AIBDWP has a larger and more significant effect as compared to PGPIUP. This result has an important implications for designing institutional arrangements for cost recovery as it shows the institutional aspect related to water rate determination and revision is more important than that related to the recovery of water charges.[9]

The negative effect of LPRSRF on cost recovery suggests that as the format of water rights tends to be more and more private, cost recovery tends to decline. While this result looks rather counterintuitive on the surface, it does have some plausible theoretical and practical consistency. The explanation for this result can be both optimistic/theoretic and pessimistic/realistic. The optimistic version is based on the theoretical reasoning that with a clear and private water rights system, the significance of price-based periodic recovery of water charges declines as the one-time/annual/full cost payment for water rights would be paid already before water use (e.g., water rights-based irrigation companies). The pessimistic but realistic version is based on the reasoning that despite the variations in water rights format, cost recovery is either poor or partial in most cases.

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participation policy is currently confined mainly to the irrigation sector, the adverse effects of either kind of transfer is likely to lead to considerable opposition from user groups.

[9] This result is a clear contradiction to the currently observed policies of both national governments and international donor/funding agencies pursued in many developing countries that focus more on institutional aspects related to recovery such as WUAs than on the institutional aspect related to pricing and rate revision. While the institutional aspect of WUAs is important as it facilitates and paves the way for other institutional aspects (e.g., conflict resolution as shown in equation [1]), the priority assigned to this aspect is more due to the political economy constraint for the pricing-related institutional aspects. For more details on the institutional issues surrounding water pricing within the political economy context, see Dinar (2000).

The institutional inter-linkage of the administration-related institutional aspect ASBUDC representing the seriousness of budget constraint with four other institutional aspects is characterized in equation [4]. The result shows that except for the variable representing the effectiveness of private sector promotion policy (PGPIPP), all the other three variables have a significant relationship with ASBUDC. These variables stated in terms of their relative significance are PCOREC, AIBDWP, and PGPIUP. While PCOREC has a negative effect, the other two have positive effects. Since the variable ASBUDC is formulated in a negative sense (i.e., seriousness of budget constraint), the positive coefficients of its independent variables will mean negative effect and *vice versa*. Thus, the negative coefficient of PCOREC actually implies the positive fact that better cost recovery reduces the seriousness of budget constraint. This variable being the linkage variable also transmits the effects of all significant variables in equation [3]. Notice that the relationship can also be interpreted in the other way, i.e., the seriousness of budget constraint also provides a policy compulsion for better cost recovery. It is, in fact, the other way interpretation that accurately explains the positive coefficient of both AIBDWP and PGPIUP. Thus, it is the seriousness of budget constraint that leads to the necessity of independent water pricing body and effective user participation policy but not the other way round. For, it would lead to an inconsistent explanation that the existence of water pricing body and effectiveness of user participation policy acerbate the seriousness of the budget constraint. It is also important to note that the insignificance of the PGPIPP can be explained by the fact that private sector role continues to be limited in most countries due to institutional constraints. As a result, their budgetary impact is yet to be felt in a significant manner.

The last among the five equations capturing inter-institutional linkages postulates the legal aspects of the effectiveness of accountability provisions (LACPRE) as a function of two each of legal and policy aspects and one administrative aspect. These aspects are: LPRSRF, effectiveness legal provisions for privatization (LOEPRV), PCOREC, the effectiveness of law-policy linkages (POELWL), and the effectiveness of administrative accountability (AACCME). All the variables capturing these aspects except the one related to the lone administrative aspect have a significant positive effect on the effectiveness of the legal provisions for accountability. Of these four variables, the linkage variable PCOREC, which transmits also the effects of all the significant variables in equation [3] into the present equation, has the largest influence. Notably, LPRSRF has both a direct effect as well as an indirect effect via the linkage variable PCOREC.

While the positive effects of both PCOREC and LPRSRF is understandable in view of the direct relationship that cost recovery and water rights system have with accountability, the positive effects of the other two variables need an explanation. The direct positive effect of LOEPRV is due to the fact that more effective legal provisions for private sector participation is likely to be also associated with better legal provisions for accountability as the latter forms part of the legal conditions necessary for private sector participation. Besides, when the legal provisions for privatization become effective to actually induce private sector involvement in the water sector, the same also contributes to a better accountability of both water sector officials and water users.[10] The positive effect of POELWL is due to the fact that stronger operational linkages between water law and water policy is likely to translate the accountability provisions better and make them, thereby, more effective in practical contexts.

Intra-institutional Linkages

Since the intra-institutional linkages deal with the institutional linkages within each of the three water institution components, they show how the overall performance of these components is affected by their respective institutional aspects. But, as we have noted in the context of equations [1] to [5], some of these institutional aspects are also affected by their counterparts both within and outside a given institutional component. As a result, the intra-institutional linkages to be evaluated below are also affected by the inter-institutional linkages discussed above. With this fact in mind, the intra-institutional linkages can be evaluated by considering the results for equations [6] to [8]. These equations capture the relationship that the overall performance of each of the three components of water institution, i.e., water law, water policy, and water administration, have with its constituent institutional aspects. Taking each of these equations, let us identify the relative role of institutional aspects and also highlight the effects of the inter-institutional linkages being transmitted by some of these institutional aspects into the three intra-institutional relationships.

Water Law Performance: Relative Role of Legal Aspects

As can be seen from Table 7.1b, equation [6] postulates the overall performance of the legal component of water institution as a function of seven legal aspects. In terms of the statistical significance of the estimated coefficients of this equation, only three of the seven legal aspects considered are significant and all have a positive effect. These variables—given in the order of their relative importance (in terms of t-ratio)—are: LCRMEE, degree of integration within water law (LINTRE), and centralization tendency within water law (LOECEN). Since LCRMEE with the dominant positive effect on water law performance is a linkage variable (equation [1]), it transmits not only its own effects but also the positive effects of the PGPIUP, ABALFS, and AARINF. As a result, the performance of water law is influenced not just by its own legal aspects but equally also by the policy aspect related to user participation as well as the administrative aspects related to functional specialization and information adequacy.

Unlike LCRMEE, LACPRE, which is also a linkage variable (equation [5]), however, is not significant. Therefore, neither its own effects nor the effects of the

[10] In fact, private sector participation is advocated as much for this healthy effects on accountability as for its financial and technical contributions (Saleth, 1999).

significant legal and policy aspects that it has captured in equation [5] could be transmitted.[11] As a result, the significant indirect effects of both LPRSRF and LOEPRV, which are insignificant in the present equation, suggesting the absence of their direct effect on water law performance, could not even be transmitted.[12] The performance of water law component, therefore, depends on the direct effects of three legal aspects (LCRMEE, LINTRE, and LOECEN) and the indirect effects of one policy (PGPIUP) and two administrative (ABALFS and AARINF) aspects. Notably, all of them have positive effects. While the positive effect of the variables other than LOECEN is perfectly understandable, that of LOECEN seems to be apparently inconsistent with the current emphasis on decentralization. The key for understanding its positive effects lies in the fact that a dose of centralization both at the legal and administrative levels is necessary even to promote an effective decentralization process and to ensure efficient coordination and conflict resolution mechanisms.[13] Thus, as per our empirical results, an effective conflict resolution provision (as reinforced by user participation, balanced functional specialization, and adequate information), legal integration, and a dose of centralization are the major factors likely to contribute to a better performance of water law.

Water Policy Performance: Relative Role of Policy Aspects

The relative role of the seven policy aspects in determining the overall performance of water policy can be evaluated from the results pertaining to equation [7] in Table 7.1b. Of the seven policy variables considered, only four are statistically significant. These policy variables—given in the order of their importance—are: PCOREC, PIRSWE, POELWL, and PGPIPP representing respectively the cost recovery status, effectiveness of water transfer policy, strength of law-policy linkage, and the effectiveness of

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[11] The insignificance of LACPRE—appearing as a linkage variable only in equation [6]—actually means that its effects as well as the effects of other institutional aspects, which it did capture in equation [5], could not be transmitted anywhere in the system. Since both its individual and acquired effects get dissipated, the institutional linkage represented by equation [5] remains very loosely connected with the system. This does not mean that this equation should be eliminated as it still implicitly contributes to the performance of the whole system and also provides an important instance for impact dissipation within institution-performance interaction. As we will see in the context of equation [9], this applies equally to equation [7].

[12] Even though the legal aspect LPRSRF has no direct effect on water law performance and its indirect effect on the same gets dissipated due to the insignificance of LACPRE, it still has significant impact on water sector performance due to its indirect effects via PCOREC in equation [3].

[13] Let us also note here that the ultimate solution to the centralization-decentralization dilemma lies not in opting for the one or the other, but in their optimal blending through institutional means. Thus, with carefully crafted institutional arrangements structured at different geographical and decision-making levels, it is possible to achieve both local flexibility and regional coordination in water use decisions. It is only within such a framework that spatially decentralized arrangements such as the River Basin Organizations can function as an effective organizational basis both for pursuing integrated water resource management as well as for resolving inter-regional and inter-sectoral water conflicts.

privatization policy. Among these four significant policy aspects, all, but PGPIPP, have positive effects on water policy performance, suggesting the intuitively consistent result that better cost recovery, effective water transfer policies, and stronger law-policy linkages improve the overall performance of water policy. The negative effect of PGPIPP representing the effectiveness of private sector promotion policies is eqaully consistent as we interpret it within the context of the two-way flow of effects between water policy and its constituent policy aspects. Since it is the failure of past water policies that has prompted current policy efforts to enhance the participation of private sector in financing, maintenance, and management, poor water policy performance leads to more effective privatization policies. Viewed in this sense, the negative coefficient of PGPIPP, in fact, indicates the positive role that successful private sector participation can play in improving the future performance of water policy.

We notice also that PCOREC and PIRSWE, with relatively stronger effects as compared to the other two significant policy aspects, are also the linkage variables capturing and transmitting the effects of other legal, policy, and administrative aspects in equations [2] and [3] respectively. Since PIRSWE is also a function of yet another law-related linkage variable LCRMEE, it captures and transmits the effects from equation [1] as well. As we can see from equations [1] to [3], the two policy-related linkage variables bring to bear on water policy performance the effects of six institutional aspects, i.e., LPRSRF, PGPIUP, AEXTST, AARINF, AIBDWP, and ABALFS. Since PCOREC and PIRSWE capture and transmit the indirect effects of these institutional aspects into equation [7], the legal and administrative aspects also affect the performance of water policy, though indirectly. They are the legal aspect of water rights as well as the administrative aspects of technology application, information adequacy, existence of independent water pricing body, and balanced functional specialization. Notice also the fact that PGPIUP, which is insignificant in equation [7], suggesting the absence of its direct effect, has significant indirect effects on water policy performance through both linkage variables PIRSWE and PCOREC. Glancing at the institutional aspects indirectly affecting water policy performance, the administrative aspects have a major influence that is, of course, consistent with the fact that the ultimate performance of water policy depends critically on the effectiveness of the administrative arrangements necessary to translate and implement it in practice.

Water Administration Performance: Relative Role of Administrative Aspects

How the performance of water administration is affected by the relative role and significance of its seven institutional aspects can be evaluated from equation [8]. As per the results in Table 7.1b, of these seven administration-related institutional aspects, only three are significant. These significant aspects—given in the order of their relative importance—are: ABALFS, AEXTST, and AARINF. As we have seen in the context of previous equations, these three administrative aspects also have substantial indirect effects on the performance of both water law and water policy due to their significant impact on the linkage variables LCRMEE and PIRSWE in equation [1] and [2] respectively. All the three administrative aspects have a positive coefficient suggesting clearly that the performance water administration can be enhanced by creating a staffing pattern with a more broad-based functional specialization, extending science & technology application in critical areas of planning and management, and improving the information basis of water sector.[14]

Among the insignificant variables, the most notable one is the linkage variable ASBUDC. Although this variable has no effect on the performance of water administration, as we will see below, it has significant direct effect on water sector performance. Similarly, AIBDWP, another insignificant variable in the present equation, has significant indirect effects not only on water administration performance via ASBUDC (equation [4]), but also on water policy performance via the linkage variable PCOREC (equation [3]). But, the other insignificant variables AORGBA and AACCME—representing respectively the spatial organization of water administration and effectiveness of administrative accountability provisions—suggest that with a better technology, information, and functional specialization, probably, these administrative aspects may become relatively less important. Besides its implications for the scope for institutional substitutability, this result also shows how the limitations associated with some institutional aspects can be overcome through information and communication technologies.

Institution-Performance Linkages

While the focus of our analysis so far has been on the relative role of institutional aspects in institutional linkages both within and across the three components of water institution, it now shifts to the evaluation of the same in the context of institution-performance linkages. But, our attention will still continue to be on the relative effects of institutional aspects on institutional linkages because it is their strength as determined by the direct and indirect effects of institutional aspects that determines water institution performance and ultimately, water sector performance. This is, of course, clear from the way the relationship between institutional aspects, institutional linkages, and the performance of water institution and water sector are structured and modeled in the system version of Model B. Just as the first five equations are nested with the next three equations, so are the latter with the last two equations. Since equations [9] and [10] represent respectively the penultimate and ultimate layers of institution-performance interaction, they provide a unified context for evaluating the ultimate performance impacts of institutional aspects as routed through various layers of institutional linkages represented by equations [1] to [8].

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[14] This result is very much in agreement with current priority on the technical agenda of many national governments and international funding agencies. It also provides a clear justification for additional investment in these key technical areas indispensable for strengthening the planning and implementation capabilities of water administration.

Water Institution Performance: Relative Role of Institutional Aspects

Equation [9] evaluates the relationship that water institution performance has with the performance of its three components. As per the results reported in Table 7.1b, while the performance levels of both water law and water administration have a positive and significant effect on the overall performance of water institution, the performance of water policy has a negative but insignificant effect. Among the two significant performance aspects, the effect of water administration performance is much stronger with almost twice as much effect as water law performance. This is understandable because, as noted already, water administration has a pivotal role in translating, enforcing and monitoring the legal provision at the grassroots level. From this angle as well as from the fact that water policy in many contexts are essentially a political economy representation of water law, the insignificance of water policy is also understandable.

Since all the three variables in [9] are linkages variables, the nature and significance of their effects also have implications for the effects of the institutional aspects being captured either directly in equations [6] to [8] or indirectly from equations [1] to [5]. From this perspective, therefore, the overall performance of water institution depends ultimately on both the direct and indirect effects of institutional aspects that determine together the individual performance of both water law and water administration. The institutional aspects playing a significant role in determining water institution performance can be identified from equations [1] to [8]. These aspects include three legal aspects (LCRMEE, LINTRE, and LOECEN), one policy aspect (PGPIUP) and three administrative aspects (ABALFS, AARINF, and AEXTST). As can be noted from equations [6] and [8] respectively, while the direct/indirect effects of the first four aspects are captured and transmitted by water law performance, those of the last three aspects are captured and transmitted by water administration performance.

We could also note that although water policy performance fails to have any significant effect on water institution performance, one of the policy aspects does have some indirect effects via the linkage variable LCRMEE. Thus, from the perspective of water institution performance, the most important and significant institutional aspects are: effective conflict resolution provisions, legal integration, a healthy dose of centralization trend within water law, user participation policy, balanced functional specialization, adequate information, and technology application. Given the fact that the performance of water administration has a stronger effect on water institution performance, among these institutional aspects, those related to water administration are more important than others. This fact is reinforced further by the results in equations [1] and [6] that the linkage variable LCRMEE having a dominant effect on water law performance is itself affected by the indirect effects of the three of the four administrative aspects noted above.

Water Sector Performance: Relative Role of Institutional Aspects

The performance linkage between water institution and water sector can be evaluated using the estimated results for equation [10] reported in Table 7.1b. This equation specifies water sector performance as a function of water institution performance as well as of five other institutional aspects used as proxies for policy bias against water sector (POPAWE), fiscal status (ASBUDC), cost recovery commitment (PCOREC), and information and technology status (AARINF and AEXTST). As such, it captures both the direct and indirect effects of the institutional aspects routed through a variety of channels that transcends various layers of institutional and performance linkages as well as the effects of these proxy variables. As per our results, only four of these six factors are found to have significant effects on the overall performance of water sector. They—listed in the order of their relative importance—are: water institution performance, cost recovery commitment, fiscal health, and information status.

While water institution performance and information status have the understandable positive effect, cost recovery commitment and fiscal health have a negative effect requiring some explanation. We note that the institutional aspect of the seriousness of budget constraint is used as a proxy for poor fiscal health of the economy on the following reasoning. That is, a serious budget constraint for water administration means more than a poor financial performance within sector as it can also be due to a lower budget allocation to water sector as compelled by a poor fiscal health of the economy. Viewed in this light, the negative coefficient of ASBUDC means that poor fiscal health of the economy and hence, a serious budget constraint for water sector, actually provide a compulsion for improving water sector performance. This can happen in a variety of ways such as the selection of few projects and their faster implementation, better cost recovery, active promotion of user and private sector participation, staff reduction, and other similar economy measures. The negative effect of PCOREC, considered here as a proxy for the general cost recovery commitment of the government, actually can imply the following. Either there is a vast gap between such commitment and its practical translation, especially in the context of water sector, or it is the poor water sector performance that remain the motivating force for improving cost recovery within water sector.

Returning to water institution performance, the most significant and dominant factor affecting water sector performance, the results confirm rather strongly the role of institutional linkages in improving water sector performance. Since water institution performance is the ultimate linkage variable in the system, it captures both the direct and indirect effects of institutional aspects flowing through all the previous equations and transmits them finally to water sector performance. As a result, all the institutional aspects that affected water institution performance also affect water sector performance indirectly while some of the institutional aspects such as PCOREC and ASBUDC affect directly in their capacity as proxies. Since these proxies are also the linkage variables, they also bring to bear the effects of the significant institutional aspects represented in equations [3] and [4]. These institutional aspects are: LPRSRF, PGPIUP, and AIBDWP representing, respectively, the water rights format, effectiveness of user participation policy, and the existence of independent water pricing body.

Taking these institutional aspects together with those affecting water institution performance, the most important institutional aspects having either a direct or indirect, or both effects on water sector performance can be listed by distinguishing the way their effects are channeled. The institutional aspects affecting water sector performance via water institution performance are: effective conflict resolution provisions, legal integration, a healthy dose of centralization trend within water law, user participation policy, balanced functional specialization, adequate information, and technology application. Those affecting water sector performance directly as proxies are: cost recovery status and seriousness of budget constraint. And, those affecting water sector performance indirectly through the direct effects of the proxy variables are: water rights format, effectiveness of user participation policy, and existence of independent water pricing body. Thus, the overall performance of water sector depends on the multifarious effects of four legal aspects (LCRMEE, LINTRE, LOECEN, and LPRSRF), two policy aspects (PCOREC and PGPIUP), and five administrative aspects (ABALFS, ASBUDC, AEXTST, AARINF, and AIBDWP). This result is very much in line with the attention that these and related institutional aspects receive in the currently ongoing debate on water sector reform both at the national and global levels.

EMPIRICAL RESULTS: VALIDITY AND RAMIFICATION

The preceding analysis of the empirical results has provided considerable insights into the relative role and significance of institutional aspects both at a given layer as well as for the whole process of institution-performance interaction within water sector. While identifying the significant institutional aspects and institutional linkages, we have also seen their insignificant counterparts. Specifically, the five institutional aspects that remain insignificant are: LTRWSA, PPSCRI, AORGBA, POPAWE, and AACCME. The first three of these aspects appear only in one equation whereas the other two appear in more than one equation but do not have significant effect in any of them. Of the nine linkage variables (i.e., the dependent variables in equations [1] to [9]), two (LACPRE and POEFWP) are insignificant causing, thereby, the insignificance of three more institutional aspects (LOEPRV, POELWL, and PGPIPP) with significant indirect effect as well as one linkage variable (PIRSWE) with significant direct effect. Thus, baring these 10 institutional aspects and three linkage equations, all the remaining 11 institutional aspects and six linkage equations have very significant effects on the overall performance of water sector both directly as well as indirectly through a variety of channels. These results, though illuminating from the perspective of our comprehension of the process of institution-performance interaction, peg three serious questions. Is this result reliable and robust enough for universal generalization? How are they influenced by the role of exogenous factors characterizing the general socio-economic, demographic, and resource environment within which the process of institution-performance interaction occurs?

And, more importantly, what are their ramifications for practical policy, especially for institutional design and reform strategy?

Validity and Robustness

The results do show rather convincingly that the model of institution-performance linkages fits the data very well and hence, remains consistent with empirical reality. As we consider the values of χ^2 and Breusch-Pagan test statistic (see Table 8.1b and 8.2b), the estimated results also seem to be free from the bias caused by noises such as auto-correlation and heteroskedasticity. The set of institutional aspects identified to have the dominant effects on water institution and water sector performance is also in consonance with the current thinking and recent reform initiatives—both proposed as well as ongoing—of many national governments and international funding and technical agencies. While our results are certainly empirically valid, econometrically reliable, and intuitively consistent, we still need to verify their robustness and sensitivity. The robustness of the model and its results can be verified by evaluating them in various contexts each of which are defined by certain distinct characteristics endogenous to the sample itself. These characteristics are related to sample size, respondents' subject specialization, and the reform status of sample countries. These endogenous characteristics can be used to categorize the sample into various groups each of which can, then, be used as a distinct context for the estimation and evaluation of the system version of Model B. Besides its role in verifying the robustness of the model, this exercise could also provide additional insights and further empirical support.

While the robustness of the model and its results can be evaluated using certain characteristics endogenous to the sample, their sensitivity can be evaluated by considering the influence of the exogenous factors. Since the constant term in all the equations of Model B captures the combined effects of these factors, its sign, magnitude, and statistical significance can indicate both the direction and intensity of the combined effects of the general socio-economic, political, legal, and resource environment on the process of institution-performance interaction. The constant terms also capture the effects of the excluded institutional aspects as well as those of the included ones but with insignificant effects. Given the intricate linkages among institutional aspects, the effects of some aspects may get either captured by or mixed with others.[15] As we see the results in tables 7.1a and 7.1b, the constant term in all equations except equation [8] is highly significant suggesting the important but combined effects of the exogenous factors as well as excluded and insignificant institutional aspects. Although it is negative and

[15] Such a possibility indicates, in fact, the practical difficulties in isolating the effects of some of the individual law, policy, and administration-related institutional aspects even when water institution is decomposed with still finer analytical details. This applies especially to water administration where not only a more accurate analytical decomposition is difficult but also the effects of most of the administrative aspects are too intertwined to isolate.

significant in the case of equations [2] and [7], it is positive and highly significant in the case of the most important equations [9] and [10].

The positive effect of the constant term, especially in equations [9] and [10], suggests clearly the intrinsic synergy that the process of institution-performance interaction can derive from the general environment that has a strong pro-reform orientation at present. As a matter of fact, considering the relative size of the coefficients, the constant terms capturing the general environment has a much stronger effect on water sector performance as compared with the variable capturing the overall performance of water institution.[16] But, the constant term that indicates the direction and significance of only the combined effects of the exogenous and other factors can help neither in distinguishing the effects of the exogenous factors from others nor in evaluating the relative individual effects of the exogenous factors. We also recognize that the individual effects of the exogenous factors can neither be incorporated into Model B nor be evaluated directly within a system framework due to the already noted data and technical problems. But, it is possible for us to evaluate their effects only indirectly by estimating the nine equations in Model C. From this extraneous analysis, we can show only the relative effects of a selected set of exogenous factors on the nine main variables related to both water institution and water sector performance but cannot demonstrate how the individual effects are captured by the institutional and performance variables in the system. The exercise of directly evaluating the robustness of Model B and indirectly evaluating the sensitivity of the model variables is carried out in Chapter 8.

Ramification for Practical Policy

The somewhat unique empirical evidence that we have provided for the existence and performance significance of institutional linkages does offers a new perspective on the process of institution-performance interaction both in general and in water sector contexts. In particular, we have shown the strategic role of the linkage variables in capturing the effects of the significant institutional aspects on various layers of inter and intra-institutional linkages and transmitting them ultimately into the two layers of institution-performance linkages. From this exercise, we have not only distinguished the direct effects from indirect effects but also indicated various channels through which these indirect effects are transmitted to sequentially influence the performance of institutional components, water institution, and water sector. With the quantification of various layers of linkages and the identification of the channels of impact transmission,

[16] This is understandable in view of the positive role of many developments that occur both within and outside water sector. These developments include the resurgence of democratic form of government that favors decentralization and participation, the increasing water scarcity that motivates many unconventional solutions (e.g., water markets), and technical progress that enables more accurate measurement and monitoring. Since these developments tend to create a pro-reform climate, their synergetic impulses can be exploited through a proper design, sequencing, and timing of the strategy for institutional reforms within the water sector.

we can quantitatively trace channels through which the effects of the institutional aspects are being ultimately transmitted on water sector performance.

As we trace out all the institutional routes through which various institutional aspects transmit their impact, it is equally possible not only to evaluate the relative performance impact of a marginal change in each of the institutional aspects but also to identify the relative significance of various impact transmission channels.[17] From this exercise, both the institutional aspects and transmission channels can be ranked in terms of their relative performance impact. Given the institutional routes or chains through which the impact transmission occurs, we can also identify both the weak and strong links that either obstruct or promote the process of impact transmission. All these information are of key value for designing institutional reform programs as they provide a basis for evaluating alternative sequencing and packaging of institutional aspects in terms of their relative performance impact. They are also indispensable for prioritizing and targeting strategic institutional aspects as well as the institutional routes of their impact transmission. The strategic significance of this tracing exercise for designing institutional reforms complete with sequencing, packaging, and timing is elaborated and numerically demonstrated in Chapter 9. Although we do not have enough numerical information to deal with the issue of timing, we will also address this critical issue based on both the observational evidence discussed in Chapter 6 as well as the inferences from the regression results for Model C to be discussed in Chapter 8.

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[17] For instance, it can be useful to show what we mean by impact transmission channels and their underlying institutional routes or chains. A change in PGPIUP affects first LCRMEE (in equation [1]), which, in turn, affects LOEFWL (in equation [6]) that, in its turn, affects WIPOEV (in equation [9]) that affects ultimately WSPOEV (in equation [10]). Thus, LCRMEE-LOEFWL-WIPOEV forms an impact transmission channel between PGPIUP and WSPOEV and thus, represents an institutional route or chain. A change in PGPIUP also creates effects through other channels some of which are significant (e.g., PCOREC and PCOREC-ASBUDC) while others are not (e.g., PCOREC-LACPRE-LOEFWL-WIPOEV and PIRSWE-POEFWP-WIPOEV).

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Chapter 8

INSTITUTION-PERFORMANCE LINKAGES: ROBUSTNESS AND CONTEXTUALITY

The analysis of empirical results in the preceding chapter has provided us with rich insights into the process of institution-performance interaction within water sector. Specifically, it enabled us to identify the most significant institutional aspects and show how their effects—both direct and indirect—are being channeled through various layers of institutional and performance linkages to get transmitted ultimately on water sector performance. The empirical knowledge on the relative significance of institutional aspects and their impact transmission channels are indeed very valuable particularly for designing reform packages including institutional prioritization and sequencing based on their linkage roles and relative performance impacts. But, the policy value of the empirical results, however, depends critically on their reliability and credibility as evaluated in terms of how robust are they with changing contexts and how sensitive are they to factors both endogenous and exogenous to our sample and estimation contexts. The main objective of this chapter is to evaluate the robustness and sensitivity of the results derived and discussed in previous chapter and to establish, thereby, their dependability for being an empirical basis for designing generic reform packages to be attempted in the next chapter.

EVALUATING ROBUSTNESS AND SENSITIVITY: CONTEXT AND APPROACH

The robustness and sensitivity aspects can be evaluated by comparing the results discussed in the Chapter 7 with those obtained in different estimation contexts. These estimation contexts are defined by certain distinct characteristics endogenous to our sample such as sample size, respondents' disciplinary background, and the reform status of sample countries. That is, by categorizing our sample into various subsets in terms of these endogenous characteristics and comparing the estimated results of the system version of Model B obtained across these sub-samples, much can be learned about the robustness and sensitivity of the results to contextual variations. Besides its role in evaluating the robustness properties of results across sample size groups, this exercise can also enable us to understand the sensitivity of the results to internal and contextual factors such as disciplinary bias, ideological domination, and regional configuration.

This comparative analysis can also provide some indirect idea as to the sensitivity of the results to exogenous factors such as demographic status, development stage, and resource conditions that define together the overall environment within which the process of institution-performance occurs within water sector. But, it is of little help in explicitly evaluating the sensitivity of the results to these exogenous factors as informational and methodological constraints do not permit the incorporation of these exogenous factors directly within the system framework of Model B. However, the sensitivity of the results to these exogenous factors can be evaluated indirectly in terms of their influence on the subjective evaluation of nine performance variables within the framework of Model C. With these points in mind, let us now describe briefly the estimation contexts as well as the evaluation approach and criteria that we specifically use for the evaluation of the robustness and sensitivity of the results.

Estimation Contexts

The estimation contexts are defined in terms of three key features, i.e., sample size, subject specialization of experts, and reform status of sample countries, that can be used to categorize our sample into various sub-groups. Since the context defined by sample size allows us to estimate the model with three different sample sizes, i.e., 43, 84, and 127 (denoted respectively as sample contexts I, II, and III), it can help us in evaluating the robustness of the results in the face of sample size variations. Besides its role in evaluating the robustness of the model and its estimated coefficients, this context also captures the role of yet another interesting dimension. As it is clear from Table 5.2, the sample size variations also correspond to the variations in survey phase and geographic focus. For instance, sample context I includes the responses from the first survey phase with a predominant focus on South Asia, China, Australia, and South America. On the other hand, sample context II corresponds to the second and third phases of the survey with a major focus on South East Asia and Europe. Of course, sample context III covering all the three surveys provides an overall global perspective. The estimation and comparison of the results from the system version of the Model B within these three sample contexts could, therefore, be useful to understand how sensitive are the results to variations in sample size and geographic focus.[1]

The estimation context defined by the disciplinary background of sample experts is based on the categorization of the sample into, more or less, two equal groups, i.e., engineers (61 responses) and social scientists (66 responses). Thus, engineers account for 48 percent of responses and social scientists account for the remaining 52 percent of the responses. Although the first group consists of almost all engineers, it also includes two experts with hydrological and geological background. Similarly, the second group, though consists mostly of economists (32 percent), also includes experts with other social science disciplines (16 percent) and legal background (4 percent). But, as we have noted in Chapter 5, this categorization does not imply any strict departmentalization of the knowledge base of respondents as they do have considerable trans-disciplinary understanding as gained through interaction and experience. The categorization is intended essentially to capture the effects that differences in personal preference,

[1] Incorporating the effects of variations in geographic focus or country coverage into the evaluation process is very valuable for gaining some additional insights into the role that regional configurations—with the corresponding configuration of endogenous and exogenous factors—play in the evaluation of institution-performance interaction.

theoretical orientation, and ideological predilections of these two sub-groups have on their subjective evaluation of institution-performance interaction and hence, on the estimated results. Thus, by comparing the results of the system version of Model B obtained for the two sample groups, it is possible to see whether there is any group-specific pattern in the configuration of statistically significant institutional and performance variables.

The estimation context defined by the reform status of sample countries is based on the classification of sample responses into two groups, i.e., those from countries recently undergoing water sector reforms (71 responses) and those from other countries (56 responses).[2] Since the reform environment and the subjective perception are interrelated, the evaluation of institution-performance interaction by respondents from countries that have undertaken substantial reforms in recent years is likely to be different from the same by respondents from other countries. The comparison of model results across the two country groups can, therefore, capture the effects of area-specific differences in the evaluation process. Specifically, the difference in the relative magnitude and statistical significance of model coefficients obtained for the two samples could provide valuable information as to the difference in the configurations of institutional variables receiving attention in the two sets of countries. The comparison can also indicate the region-specific differences in the nature and role of exogenous factors affecting both the perception and reality of institution-performance linkages. Moreover, we can also expect that the institutional and performance linkages are likely to be stronger in the case of reform countries as compared to others.

While the robustness of the results and their sensitivity to internal and contextual factors are evaluated by comparing the 3-SLS results of Model B across the contexts noted above, their sensitivity to exogenous factors is inferred through an analysis of the simple and step-wise OLS results of Model C. Since the nine equations in Model C postulate the nine performance variables as dependent on a set of variables representing some major economics, demographic, environmental, and institutional variables, their estimation can provide information on the relative direction, magnitude, and significance of the exogenous factors on performance evaluation. From this exercise, we can understand the relative effects of exogenous factors on the subjective process of performance evaluation and infer, thereby, the potential for their direct impact on the performance of both water institution and water sector.

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[2] The reform status-based classification of countries is based both on literature review (see Saleth and Dinar, 1999a and 2000) as well as on our own subjective considerations as to the extent and depth of recently observed reform initiatives based on interaction with key water experts in sample countries. Note that this classification is based only in terms of water sector reforms undertaken in the 1990s. As a result, the 'other countries' include not only those with no reform but also those with significant reforms in the 1980s (e.g., United Kingdom, France, and Philippines).

Approach and Focus

The main approach for evaluating the consistency and reliability of the results discussed in Chapter 7 essentially involves a comparison of the 3-SLS results of Model B related to the all-sample context with those related to various sub-sample contexts described above. The sets of context-specific results will also be compared among themselves to isolate area and group-specific differences in the influence of factors endogenous and contextual to the sample.[3] This comparative analysis will focus essentially on the size, direction, and significance of the coefficients of all the variables in Model B obtained under the three estimation contexts. The purpose of evaluation at this stage is fourfold. The first is to identify the most robust variables, i.e., those with significant coefficients in all contexts, and contrast them with the contextual ones. The second is to compare the size and direction of the coefficient pertaining to both the robust and contextual variables and show the variations in their relative significance. The third is to identify some of the reasons for the contextual differences in the behavior of institutional variables, and identify caveats, if any, for the general results discussed in Chapter 7. And, the last is to explain the overall implications of the robustness of institutional variables for various layers of institutional and performance linkages.

We recognize that our evaluation of both the robustness and sensitivity properties of the results is only relative and indicative rather than absolute and exhaustive. This is because of the fact that the contexts being considered here are just a few among many possible ones.[4] Nevertheless, by comparing the 3-SLS results of Model B under various sub-sample contexts, it is possible to gain additional insights into the relative significance, linkage effects, and the contextual properties of institutional aspects. Besides its role in evaluating the robustness and sensitivity of the results, the estimation exercise in various contexts and perspectives can also enrich our evaluation framework and maximize, thereby, our understanding of the robustness, sensitivity, and contextual properties of the process of institution-performance interaction. Specifically speaking, the comparative analysis of context-specific results with those obtained in the all-sample context helps not only in identifying exceptions and caveats to the general pattern in the behavior of institutional aspects but also in indicating the extent of convergence in perceptional evaluation.

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[3] Although the two expert groups and two country groups themselves define four different sample contexts, the focus here is not on the role of sample size variations but on the influence of endogenous factors, i.e., disciplinary background and reform environment, on the subjective perception and hence, on the regression results.

[4] For instance, many more sample contexts can also be defined by categorizing the sample in terms of both endogenous and exogenous factors such as profession and age of experts as well as development status, demographic features, and water resource endowment of sample countries.

The sensitivity of the results to exogenous factors are indirectly evaluated based on inferences derived from a comparison of the estimated results of the nine equations of Model C both under simple and step-wise OLS procedures. Needless to add here that Model C is estimated using only the secondary data described in Chapter 5. Notice that it is equally possible to conceive some sequential relationships among the nine equations in Model C. For instance, as we follow the specification of equation [B9], it is possible to see that equations [C1], [C2], and [C3] can be linked with equation [C4] in the sense that the dependent variables in the former three equations can enter as independent variables in the latter equation. Similarly, equations [C5], [C6], [C7], and [C8] can also be linked with equation [C9] as the dependent variables in the former four equations are basically the four performance components of the dependent variable in the latter equation. Certainly, it would be very interesting to estimate Model C with a system perspective. Unfortunately, we could not adopt a system approach for Model C for a serious technical reason. Since the independent variables in all the nine equation of the model are the same, there is a major econometric problem of identification that prevents us from estimating the equations with a system approach.[5] As a result, the only approach feasible for estimating the equations in Model C is the single equation approach and hence, they are all estimated with the OLS technique.

Even though Model C is estimated with a single equation approach, nevertheless, we have used both the simple and step-wise procedures of the OLS technique. The simple procedure includes all the 12 independent variables in Model C regardless of their explanatory power and statistical significance but identifies the most significant among them. In contrast, the step-wise procedure considers one variable at a time and includes only those remaining significant at a specified probability level, which, in our case, is 20 percent. Thus, the step-wise procedure helps to identify the most effective combination of independent variables that together that together explains the variations in the performance variables. The purpose of comparing Model C results under the two OLS procedures is twofold. The first is to know whether the explanatory power and relative significance of all the variables taken together differs from that of the most significant subset among the 12 variables. And, the second is to see whether the set of statistically significant variables that are identified by one procedure differs from that identified by the other procedure. The latter aspect is very crucial because the relative effect of each variable is highly sensitive to the variables with which it is combined in an equation.[6]

[5] The identification condition requires that the number of exogenous variables excluded from any given equation must be, at least, equal to the number of endogenous variables minus one. As we can see, unlike the equations in Model B, none of those in Model C can satisfy this condition and hence, could not be econometrically identified or estimated. For details, see Johnston (1984: 250-255).

[6] Note that under the step-wise procedure, unlike its simple OLS counterpart, the variations in the dependent variable is explained not only by the individual variations in each of the independent variables but also by their joint variations. This fact, though makes the step-wise estimates biased, also shows how the step-wise procedure exploits well the available information on the relationship among all the variables in an equation. For details, see Kennedy (1987:77-79).

Although this sensitivity implies the econometric problem of multicollinearity, it shows, however, the interesting phenomenon of linkages among exogenous factors that together define the overall environment for institution-performance interaction. Since this exercise could help us identifying the most effective combination of independent variables in the case of each equation, it could provide valuable insights into the individual and joint effects of the exogenous factors on performance evaluation and, by induction, on the performance of water institution and water sector.

ROBUSTNESS OF RESULTS

Since robustness relates to the sensitivity of results to variations in sample size, this property can be evaluated by comparing the 3-SLS results obtained in three contexts defined by different sample sizes. As the sample size variations also coincide with a change in the configuration of sample countries, the comparison can also shed lights on the effects of regional differences in water sector concerns and institutional challenges. The sample-specific results are reported in tables 8.1a and 8.1b. The main purpose of comparing these sample-specific results is to see how durable and reliable are the all-sample results—especially, on the relative significance of institutional variables and their configurations—obtained in Chapter 7 when sample size and regional coverage vary. From this comparison, it is possible have some insights into the four key aspects relevant for evaluating the reliability of the all-sample results. These aspects are: robustness and contextuality of institutional variables, variations in their relative significance, causes and caveats for the robustness properties and relative significance, and implications for institutional and performance linkages.

Robustness and Contextuality

Let us focus first on the most robust among the institutional variables included in the first five equations representing various layers of institutional inter-linkages. In the case of equation [1] capturing the effects of inter-institutional linkages on the effectiveness of conflict resolution mechanisms (LCRMEE), the only variable that is significant in all sampling contexts is the one representing the institutional aspect of user participation policy (PGPIUP). While the variable representing the impact of other policies affecting water policy (POPAWE) is uniformly insignificant, the other institutional variables are significant either in the sampling context I or III. Of the four institutional variables included in equation [2], only two are robust with significant coefficients in all sampling contexts. They are the water rights format (LPRSRF) and extensiveness of science & technology application (AEXTST). This means that it is these two institutional aspects that have a more durable role in determining the effectiveness of water transfer policy

Table 8.1a. Institution-Performance Interaction in Water Sector: Effects of Sample Size and Country Coverage.

(3-SLS Estimates of Model B)

Equa-Tions	Dependt. Variables	Independt. Variables	Sample 1-43		Sample 44-127		Sample 1-127	
			Coeffi-cient[a]	t-Ratio	Coeffi-cient[a]	t-Ratio	Coeffi-cient[a]	t-Ratio
[1]	LCRMEE	LPRSRF	-0.129	-0.791	**0.496**	2.108	0.079	0.556
		PGPIUP	**0.316**	2.523	**0.182**	2.111	**0.246**	3.481
		POPAWE	0.137	0.846	-0.038	-0.262	0.096	0.880
		ABALFS	**1.357**	2.441	0.132	0.250	**0.822**	2.212
		AARINF	0.015	0.128	0.130	0.962	***0.122***	1.408
		AEXTST	-0.007	-0.046	**0.234**	1.662	***0.141***	1.303
		Constant	**2.522**	1.757	***1.810***	1.594	**1.818**	2.085
[2]	PIRSWE	LPRSRF	**0.457**	2.307	**0.405**	2.467	**0.209**	1.686
		LCRMEE	**1.350**	5.438	-0.094	-0.614	**0.698**	3.633
		PGPIUP	**-0.364**	-2.118	0.016	0.188	***-0.139***	-1.557
		AEXTST	***0.230***	1.274	**0.587**	5.833	**0.299**	3.025
		Constant	**-4.019**	-2.738	-0.008	-0.011	**-1.750**	-2.025
[3]	PCOREC	LPRSRF	**-0.096**	-2.032	-0.052	-0.858	**-0.070**	-1.833
		PGPIUP	**0.065**	1.837	-0.004	-0.157	***0.024***	1.297
		POPAWE	-0.003	-0.055	0.031	0.766	-0.018	-0.593
		AIBDWP	**0.815**	4.087	0.105	0.639	**0.265**	2.153
		Constant	**1.894**	5.151	**2.221**	8.719	**2.358**	11.750
[4]	ASBUDC	AIBDWP	**2.922**	2.462	***1.119***	1.266	**1.485**	2.008
		PCOREC	**-3.713**	-3.814	**-2.322**	-2.126	**-3.426**	-3.590
		PGPIPP	-0.136	-0.925	0.034	0.287	-0.022	-0.233
		PGPIUP	***0.244***	1.291	0.123	0.989	***0.155***	1.463
		Constant	**10.265**	5.354	**7.694**	3.143	**10.178**	5.111
[5]	LACPRE	LPRSRF	**0.039**	0.249	0.095	0.392	***0.200***	1.292
		LOEPRV	**0.394**	3.140	**0.230**	2.031	**0.289**	3.600
		PCOREC	**1.363**	2.549	**2.588**	3.129	**3.814**	6.499
		POELWL	**0.248**	1.626	***0.130***	1.338	**0.208**	2.486
		AACCME	***0.171***	1.466	-0.093	-1.085	-0.021	-0.278
		Constant	**-2.962**	-1.938	***-3.108***	-1.598	**-7.036**	-4.769

Note: [a]Bolded coefficients are significant at 10 percent or better whereas bolded and italicized coefficients are significant at 20 percent.

Table 8.1b. Institution-Performance Interaction in Water Sector: Effects of Sample Size and Country Coverage.

(3-SLS Estimates of Model B)

Equa-tions	Dependt. Variables	Independt. Variables	Sample 1-43		Sample 44-127		Sample 1-127	
			Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio
[6]	LOEFWL	LTRWSA	**1.222**	2.443	0.054	0.117	0.259	0.730
		LPRSRF	**0.190**	1.969	-0.050	-0.226	0.095	0.853
		LCRMEE	**0.327**	2.179	0.241	1.176	***0.321***	1.489
		LACPRE	-0.114	-0.631	**0.749**	2.934	0.241	1.173
		LINTRE	**0.171**	2.630	-0.019	-0.256	**0.093**	1.779
		LOECEN	-0.036	-0.495	**0.223**	3.166	***0.076***	1.462
		LOEPRV	**0.212**	1.700	-0.079	-0.710	0.066	0.790
		Constant	**1.669**	1.892	0.266	0.280	***1.256***	1.556
[7]	POEFWP	PPSCRI	**-0.248**	-2.545	-0.043	-0.300	-0.107	-1.189
		PCOREC	**1.024**	2.830	**2.363**	3.727	**1.523**	3.241
		PIRSWE	**0.180**	1.753	**0.526**	2.109	**0.783**	5.278
		PGPIPP	**-0.152**	-2.366	-0.066	-1.238	**-0.103**	-2.265
		PGPIUP	-0.021	-0.258	**0.129**	1.644	0.062	0.977
		POPAWE	0.080	0.726	-0.002	-0.019	0.053	0.590
		POELWL	**0.415**	4.633	0.118	1.189	**0.179**	2.605
		Constant	0.914	0.811	**-3.433**	-2.736	**-2.067**	-1.977
[8]	AOEFWA	AORGBA	-0.049	-0.246	0.053	0.538	0.035	0.359
		ABALFS	***0.941***	1.422	**0.952**	3.573	**1.062**	3.827
		AIBDWP	0.773	1.179	0.126	0.371	0.121	0.383
		ASBUDC	0.161	0.826	-0.056	-0.509	0.149	1.098
		AACCME	-0.139	-0.857	0.056	1.107	-0.030	-0.481
		AARINF	0.082	0.631	**0.258**	3.060	**0.226**	3.126
		AEXTST	**0.363**	2.077	**0.364**	4.188	**0.356**	**4.661**
		Constant	***1.904***	1.425	**1.070**	1.701	0.841	1.188
[9]	WIPOEV	LOEFWL	**0.762**	3.347	-0.056	-0.403	**0.371**	2.484
		POEFWP	-0.158	-0.678	***-0.272***	-1.529	-0.072	-0.415
		AOEFWA	**0.276**	1.999	**1.095**	5.917	**0.622**	4.188
		Constant	1.051	1.204	**1.480**	2.339	***0.840***	1.304
[10]	WSPOEV	WIPOEV	**0.786**	6.256	**0.399**	3.054	**0.843**	7.355
		POPAWE	***-0.139***	-1.543	-0.066	-0.922	-0.063	-1.149
		ASBUDC	-0.043	-0.633	0.002	0.021	**-0.132**	-1.570
		PCOREC	0.046	0.155	***0.605***	1.335	***-0.450***	-1.278
		AARINF	0.053	0.854	**0.205**	2.588	**0.098**	1.934
		AEXTST	0.002	0.023	**0.139**	1.617	0.041	0.672
		Constant	***1.297***	1.301	0.065	0.067	**1.537**	1.972
System R^2				0.884		0.797		0.765
χ^2				92.694		134.090		183.850
Breusch-Pagan Test				75.554		174.640		230.710
Sample Size				43		84		127

Note: [a]Bolded coefficients are significant at 10 percent or better whereas bolded and italicized coefficients are significant at 20 percent.

(PIRSWE) irrespective of sampling variations. The other two institutional aspects representing LCRMEE and PGPIUP, though insignificant in sampling context II, are, however, significant in the other two sampling contexts. It is also clear in equation [2] that the behavior of all four variables in the sampling context I remain rather consistent with that observed in the all-sample context, though there are considerable differences in the magnitude of their coefficients across these two sampling contexts.

The consistent behavior of institutional variables across the sampling contexts I and III seen in equation [2] can also be observed in the context of both equations [3] and [4]. Notably, in the particular case of equation [3], since none of the institutional variables are significant in sampling context II, the institutional inter-linkage being captured by the equation itself seems to be contextual in nature. In contrast, equation [4] has two robust and context independent variables having a more durable and consistent effect on the linkage variable capturing the seriousness of budget constraint (ASBUDC). They are the institutional variables representing respectively the presence of independent water pricing body (AIBDWP) and cost recovery status (PCOREC). Interestingly, the latter is also a linkage variable in equation [2], which, as noted above, not only has no robust variables across the sampling contexts but also has no significant institutional variables in the particular case of sampling context II. Of the remaining two institutional aspects in equation [4], the variable representing user participation policy (PGPIUP) is significant across all sampling contexts except II whereas that representing the institutional aspect of private sector promotion policy (PGPIPP) remains insignificant irrespective of the sampling contexts.

Of the five institutional variables in equation [5], the three variables, i.e., PCOREC, LOEPRV representing the effectiveness of legal provisions for private participation, and POELWL representing the overall water law-water policy linkages, are robust with consistent behavior across sample contexts. In contrast, the remaining two institutional variables, i.e., LPRSRF and AACCME representing respectively property rights format and the effectiveness of administrative provisions for accountability, are contextual. The effects of these two contextual variables, unlike the three robust variables noted above, on the effectiveness of the legal provisions on accountability (LACPRE) are, therefore, sensitive to sample size variations and regional coverage. Although the institutional variables in equation [6] show some consistency in their behavior, none of them is robust enough to have behavioral consistency across all the three sample contexts. Notably, of the seven institutional variables in this equation, three (LTRWSA representing the legal treatment of water from difference sources, LACPRE, and LOEPRV) are relatively more contextual as they are significant only in one sample context. Notably, LPRSRF that is robust in equation [2] and significant in two of the three sample contexts in equations [3] and [5] turns out to be insignificant here in all the three sample contexts. By and large, all the law-related institutional aspects are essentially contextual in their effects on the overall effectiveness of water law (LOEFWL).

Among the seven institutional variables in equation [7], only PCOREC and PIRSWE are robust whereas the others are contextual in terms of their effect on the overall effectiveness of water policy (POEFWP). Importantly, both the robust variables are also linkage variables bringing with them the effects of inter-institutional linkages captured respectively in equations [2] and [3]. Of the contextual variables, PGPIPP and POELWL, though insignificant in sample context II, show consistency in terms of their significance in the other two sample contexts. Turning now to equation [8], of the seven institutional variables determining the overall effectiveness of water administration (AOEFWA), only the two representing respectively the administrative aspects of balanced functional specialization (ABALFS) and extensiveness of science & technology application (AEXTST) are robust. The variable representing the institutional aspect of information adequacy within water administration (AARINF) is significant in two of the three sample contexts whereas the rest of the variables are uniformly insignificant.

The only variable that is most robust and consistent in equation [9] is AOEFWA. The other two variables, i.e., LOEFWL and POEFWP, are significant only in one or two sample contexts. Among the latter, although LOEFWL is not significant in sample context II, it shows, however, a consistent behavior in the remaining two sample contexts. Obviously, it seems that AOEFWA, followed by LOEFWL, has a more consistent effect on the overall performance of water institution (WIPOEV) as compared to POEFWP. Coming to the last equation, the only variable having a most robust and consistent effect on the overall performance of water sector (WSPOEV) is WIPOEV. The rest of the variables remain essentially contextual. Although PCOREC and AARINF are significant in two sample contexts, their behavior is not consistent due to differences in the magnitude and direction of their impact.

From an overall perspective, it is clear from tables 8.1a and 8.1b that of the 25 institutional and performance variables—covering 16 exogenous and nine endogenous variables but excluding the ultimate dependent variable WSPOEV—in the model, only 12 variables are robust. Among these robust ones, four are linkage or endogenous variables (PCOREC, PIRSWE, AOEWA, and WIPOEV) and eight are exogenous variables (LPRSRF, LOEPRV, POELWL, PGPIUP, AIBDWP, ABALFS, AARINF, and AEXTST). However, the robustness of these variables are also context-specific as some of the variables that are robust in one equation is not so in the case of other equation(s). For instance, PGPIUP that is robust in equation [1] is not so in all the four other equations where it enters as an exogenous or independent variable. Similar is also the case with LPRSRF that remains a robust variable in equation [2]. But, the endogenous or linkage variable PCOREC that remains most robust as an independent variable in equations [4], [5], and [7] becomes contextual in equation [10]. In view of the contextual nature of even the robust variables, the robustness properties of individual institutional aspects need not always be a sufficient condition for ensuring the robustness of the institutional and performance linkages that these variables capture and transmit.

Consistency and Caveats

While we have distinguished the robust variables from the contextual ones mainly in terms of their uniform statistical significance across sample contexts, it is still more important to see how sensitive are the magnitude and direction of their coefficients to sampling variations. More specifically, we like to know whether the sampling variations lead to a change in the relative importance and significance of the institutional variables in the case of each equation. The evaluation of the robustness properties of institutional aspects clearly shows that their relative influence as evaluated in terms of the size of their coefficients vary considerably across sample contexts. The sensitivity in the behavior of institutional aspects to sample size variations is rather clear as we compare the size and significance of each of the institutional aspects in all equations across sample contexts. While this is certainly not an unexpected result, the comparison does yield few distinct but interesting patterns with considerable implications for the relative significance of the institutional linkages as well as for the overall reliability of our model itself. Let us now deal with each of these patterns.

Relative Significance of Institutional Aspects

Although the relative size of the coefficients associated with institutional aspects vary across sample contexts, there is a notable consistency in the relative importance and direction of the impact of institutional aspects as evaluated respectively by the absolute size and sign of their coefficients in the case of most equations. This consistency is particularly remarkable, as the institutional aspect having dominant effect is the same across sample contexts in the case of most equations. This consistency taken along with the robustness properties of institutional aspects indicates that the relative importance of institutional variables in various layers of institutional and performance linkages is largely free from sample size variations. This is an important result as it provides significant evidence for the overall robustness of our model of institution-performance interaction itself. But, as we will see below, this result is not free from exceptions and caveats.

While emphasizing the overall consistency in the relative importance of institutional aspects across sample contexts, let us also identify some notable exceptions that provide the basis for identifying few caveats to the general pattern. Although these caveats are relatively more important in sample context II, there are also few of them in sample context I. For instance, in the case of equation [1], the institutional variable of LPRSRF that is insignificant in sample contexts I and III, becomes, the most dominant variable in sample context II. The relative importance of institutional variables in the case of equations [3] is rather consistent across sample contexts I and III whereas none of them is significant in sample context II. This means the layer of institutional linkages characterized by equation [3] itself seems to be largely irrelevant in this particular context. In contrast, equation [6] displays considerable inconsistency in the relative importance of institutional aspects across sample contexts with each context showing a different institutional aspect as dominant.

Interestingly, in the case of equation [9], although sample contexts I and III identify the same institutional aspects as significant, they differ in terms of the relative importance of these significant variables. That is, LOEFWL has the dominant effect in sample context I whereas AOEFWA has that distinction in sample context III. While AOEFWA remains the dominant institutional aspect both in sample contexts II and III, sample context II, unlike the other two sample contexts, identifies POEFWP as the next most important institutional variable in equation [9]. It means that among the three water institutional components, the relative importance of water law and water policy component remains relatively more contextual than water administration component. Similarly, in the case of equation [10] forming the most critical component of the system, although WIPOEV remains consistently the most dominant institutional variable affecting the overall performance water sector, the relative importance of the remaining variables shows considerable variations across sample contexts.

The analysis of the relative significance, robustness, and consistency of institutional aspects across sample contexts provides valuable insights useful for designing institutional reform packages. The exceptions and caveats to the general pattern provide equally valuable information necessary for ensuring the institutional reform package to address location-specific concerns and problems. From the evaluation of the robustness properties of institutional aspects as well as the consistency in their relative significance, it is possible to identify some of the critical institutional components that can enhance the overall performance of water institution and water sector in most contexts. From the perspective of developing institutional reform packages, these key components will form the nucleus around which other context-specific components can be built to enhance the effectiveness of the reform package in addressing contextual and location-specific problems and concerns. The exceptions and caveats, in fact, help in identifying additional institutional components necessary for ensuring the flexibility and location-specificity of the reform packages.

Relative Strength of Institution-Performance Linkages

As we compare the results of sample contexts I and II, we see that the size of the coefficients associated with most of the institutional aspects in almost all equations is larger in sample context I as compared to sample context II. This is also true in terms of the number of institutional aspects remaining significant in the case of most equations. It is an important indication for the fact that the linkages among institutional aspects and their performance implications are much stronger in sample context I as compared to sample context II. This important result is basically an outcome of the difference in the country coverage and geographical focus of the two sample contexts. As we could see from Table 5.2, sample context I includes mostly the responses from South Asia including China, North and South America, Australia, and the Middle East with a water sector dominated by heavy irrigation demand, water scarcity, and associated social and political problems. In contrast, sample context II covers the responses mostly from Europe and South East Asia where water sector is affected more by water quality and flood-related problems than by water scarcity.

As we can see from Table 5.1, the countries covered by the two sets of sample display a distinct pattern in certain key features of their water sector. For instance, the average water withdrawal per capita of countries covered by sample I (5600 cum) is lower than that (6500 cum) of those covered by sample II. Even though sample I covers only 11 countries as against 28 countries covered by sample II, the irrigated area in the former (131 mha) is far higher than that (47 mha) in the latter. While the total annual water demand is about 554 bcum in countries covered by sample I, it is only 182 bcum in countries covered by sample II. But, the differences among the two sets of countries are much deeper than a mere resource endowment difference in view of equally serious differences on the demographic and socio-economic fronts. For instance, countries in sample I have a combined population of 3.05 billion with an average population density of 71/person/sqkm. But, countries in sample II have a combined population of only 1.35 billion and an average population density of 51/persons/sqkm. Notably, people below poverty line in countries in sample I (588 million) are much higher than those in countries in sample II (212 million).

It is clear that the water sector of countries covered in sample I is subject to more acute demographic and socio-economic pressures. It is precisely this condition that explains why the institutional linkages and their implications for water sector performance are relatively stronger in countries covered in the first sample as compared to those covered in the second sample. On the same token, the perception of institution-performance linkages is much stronger among experts in the first set of countries than that among those in the second set of countries. This is the main reason for the differential results observed in the two sample contexts. The implication is that water institutional reforms, though equally necessary in both sets of countries, their importance for water sector performance is perceived much strongly in countries covered in the first sample as compared to those covered in the second sample. It is this fact that also explains why most of the recently observed institutional changes in the water sector—described in Chapter 6—are concentrated in the 11 countries covered in the first sample.

Implications for Overall Reliability

Turning now to the overall implications of the observed consistency as well as variations in the sample-specific results, we note that the configurations of robust variables in most equations observed across sample contexts I and II are rather distinct. As noted already, this distinct pattern implies that the strength of institution-performance linkages is stronger in sample context I as compared to the same in sample context II. Such a differential pattern in the configuration of robust variables and their implications for institution-performance linkages have also been explained in terms of the distinct pattern in the features of water sector in countries covered by the first two sample contexts. But, the comparison of the size of the coefficients of robust institutional across sample contexts I and II also reveals yet another interesting aspect with considerable implications for the relative significance and performance implications of various layers of institutional linkages. That is, the size of the coefficients of robust variables is larger for sample I than that for sample II in all equations except equations [7], [8], and [9]. These exceptions imply three interrelated aspects.

First, the inter-institutional linkages are relatively stronger than the intra-institutional in countries covered by sample I. In contrast, the intra-institutional linkages are relatively stronger than their inter-institutional counterparts in countries covered by sample II. Second, while inter-institutional linkages observed among countries in sample I is stronger than those observed among countries in sample II, the intra-institutional linkages observed in the latter is stronger than those observed among the former. And, finally but more importantly, given the two points noted above and the relative size of the coefficients associated with WIPOEV in equation [10], it is also possible to infer the relative performance implications of inter and intra-institutional linkages. As the coefficient of WIPOEV—the ultimate linkage variable that captures the impacts transmitted through various layers of institutional linkages—is larger for sample I, the inter-institutional linkages as captured by the first five equations seem to be relatively more important in determining the overall performance of water sector.

The above results taken together with the exceptions noted in the previous sections suggests a clear need for a regionally differentiated policy for institutional reform. In general, the institutional reform in the context of countries covered by sample I should focus more on strengthening intra-institutional linkages whereas the same in countries covered by sample II should focus more on strengthening inter-institutional linkages. The recognition of the regionally differentiated strategy is, however, not at the cost of underestimating the importance of some of the institutional aspects with universal relevance. We have indeed identified such institutional aspects in our evaluation of robust properties of the results. The evaluation of the robustness properties of the institutional variables also provides some key insights into the robust properties of various layers of institutional linkages characterized by different equations. As can be seen from tables 8.1a and 8.1b, with the exception of the layers of institutional linkages represented by equations [1], [3], and [6], other layers are robust and relatively more durable. This means, among other things, that the results on the relative significance of institutional aspects and their performance implications discussed in Chapter 7 are relatively more generalizable and reliable. But, the notable exceptions noted above do signify certain important caveats as to the contextuality of some of the layers of institutional linkages.

SENSITIVITY OF RESULTS: ROLE OF DISCIPLINARY BIAS

The evaluation of the sensitivity of results to sample size variation has certainly provided us with some interesting insights into their stability and consistency properties. But, for a still firmer conclusion in this respect, it is also necessary to see how sensitive are the results to two other aspects endogenous to our sample, i.e., subject background of sample experts and reform status of sample countries. As noted already, the influence of the disciplinary background and subject specialization of sample experts is evaluated by categorizing the sample respondents into two groups: engineers and social scientists. The objective of evaluating the model in the context of the two respondent groups is essentially to see whether the frequently alluded disciplinary divide in the water sector lead to any perceptible differences in the perception of institution-performance linkages. The comparison of results across the expert groups can enable us to evaluate whether there is any group-specific difference in the relative importance attached to different institutional aspects.

Based on this evaluation, it is also possible to verify whether the so-called disciplinary divide in the water sector really has any effect on the choice of institutional configurations and their implications for institution-performance linkages. One obvious but general hypothesis in this respect is that while engineers are likely to emphasize engineering and administration-related institutional aspects, social scientists are likely to highlighted economic and market-related institutional aspects. But, as long as the experts—whether engineers or others—display either some uniformity or convergence in their evaluation of institution-performance linkages, the alternative to the above stated hypothesis will be true. That is, the discipline-induced bias in the preference of institutional aspects can be expected to be either least or absent. Obviously, it is the evaluation of this fact that will receive our attention while attempting a comparative evaluation of the group-specific results.

Disciplinary Background and Subjective Perception

Since the subjective perception of sample experts as to the existing and alternative institutional arrangements is the information basis of our estimated results, these results will obviously reflect the effects of both the objective and subjective factors affecting experts' perceptional evaluation. One of the most important factors that can have a powerful influence on the process of subjective evaluation is related to norms. While these norms depend upon many social, cultural, and legal factors (see Sjostrand, 1995:24), they are also shaped by educational curricula and professional affiliations (DiMaggio and Powell, 1983; Meyer, *et al.*, 1992). When this is true, then, there can be a distinct pattern in the perception of the relative importance of institutional aspects and their configurations among groups with distinct disciplinary background. However, the mobility of and interaction among individuals often lead to a "flow of norms between contexts" and generate a "continuous stream of experiences and ideas across previously unlinked or relatively autonomous settings" (Sjostrand, 1995:40). This means that despite a basic difference in the discipline-based norms across individuals, the increasing sense of empathy and inclination for accommodation can lead to a tendency for convergence in their subjective perception of institutional arrangements.

To what extent this proposition about disciplinary bias has empirical validity can be evaluated with the help of tables 8.2a and 8.2b giving the estimated results for engineers and social scientists. Notice that these tables also provide the corresponding results for the all-sample context so that we can also evaluate the consistency of the group-specific results with the overall pattern. While this consistency aspect will be dealt later, let us first consider the convergence properties of the group-specific results by focussing both on the nature and extent of convergence in the evaluation observed across the expert groups. As we did in the context of our evaluation of the robustness of results, the convergence properties of group-specific results will also be evaluated in terms of the size, significance, and direction of the coefficients associated with the institutional and performance variables in various equations. Understandably, the objective of this evaluation is twofold. The first is to see how far the expert groups converge or diverge in their evaluation of the relative significance of institutional and performance variables in different equations and highlight the extent of convergence observed in the configuration and relative ordering of institutional aspects across expert groups. And, the second is to show how the convergence noted above relates to the group-specific evaluation of the relative strength of various layers of institution-performance linkages and indicate their implications for institutional design and packaging.

Convergence in Institution-Performance Evaluation

The issue of convergence in institution-performance evaluation between the two groups of experts can be evaluated better by considering each of the equations representing a particular layer of institution-performance interaction. To begin with, in equation [1], although there is a difference in the number of significant institutional variables between the expert groups, there is an agreement on the significance of effective user participation policy (PGPIUP) and effective legal mechanisms for conflict resolution (LCRMEE). Importantly, there is also a difference between the two groups in terms of the relative importance of institutional aspects as balanced functional specialization (ABALFS), which is not at all considered significant by engineers, is considered highly significant among social scientists, that too, with a much larger effect than PGPIUP. In equation [2], the expert groups agree on the importance of two institutional aspects, i.e., LCRMEE and AEXTST representing the extensiveness of science & technology application. There is also a further agreement as to the dominant role played by LCRMEE, which is actually a linkage variable transferring the effects from equation [1]. But, there is a divergence in perception as to the institutional aspect having the next level of importance because social

Table 8.2a. Institution-Performance Interaction in Water Sector: Effects of the Disciplinary Background of Sample Experts.

(3-SLS Estimates of Model B)

Equa-tions	Dependt. Variables	Independt. Variables	Engineers		Social Scientists		All-Sample	
			Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio
[1]	LCRMEE	LPRSRF	0.183	0.868	0.069	0.363	0.079	0.556
		PGPIUP	**0.296**	3.053	***0.150***	1.540	**0.246**	3.481
		POPAWE	-0.012	-0.074	0.154	1.074	0.096	0.880
		ABALFS	0.501	0.894	**1.065**	2.004	**0.822**	2.212
		AARINF	0.100	0.733	0.114	0.975	***0.122***	1.408
		AEXTST	0.117	0.617	0.162	1.235	***0.141***	1.303
		Constant	**2.545**	1.809	***1.581***	1.394	**1.818**	2.085
[2]	PIRSWE	LPRSRF	0.147	0.736	**0.318**	1.884	**0.209**	1.686
		LCRMEE	**0.696**	2.728	**0.764**	3.533	**0.698**	3.633
		PGPIUP	-0.121	-0.882	***-0.128***	-1.271	***-0.139***	-1.557
		AEXTST	**0.368**	1.969	**0.220**	1.845	**0.299**	3.025
		Constant	***-2.077***	-1.422	**-1.946**	-1.992	**-1.750**	-2.025
[3]	PCOREC	LPRSRF	-0.009	-0.178	**-0.105**	-1.840	**-0.070**	-1.833
		PGPIUP	0.014	0.568	0.029	0.973	***0.024***	1.297
		POPAWE	**-0.101**	-2.288	**0.075**	1.643	-0.018	-0.593
		AIBDWP	0.154	0.995	**0.445**	2.292	**0.265**	2.153
		Constant	**2.734**	9.877	**1.879**	6.247	**2.358**	11.750
[4]	ASBUDC	AIBDWP	**1.544**	1.719	0.332	0.315	**1.485**	2.008
		PCOREC	**-1.647**	-1.625	**-1.906**	-1.841	**-3.426**	-3.590
		PGPIPP	-0.027	-0.233	0.032	0.230	-0.022	-0.233
		PGPIUP	0.052	0.397	0.179	1.221	***0.155***	1.463
		Constant	**6.681**	2.956	**6.662**	3.152	**10.178**	5.111
[5]	LACPRE	LPRSRF	0.186	0.880	-0.009	-0.051	***0.200***	1.292
		LOEPRV	**0.422**	3.644	**0.312**	2.975	**0.289**	3.600
		PCOREC	**2.882**	3.662	**1.562**	2.652	**3.814**	6.499
		POELWL	-0.076	-0.574	**0.415**	3.656	**0.208**	2.486
		AACCME	**0.290**	2.491	-0.111	-1.078	-0.021	-0.278
		Constant	**-5.417**	-2.583	**-2.316**	-1.632	**-7.036**	-4.769

Note: [a]Bolded coefficients are significant at 10 percent or better whereas bolded and italicized coefficients are significant at 20 percent.

Table 8.2b. Institution-Performance Interaction in Water Sector: Effects of the Disciplinary Background of Sample Experts.

(3-SLS Estimates of Model B)

Equa-tions	Dependt. Variables	Independt. Variables	Engineers		Social Scientists		All-Sample	
			Coefficient[a]	t-Ratio	Coefficient[a]	t-Ratio	Coefficient[a]	t-Ratio
[6]	LOEFWL	LTRWSA	-0.200	-0.398	**0.868**	1.996	0.259	0.730
		LPRSRF	0.092	0.639	0.133	0.960	0.095	0.853
		LCRMEE	**0.488**	2.446	**0.357**	1.647	***0.321***	1.489
		LACPRE	-0.153	-0.740	0.093	0.473	0.241	1.173
		LINTRE	0.012	0.162	**0.198**	3.035	**0.093**	1.779
		LOECEN	**0.175**	2.332	0.002	0.041	***0.076***	1.462
		LOEPRV	**0.246**	2.326	0.061	0.662	0.066	0.790
		Constant	1.248	1.177	***1.367***	1.562	***1.256***	1.556
[7]	POEFWP	PPSCRI	-0.076	-0.548	-0.077	-0.684	-0.107	-1.189
		PCOREC	***0.891***	1.399	**1.578**	3.089	**1.523**	3.241
		PIRSWE	**0.638**	3.019	**0.278**	1.971	**0.783**	5.278
		PGPIPP	**-0.109**	-1.628	***-0.087***	-1.373	**-0.103**	-2.265
		PGPIUP	0.071	0.836	***0.099***	1.375	0.062	0.977
		POPAWE	**0.247**	1.734	-0.072	-0.596	0.053	0.590
		POELWL	0.101	0.975	**0.395**	4.385	**0.179**	2.605
		Constant	-0.818	-0.439	***-1.464***	-1.519	**-2.067**	-1.977
[8]	AOEFWA	AORGBA	**0.319**	2.210	-0.159	-1.227	0.035	0.359
		ABALFS	**0.854**	2.203	**1.355**	3.603	**1.062**	3.827
		AIBDWP	**-1.059**	-2.273	**0.774**	1.793	0.121	0.383
		ASBUDC	**0.547**	3.523	0.174	1.068	0.149	1.098
		AACCME	-0.060	-0.789	-0.017	-0.206	-0.030	-0.481
		AARINF	**0.289**	2.757	**0.159**	1.637	**0.226**	3.126
		AEXTST	**0.408**	3.413	**0.390**	3.940	**0.356**	4.661
		Constant	-1.281	-1.039	***1.067***	1.330	0.841	1.188
[9]	WIPOEV	LOEFWL	**0.412**	2.612	**0.402**	2.193	**0.371**	2.484
		POEFWP	**-0.358**	-1.762	0.108	0.571	-0.072	-0.415
		AOEFWA	**0.647**	3.813	**0.543**	2.905	**0.622**	4.188
		Constant	**1.961**	2.116	0.152	0.192	***0.840***	1.304
[10]	WSPOEV	WIPOEV	**0.875**	6.158	**0.854**	6.731	**0.843**	7.355
		POPAWE	-0.078	-0.891	-0.104	-1.170	-0.063	-1.149
		ASBUDC	0.012	0.158	***-0.211***	-1.597	**-0.132**	-1.570
		PCOREC	-0.097	-0.244	-0.107	-0.230	***-0.450***	-1.278
		AARINF	**0.209**	3.266	0.004	0.058	**0.098**	1.934
		AEXTST	-0.072	-0.851	0.084	1.029	0.041	0.672
		Constant	-0.218	-0.194	**1.712**	1.800	**1.537**	1.972
System R^2				0.783		0.888		0.797
χ^2				93.127		144.550		113.080
Breusch-Pagan Test				153.830		102.640		170.110
Sample Size				61		66		71

Note: [a]Bolded coefficients are significant at 10 percent or better whereas bolded and italicized coefficients are significant at 20 percent.

scientists consider this aspect to be water rights format (LPRSRF) whereas engineers consider this to be AEXTST.

The group-specific differences in the configuration and relative ordering of institutional variables can also be seen in equation [3]. Here, engineers consider the variable representing the effects of other sectoral policies on water policy (POPAWE) as the only institutional aspect affecting the cost recovery status (PCOREC). But, social scientists, though agree with the importance of POPAWE, also consider two additional institutional variables, i.e., LPRSRF and AIBDWP representing the existence of independent water pricing body, as important. In fact, for the social scientists, these additional variables are relatively more important than POPAWE in determining cost recovery status. Notably, although both groups agree on the importance of POPAWE, they differ fundamentally in terms of the direction of its effects as engineers consider it to have a negative effect whereas social scientists view it to have a positive effect on cost recovery status. In the case of the institutional inter-linkage characterized by equation [4], the expert groups agree on the fact that better cost recovery status can reduce the seriousness of budget constraint (ASBUDC). But, engineers, unlike social scientists, consider an additional institutional aspect, i.e., AIBDWP, to be also an important factor having a positive role. Similar pattern can also be seen in the context of equation [5] except that there is convergence on the importance of two institutional aspects but divergence as to the role of an additional institutional aspect identified by each group. Although the configuration and relative importance of the institutional aspects differ among the expert groups, they still agree on the dominant role of the linkage variable PCOREC.

Turning now to the group-specific differences in the configuration and relative importance of institutional aspects in equations characterizing intra-institutional linkages, the results for equation [6] in Table 8.2b show considerable divergence in the perceptional evaluation of the two groups. Of the three institutional aspects identified to be important by each group, except the linkage variable LCRMEE, the others are highly groups-specific. That is, engineers consider the centralization tendency in water law (LOECEN) and the effectiveness of the legal provisions for privatization (LOEPRV) as the two other important variables. In contrast, social scientists consider unified legal treatment of difference water sources (LTRWSA) and internal consistency within water law (LINTRE) to be the other two important variables. Besides, since the social scientists consider LTRWSA to be the dominant institutional aspect determining the overall effectiveness of water law (LOEFWL), the groups-specific differences in institutional configuration also involves a differential prioritization of institutional aspects.

In contrast to a predominantly divergent tendency in their groups-specific evaluation of equation [6], the expert groups display a highly convergent tendency in their evaluation of both equations [7] and [8]. In equation [7], even though social scientists identify five institutional aspects to be important as against only the four identified by engineers, both groups agree on the important role played by three institutional aspects in determining the overall effectiveness of water policy (POEFWP). These institutional aspects whose significance are agreed by both groups are PCOREC, effectiveness of water transfer policies (PIRSWE), and effectiveness of private sector promotion policy (PGPIPP). The divergence is, however, restricted to POPAWE (emphasized only by engineers), and PGPIPP and POELWL (both underlined only by social scientists). These additional institutional variables identified by the two groups, however, alter the relative importance and priority of even the institutional aspects on which there is agreement. While both groups agree on the dominant role of PCOREC, they differ in terms of the relative importance assigned to all the other significant institutional aspects.

In equation [8], engineers, who agree with all the four institutional variables identified as important by social scientists, underline, however, two additional variables to be important in determining the overall effectiveness of water administration (AOEFWA). The four institutional aspects eliciting convergence are ABALFS, AIBDWP, AEXTST, and AARINF and the two additional institutional aspects identified only by engineers are the organizational basis of water administration (AORGBA) and ASBUDC. It is important to note that despite a greater degree of convergence in the evaluation of equation [8] by expert groups, they have a different prioritization of institutional aspects. For instance, engineers assign top priority to AIBDWP followed by ABALFS, ASBUDC, AEXTST, and AARINF whereas social scientists give priority to ABALFS followed by AIBDWP, AEXTST, and AARINF. Notwithstanding the differences in the relative ordering of institutional aspects, the expert groups largely converge as to the configuration of institutional aspects significant in equation [8]. Turning now to the last two equations capturing the performance implications of institutional inter-linkages, equation [9], unlike equation [8], shows that there is convergence in priority but a slight change in the configuration of institutional components. While both groups agree that AOEFWA followed by LOEFWL has the dominant role, engineers, unlike social scientists, consider POEFWP is also important for determining the overall effectiveness water institution (WIPOEV).[7] In equation [10], both groups agree on the dominant role played by WIPOEV in determining the overall performance of water sector (WSPOEV). But, they differ in terms of the role of additional institutional variable as engineers consider this to be AARINF whereas social scientists consider this to be ASBUDC.

From and overall perspective, the configuration of institutional aspects identified by both groups are relatively more consistent in all equations except [3] and [6]. But, the group-specific differences in the ordering of even the commonly agreed institutional

[7] Note that the coefficient associated with POEFWP is negative for engineers and the reasons for this inverse relationship of POEFWP with WIPOEV have already been explained in Chapter 7 using the argument based on two-way flow of effects between these performance variables. Thus, instead of viewing a more effective water policy negatively affecting the overall performance of water institutions, it is realistic to see poor performance of water institutions as creating a compulsion for a creating a more effective water policy.

aspects in the case of most equations suggest that the expert groups differ in terms of the relative importance of relative importance of institutional aspects. This means that the agreement on the role of institutional aspects is only necessary but not sufficient for the convergence on the relative significance of institutional aspects. For instance, social scientists assign greater importance to LTRWSA, LPRSRF, LINTRE, and POELWL whereas engineers place greater attention on institutional aspects such as LOECEN, LOEPRV, AORGBA, and AACCME. Thus, it seems that social scientists place a considerable importance on legal aspects, especially those related to water rights, internally consistent water law, and a legally consistent water policy. But, engineers attach a greater significance on a relatively centralized water law, private sector participation, organizational aspects, and administrative accountability. This differential pattern of institutional aspects identified by the two groups can be interpreted as an evidence for the presence of disciplinary bias in institution-performance evaluation. But, considering the degree of consistency on the role and significance of many key institutional aspects, we can conclude that the disciplinary bias is restricted more to micro details than to macro thrust and focus. The presence of macro convergence in the face of micro divergence can be shown still more clearly from the group-specific pattern of the relative importance of various layers of institution-performance interaction.

Relative Significance of Institution-Performance Layers

As a direct consequence of the group-specific differences in the relative significance of institutional aspects, there is also a difference in the relative importance assigned to both the direct and linkage roles of some institutional aspects. For instance, although the expert groups agree on the importance of the linkage roles of PGPIUP in equation [1] and POPAWE in equation [3], they differ on the importance of their direct roles in equation [7]. Similarly, although both groups recognize the importance of ASBUDC in the context of different equations, they differ in terms of the routes though which its effects are transmitted to water sector performance. While engineers consider its effects are transmitted indirectly via AOEFWA in equations [8] and [9], social scientists underline its direct effects on water sector performance in equation [10]. Likewise, social scientists consider the inter-institutional linkage effects of AIBDWP are transmitted mainly through PCOREC in equation [3] whereas engineers consider the transmission channel to be ASBUDC in equation [4]. Furthermore, although both groups recognize the intra-institutional linkage effects of AIBDWP in equation [8], they disagree as to the direction of its effects. Similar disagreement on the direction of effects can also seen in the case of POPAWE in equation [3].

Apart from the differences in the perception on the layers or channels through which the effects of some of the institutional aspects are transmitted, the groups also differ in terms of the composition of these effects. For instance, as per the evaluation of engineers, the linkage variable LCRMEE that transfers the inter-institutional effects from equation [1] to [2] brings with it only the effects of PGPIUP. But, in terms of the evaluation of social scientists, it transmits the effects of both PGIPUP as well as ABALFS. Notably, in the perception of social scientists, the linkage effects of ABALFS dominate over that of PGPIUP. Similarly, the evaluation of engineers shows that the linkage variable PCOREC in equation [4] transfers the effects of only POPAWE from equation [3]. But, from the perspective of social scientists, PCOREC transfers the effects of not just POPAWE but also the effects of both AIBDWP and LPRSRF. Similar group-specific differences in the composition of effects can also be seen in the context of other linkage variables such as LOEFWL and AOEFWA transferring respectively the intra and inter-institutional effects from equations [6] and [8] to equation [9].

It is the group-specific differences in the relative importance of transmission channels as well as in the composition of the transmitted effects that explain the variations in the size, significance, and direction of the coefficients associated with various institutional variables in different equations. Although this pattern appears to indicate the effects of the disciplinary bias, we need to reckon, however, the general agreement among the experts groups on the role and relative importance of many other institutional aspects. Such an agreement, in fact, suggest that the group-specific differences observed in the relative role, significance, and linkage effects of institutional aspects need not be interpreted as an outcome of any group-specific subjective bias but as an outcome of genuine differences in the technical background and objective considerations of experts. Even if there is any subjective bias or partisan tendency due to disciplinary bias, they are likely to confine to the lower echelons of the layers of institution-performance interaction.

Our results, in fact, provide some support for the increasing degree of convergence at higher layers of institution performance interaction. For instance, as we relate the size of the coefficient associated with the most important linkage variables in equations [9] and [10] with that in the rest of the equations, we find an interesting pattern with considerable implications for perceptional convergence. That is, the group-specific differences in the size of the coefficients of the most important institutional variables tend decline as we move up to the higher layers of institution-performance linkages. This can be easily verified by noting how close is the size of the group-specific coefficients associated with LOEFWL and AOEFWA in equation [9] and WIPOEV in equation [10]. As we can see from tables 8.2a and 8.2b, this is not the case with the coefficients of most institutional aspects—both convergent and divergent—in other equations. This suggests that the experts groups differ more in their evaluation of the relative strength of inter and intra-institutional linkages than in their evaluation of the strength of the overall linkage between water institution and water sector performance. In other words, divergence confines more to details and particulars than to the main thrust and focus.

CONTEXTUALITY OF RESULTS: ROLE OF REFORM ENVIRONMENT

As we have argued in the context of our stage-based perspective of institutional change outlined in chapter 3, it is an increasing convergence in the perception of the need for institutional change that initiates the process of change. But, institutional change also plays a major role in reinforcing and sustaining convergence in perception.[8] Just as the growing consensus on the perception of institution-performance linkages determines the nature and direction of institutional change so does the reform environment in reinforcing convergence in subjective perception. It is this convergence in perception that, in fact, sustains the process of institutional change. In other words, in an advanced and mature stage of institutional change, the change process has some in-built mechanisms for sustaining itself. If this is true, then, we can expect that various layers of institution-performance linkages observed in the context of reform countries to be stronger than that seen in the context of other countries. It is this important aspect that will receive our attention while attempting a comparative evaluation of the results across country groups.

The influence of the overall reform environment on the subjective perception and hence, on institution-performance interaction, is evaluated by comparing the model results of two country groups defined in terms of the presence or absence of recent institutional reforms within water sector. Since the subjective perception and reform environment are intricately linked in a two-way relationship, the evaluation of the process of institution-performance interaction by experts in reform countries are likely to be different from that by their counterparts in other countries. Obviously, such evaluation differences lead to area-specific differences both in the configuration and relative ordering of institutional aspects as well as in the nature and strength of institutional and performance linkages. We also expect further that the area-specific pattern of evaluation is more pronounced and powerful enough to transcend the discipline-based group-specific differences among the expert-groups both within and across country groups. What effects that the interface between reform environment and subjective evaluation has on the configuration of institutional aspects and the nature of their linkages can be evaluated by comparing the results for the country groups. The area-specific results, along with the all-sample results, are presented in tables 8.3a and 8.3b. As in the context of our evaluation of the results across expert groups, we focus, again, on the convergence in institutional configurations and the relative significance of various layers of institution-performance linkages across country groups.

[8] Note that this fact does not involve any circular reasoning, as it is the initial convergence in perception that leads to institutional change, which, in turn, play a major role in the reinforcement of the initial consensus needed for sustaining the already initiated process of institutional change.

Table 8.3a. Institution-Performance Interaction in Water Sector: Effects of the Reform Status of Sample Countries.

(3-SLS Estimates of Model B)

Equa-tions	Dependt. Variables	Independt. Variables	Reform Areas		Other Areas		All-Sample	
			Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio
[1]	LCRMEE	LPRSRF	0.030	0.158	0.250	1.166	0.079	0.556
		PGPIUP	**0.235**	2.540	**0.247**	2.433	**0.246**	3.481
		POPAWE	-0.052	-0.350	**0.291**	2.026	0.096	0.880
		ABALFS	0.388	0.862	**1.203**	2.238	**0.822**	2.212
		AARINF	0.114	1.005	0.084	0.724	***0.122***	1.408
		AEXTST	**0.273**	1.656	-0.012	-0.086	***0.141***	1.303
		Constant	**2.555**	2.064	1.010	0.853	**1.818**	2.085
[2]	PIRSWE	LPRSRF	***0.229***	1.364	0.112	0.544	**0.209**	1.686
		LCRMEE	**0.644**	2.792	**0.740**	3.140	**0.698**	3.633
		PGPIUP	-0.096	-0.782	-0.104	-0.879	***-0.139***	-1.557
		AEXTST	***0.217***	1.366	**0.332**	2.628	**0.299**	3.025
		Constant	-1.186	-0.952	**-2.143**	-2.040	**-1.750**	-2.025
[3]	PCOREC	LPRSRF	-0.022	-0.482	***-0.087***	-1.333	**-0.070**	-1.833
		PGPIUP	0.016	0.687	0.016	0.490	***0.024***	1.297
		POPAWE	**-0.097**	-2.364	**0.080**	1.651	-0.018	-0.593
		AIBDWP	***0.218***	1.468	***0.323***	1.530	**0.265**	2.153
		Constant	**2.696**	10.700	**1.905**	5.797	**2.358**	11.750
[4]	ASBUDC	AIBDWP	**1.828**	1.977	0.477	0.428	**1.485**	2.008
		PCOREC	**-3.434**	-3.449	-1.165	-1.070	**-3.426**	-3.590
		PGPIPP	-0.094	-0.770	0.106	0.772	-0.022	-0.233
		PGPIUP	0.077	0.552	0.101	0.701	***0.155***	1.463
		Constant	**10.807**	5.170	**4.835**	2.044	**10.178**	5.111
[5]	LACPRE	LPRSRF	0.155	0.831	0.051	0.225	***0.200***	1.292
		LOEPRV	**0.365**	3.287	**0.335**	2.908	**0.289**	3.600
		PCOREC	**3.505**	5.281	**1.638**	2.450	**3.814**	6.499
		POELWL	-0.005	-0.044	**0.383**	3.196	**0.208**	2.486
		AACCME	**0.169**	1.661	-0.096	-0.876	-0.021	-0.278
		Constant	**-6.172**	-3.672	***-2.613***	-1.481	**-7.036**	-4.769

Note: [a]Bolded coefficients are significant at 10 percent or better whereas bolded and italicized coefficients are significant at 20 percent.

Table 8.3b. Institution-Performance Interaction in Water Sector: Effects of the Reform Status of Sample Countries.

(3-SLS Estimates of Model B)

Equa-tions	Dependt. Variables	Independt. Variables	Reform Areas		Other Areas		All-Sample	
			Coeffi-cient[a]	t-Ratio	Coeffi-cient[a]	t-Ratio	Coeffi-cient[a]	t-Ratio
[6]	LOEFWL	LTRWSA	-0.234	-0.452	**0.753**	1.653	0.259	0.730
		LPRSRF	0.154	1.120	0.173	0.912	0.095	0.853
		LCRMEE	**0.544**	2.032	0.094	0.435	***0.321***	1.489
		LACPRE	-0.064	-0.279	**0.478**	1.971	0.241	1.173
		LINTRE	-0.002	-0.024	**0.189**	2.429	**0.093**	1.779
		LOECEN	**0.170**	2.410	0.044	0.622	***0.076***	1.462
		LOEPRV	**0.248**	2.371	-0.066	-0.564	0.066	0.790
		Constant	0.313	0.269	**1.511**	1.626	***1.256***	1.556
[7]	POEFWP	PPSCRI	-0.145	-1.209	-0.082	-0.639	-0.107	-1.189
		PCOREC	**1.368**	2.699	**1.803**	2.962	**1.523**	3.241
		PIRSWE	**1.010**	5.117	**0.368**	2.347	**0.783**	5.278
		PGPIPP	**-0.100**	-1.751	-0.086	-1.252	**-0.103**	-2.265
		PGPIUP	0.047	0.543	0.100	1.247	0.062	0.977
		POPAWE	**0.289**	2.186	-0.170	-1.222	0.053	0.590
		POELWL	0.078	0.918	**0.392**	3.895	**0.179**	2.605
		Constant	**-3.093**	-1.999	***-1.655***	-1.400	**-2.067**	-1.977
[8]	AOEFWA	AORGBA	***0.230***	1.533	***-0.208***	-1.284	0.035	0.359
		ABALFS	**1.106**	3.200	**0.949**	2.041	**1.062**	3.827
		AIBDWP	***-0.520***	-1.260	***0.758***	1.367	0.121	0.383
		ASBUDC	***0.206***	1.484	**0.476**	2.420	0.149	1.098
		AACCME	-0.014	-0.191	0.011	0.117	-0.030	-0.481
		AARINF	**0.282**	2.904	**0.219**	1.710	**0.226**	3.126
		AEXTST	**0.356**	3.132	**0.353**	2.772	**0.356**	4.661
		Constant	-0.193	-0.163	0.205	0.232	0.841	1.188
[9]	WIPOEV	LOEFWL	**0.278**	1.629	**0.421**	2.220	**0.371**	2.484
		POEFWP	-0.024	-0.110	0.076	0.400	-0.072	-0.415
		AOEFWA	**0.402**	2.638	**0.541**	2.728	**0.622**	4.188
		Constant	**2.319**	2.882	0.157	0.190	***0.840***	1.304
[10]	WSPOEV	WIPOEV	**0.896**	6.407	**0.676**	4.680	**0.843**	7.355
		POPAWE	***-0.119***	-1.418	-0.081	-0.850	-0.063	-1.149
		ASBUDC	-0.060	-0.967	0.017	0.136	**-0.132**	-1.570
		PCOREC	-0.171	-0.468	0.059	0.110	***-0.450***	-1.278
		AARINF	**0.228**	3.925	0.079	0.728	**0.098**	1.934
		AEXTST	-0.048	-0.617	0.073	0.790	0.041	0.672
		Constant	0.093	0.098	1.065	1.105	**1.537**	1.972
System R^2				0.783		0.797		0.898
χ^2				93.127		113.080		128.080
Breusch-Pagan Test				153.830		170.110		98.026
Sample Size				61		71		56

Note: [a]Bolded coefficients are significant at 10 percent or better whereas bolded and Italicized coefficients are significant at 20 percent.

Variations in Institutional Configuration and Relative Significance

Across country groups, the institutional variables showing consistent behavior in terms of significance in one or more equations are: LCRMEE, LOEPRV, PCOREC, PIRSWE, PGPIUP, PGPIPP, POPAWE, AIBDWP, AORGBA, ABALFS, ASBUDC, AARINF, and AEXTST. All these variables except POPAWE, AORGBA, and AIBDWP also have a consistent behavior in term of the direction of effects as well. But, the consistency in the significance and direction of their effect is not uniform across equations suggesting the presence of regional-specific differences in the nature of institution-performance linkages. For instance, the administration-related institutional aspect AIBDWP remaining significant for both areas in equations [3] and [8] is significant only for the reform areas in equation [4]. Notably, this institutional aspect with a positive effect in equations [3] and [4] for both areas has a negative effect in equation [8] for the reform area. Similarly, the policy-related institutional aspect PCOREC that is significant with a positive sign for both regions in equations [5] and [7] become significant only for the reform regions in equation [4], that too, with a negative effect. While other institutional variables in the remaining equations also display similar kind of area-specific differential behavior, the behavior of the policy-related institutional aspect POPAWE requires a closer examination in view of its dual role both as an institutional aspect and as a proxy for the overall policy environment.

Although POPAWE is significant in the context of inter-institutional linkage represented by equation [3] for both areas, it has a negative effect in the case of reform areas but a positive effect for other areas. That is, other sectoral policies have an unfavorable effect on cost recovery in reform areas whereas they have a favorable effect on the same in other countries. In contrast, in the context of both the intra-institutional linkage represented by equation [7] as well as the institution-performance linkage represented by equation [10], the same institutional variable is significant only in reform areas. Notably, it has a positive effect in equation [7], but a negative effect in equation [10]. This result seems to be paradoxical as it suggests that in the particular context of the reform countries, the other sectoral policies affecting water policy with a positive effect on the overall performance of water policy have an unfavorable effect on the overall performance of water sector. This paradox can be explained partly by the dual role of POPAWE--as a policy-related institutional aspect and as a proxy for a general policy bias against water sector--and partly by the two-way flow of effects discussed already in several contexts.[9]

[9] The paradox can also be interpreted in the light of the following two other facts. First, since the positive effects of POPAWE in equation [7] are indirect, they get nullified due to the insignificance of the linkage variable POEFWP in equation [9]. And, second, its indirect negative effects in equation [3], though partially lost due to the insignificance of few variables in the linkage chain, are captured, however, by others (e.g., ASBUDC) and gets reflected in equation [9] via equation [8]. These residual indirect negative effects are further reinforced with the direct negative effects in equation [10]. In

Apart from the 13 distinct institutional variables that are significant for both areas in one or more equations, there are also area-specific sets of additional institutional aspects. These additional institutional variables (excluding some of those which are included in the 13 variables listed above) for reform areas are: LPRSRF, LOECEN, PGPIPP, AACCME, AARINF. Those for other areas are: LPRSRF, LTRWSA, LACPRE, LINTRE, and POELWL. Although LPRSRF is included in the set of additional institutional variables for both areas, there is a notable difference as it is significant with a positive effect for reform areas in equation [2] whereas it has a significant negative effect for other areas in the context of equation [3]. But, this law-related institutional aspect remains insignificant for both areas in equation [6]. Thus, the significance and direction of its effects differ both across areas as well as across institutional layers. In any case, layer-specific differences in the behavior of common variables as well as the area-specific differences in the set of additional variables suggest that the constellations of institutional aspects underlying the process of institution-performance interaction differ significantly across country groups.

Variations in the Relative Strength of Institutional Layers

As to the nature and relative strength of institutional inter-linkages, since all equations except [4] and [6] have at least one institutional variable common to both country groups, the institutional and performance linkages represented by them are considered equally important on both contexts. But, the absence of consistency in the set of significant institutional aspects across country groups for equations [4] and [6] clearly suggests that there is a marked difference in the nature and strength of the institutional linkages represented by these equations across country groups. The fact that none of the institutional variables in equation [4] is significant for other countries suggests that the institutional inter-linkages represented as well as captured by this equation seem to be irrelevant for these countries. As a direct consequence of the irrelevance of equation [4], the linkage effects transmitted by PCOREC from equation [3] have also become nullified. In contrast, the linkage among the institutional aspects within equation [4] as well as that between equations [3] and [4] are both strong and effective in the context of reform countries. As a result, ASBUDC—the linkage variable in equation [4] entering as an independent variable in equation [8]—captures and transmits the effects of more institutional aspects in reform countries than in others. In reform countries unlike their

other words, the negative effects of POPAWE are dominant and reflect indirectly the effects of poor cost recovery and the resultant budget constraint, even both the direct and indirect effects of the institutional variables capturing these aspects (e.g., PCOREC and ASBUDC in equation [10]) are insignificant.

counterparts, therefore, the relatively stronger inter-institutional linkages also contribute to stronger intra-institutional linkages with considerable performance implications.[10]

The inconsistent set of significant institutional aspects for equation [6] across country groups adds yet another dimension to the area-specific differential pattern as to the nature of institution-performance linkages. Note that in this equation representing the effects of law-related institutional aspects on LOEFWL, LCRMEE is significant for reform countries whereas LACPRE is significant for reform countries. Thus, in the case of reform countries, LOEFWL captures the effects transmitted through the institutional layer represented by equation [1]. But, in the context of other countries, it captures the effects being transmitted through the institutional layer represented by equation [5]. Notice that since equation [5] is also linked with equation [3] through PCOREC, LOEFWL, in the context of other countries, also captures indirectly the institutional layer represented by the latter equation as well. This distinct pattern in the layers of linkages being captured by LOEFWL in equation [6] has a direct bearing on the strength of the performance linkages represented by equation [9] across the country groups.

Even in the case of equations other than [4] and [6] with one or more institutional aspects significant for both groups of countries, there are also area-specific differences in the additional institutional variables in the context of the remaining equations. This fact suggests that there also some distinct patterns in the institutional configurations defining various layers of institution-performance interaction across the country groups. But, from an overall perspective, these distinct patterns appear to be relatively more pronounced in the context inter-institutional linkages represented by the first five equations than in the context of intra-institutional linkages characterized by the next four equations. This is very much consistent with our observation that the group/area-specific differences confine mostly to the lower echelons of institution-performance linkages and tend to diminish as we move up to higher levels of linkages.

Since we have hypothesized that the institution-performance linkages will be stronger in the reform countries, it is useful to compare the size of the coefficients of the institutional variables considered significant in both areas. As we can see from tables 8.3a and 8.3b, for the system as a whole, there are 18 cases where there is consistency in terms of the significance of the institutional aspects.[11] While the coefficients in nine of these cases are larger for reform countries, those in the remaining nine cases are larger for the other countries. Although the size of the coefficients of the institutional variables in the context of the reform countries are lower in half of the cases, the institution-

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[10] For instance, in the case of reform countries, ASBUDC has not only a direct effect but also brings the effects of equations [3] and [4] to bear upon equation [8]. In contrast, in the case of other countries, this variable only has a direct effect just in the latter equation.

[11] These 18 cases include the 15 cases of single and multiple occurrence of the 13 variables (listed earlier) in equations [1] to [8] and the three performance variables (LOEFWL, AOEFWA, and WIPOEV) in equations [9] and [10].

performance linkages here can still be considered to be relatively stronger than the same in other countries in view of the following two results. First, the number of significant institutional variables observed for reform countries is the same or more than that observed for other countries in all equations except equation [5]. And, second, the size of the coefficient of WIPOEV, the ultimate linkage variable, is far larger for reform countries than that for others suggesting larger performance implications of stronger institutional linkages.

It is clear that the institution-performance linkages are relatively stronger in reform areas and it is exactly this perception that has led to the actual emergence of reform in the first place. While the same rationale can be used to explain the absence or inadequacy of recent reforms in non-reform countries, there are also other reasons linked with resource-related and political economic conditions. As we have noted earlier, most of the countries lacking recent reforms are resource-wise well-placed (e.g., those in South East Asia). Others (e.g., France, Germany, and United Kingdom), though do not have quantity-related scarcity issues, have undertaken significant reforms in the past to address water quality and inter-sectoral allocation issues. But, there are still others (e.g., those in North and East Africa) where the absence of reforms relate more to political economy constraints than to the absence of any pressures for reforms. It is the interactive effects of these three factors that explain the absence or inadequacy of reforms notwithstanding the fact that there is considerable consensus on the nature and configuration of institutional aspects. The message is clear that the general consensus as to the need, nature, and thrust of institutional change, though necessary, cannot be effective enough to initiate reform without a strong socio-economic and political pressures. As we have seen in Chapter 6, there are many cases where these pressures have actually played a critical role in shaping and strengthening consensus and coalitions for institutional reform

The region-specific differences in institutional configurations and their implications for institutional and performance linkages also suggest some interesting aspects related to both the motivation and thrust of perceived institutional change. As per a more generic interpretation of our results, the financial deterioration within water sector caused by poor cost recovery and represented by the seriousness of budget constraint has been a major factor motivating institutional change in many reform countries. Since the financial performance of water sector is also affected by other sectoral policies, especially the macro economic policies and those related to agriculture, the critical role of the effects of these policies cannot be underestimated as well. In fact, apart from the seriousness of water conflicts contributed by increasing water scarcity, macro economic reform has been a major factor behind water sector reform initiatives in most countries. As we have seen in Chapter 6, the investment crunch caused by fiscal crisis has forced many countries to look for avenues for resource mobilization within water sector as well as opt for additional resources from private sector. It is in view of the intricate role of the financial and policy aspects that the sample experts in reform countries have a major emphasis on the institutional linkages involving these aspects.

As the configuration of institutional aspects identified in the context of reform countries suggest, there is a greater emphasis on cost recovery, conflict resolution, organizational structures, administrative accountability, user involvement, and private sector participation. Although the reform process in most of these countries tends towards decentralization and market orientation, there is an overall thrust on a centralized system of water law as decentralization cannot succeed without a dose of centralization. In contrast, in the case of countries lacking recent reforms, the emphasis is more on the integrated approach to water resources, legal aspects of accountability, aligning water policy closely with water law, and policy aspects related to inter-sectoral and regional water transfers. This configuration of institutional aspects observed in the non-reform counties is understandable as they face water quality and water allocation rather than water quantity and water development as major water sector challenges. Besides, since many of these countries (especially, in Europe) also have a relatively comprehensive water law, the major thrust here is to integrate and strengthen the law-policy linkages.

ROLE OF EXOGENOUS FACTORS IN PERFORMANCE EVALUATION

In Chapter 6, we have show how exogenous factors such as economic and political reform, demographic condition, resource endowment, and, even, natural calamities have played a catalyst role in inducing water sector reforms in some of the sample countries. We have also seen some evidences for the exogenous influence while explaining the differential perception and evaluation of institution-performance linkages across country groups. These evidences are, however, descriptive and indirect. They are also too general and qualitative to be convincing, as we are unable to show either the magnitude or the relative importance of the effects of these exogenous factors. But, we can provide a relatively more specific and quantitative, though still indirect, evidence for the relative role and significance of exogenous factors on perceptional evaluation and infer, thereby, their possible effects on our results related to institution-performance interaction. This we attempt by using the regression results for Model C. As we can see from Chapter 4, Model C explicitly relates the performance variables—pertaining to both water institution and water sector—with a common set of 12 exogenous variables representing various socio-economic, demographic, institutional, and resource-related aspects.

Since performance variables are perceptional in nature and exogenous variables are actually observed, Model C provides a framework for directly capturing a major segment of the interface between the subjective evaluation of institution-performance interaction and the objective reality of the general environment within which it evolves. The estimated results for Model C can, therefore, enable us to quantitatively evaluate the relative effects of the exogenous factors on the subjective evaluation of performance components. Since we have estimated all the equations in Model C both under the simple and step-wise OLS procedures, we are also in a position to distinguish the individual effects of the exogenous factors from their joint effects and show, thereby, how their relative significance and configurations vary across performance components. As noted already, the configurations of exogenous factors identified for various equations of Model C enable us to delineate the subset of exogenous factors jointly having a dominant effect on various performance variables. Since this subset defines together the objective environment within which the subjective evaluation is performed, it can identify the components of the institutional environment relevant for the evaluation of different layers of institution-performance interaction.

Although it is possible to evaluate the effects of the exogenous factors on the subjective perception of all the institutional variables included in Model B, we confine our attention only on their effects on the perceptional evaluation of only five performance related variables. These are the four variables representing the overall and component-wise performance of water institution and one variable representing the overall performance of water sector. Although Model B includes only the variable representing the overall performance of water sector, we also consider the influence of exogenous factors on the four main dimensions of water sector performance, i.e., physical, financial, economic, and equity performance. Since the aim here is essentially to demonstrate the relative role and significance of exogenous factors taken both individually and jointly, this selective focus does not imply any limitation of our analysis. In fact, as we could see from Model B, since the variables representing water institutional and sectoral performance enter in equations representing higher level linkages, the focus on them can help in understanding the kind of effects that the exogenous factors have on the most important layers of institution-performance interaction.

Effects on the Evaluation of Institutional Performance

The nature and extent of exogenous influence on the evaluation of the four variables representing institutional performance can be inferred from the regression results for the first four equations of Model C. The simple and step-wise OLS estimates for these equations are presented in Table 8.4a. Considering first the effects of exogenous variables on the evaluation of the overall performance of water institution (WIPOEV), we can see from simple OLS results, only three of the 12 exogenous variables have a significant effect on (WIPOEV). These three variables—all having a positive effect—given in the order of their relative importance are GNP per capita (GNPPPC), index of food production (FPIIND), and population density (POPDEN). The configuration of the exogenous variables having significant effects on WIPOEV, however, changes with the step-wise estimates. In this case, the four significant variables, given in the order of their significance, are environmental regulatory regime index (ENVRRI), GNPPPC, decadal change in urban population (DCPOUP), and POPDEN. Since the step-wise estimates basically identify the subset among the exogenous variables having together the dominant

Table 8.4a. Influence of Exogenous Variables on the Perceptional Evaluation of Institutional Performance.

(Simple OLS Estimates of Model C)								
Independent Variables	**Equation Numbers/Dependent Variables**							
	[C1]/LOEFWL		[C2]/POEFWP		[C3]/AOEFWA		[C4]/WIPOEV	
	Coefficient[a]	**t-Ratio**	**Coefficient**[a]	**t-Ratio**	**Coefficient**[a]	**t-Ratio**	**Coefficient**[a]	**t-Ratio**
GNPPPC	**0.111**	1.715	**0.145**	1.910	**0.102**	1.498	**0.114**	1.511
POPDEN	-0.002	-1.248	0.002	1.084	**0.002**	1.335	**0.003**	1.613
DCPOUP	-0.007	-0.229	-0.028	-0.747	-0.038	-1.118	-0.045	-1.196
FWATWC	-0.001	-0.791	0.000	-0.141	0.000	-0.005	0.000	-0.553
PWATAG	0.011	0.787	0.021	1.258	0.002	0.137	0.009	0.540
ALANDC	**-1.394**	-2.325	-0.110	-0.155	**-1.013**	-1.601	-0.116	-0.165
FPIIND	0.028	1.227	0.032	1.209	**0.043**	1.804	**0.038**	1.446
EXPEDU	0.101	0.636	0.188	1.004	**0.242**	1.440	0.225	1.204
GININD	-0.001	-0.046	0.026	0.702	-0.025	-0.749	-0.007	-0.179
NCNATW	0.019	0.404	**-0.132**	-2.441	-0.030	-0.619	0.020	0.377
ENVRRI	**0.708**	2.218	-0.276	-0.734	0.351	1.042	0.223	0.595
ININCR	0.016	0.862	-0.010	-0.461	0.007	0.375	0.010	0.462
Constant	0.053	0.015	-2.500	-0.577	-1.448	-0.373	-2.106	-0.489
R^2	0.541		0.437		0.544		0.445	
(Step-wise OLS Estimates of Model C)								
GNPPPC	-	-	0.112	2.392	0.106	3.684	0.076	2.572
POPDEN	-0.002	-1.635	-	-	-	-	0.002	1.331
DCPOUP	-	-	-	-	-0.044	-1.417	-0.058	-1.758
FWATWC	-	-	-	-	-	-	-	-
PWATAG	-	-	0.023	1.721	-	-	-	-
ALANDC	-0.892	-1.898	-	-	-0.943	-1.897	-	-
FPIIND	-	-	-	-	-	-	-	-
EXPEDU	-	-	-	-	-	-	-	-
GININD	-	-	-	-	-	-	-	-
NCNATW	-	-	-0.107	-2.535	-	-	-	-
ENVRRI	0.869	3.326	-	-	0.486	1.691	0.417	1.351
ININCR	0.026	2.937	-	-	-	-	-	-
Constant	4.586	7.959	2.579	1.923	4.439	9.449	4.858	9.378
R^2	0.465		0.364		0.444		0.367	

Note: In the case of simple OLS estimates, bolded coefficients are significant at 20 percent or better. In the case of step-wise OLS estimates, on the other hand, all the variables with reported coefficients are significant at 20 percent or better and those with '-' were automatically excluded by the step-wise estimation process.

effect on the dependent variable, it is the individual and joint variations in these four exogenous variables that account for the major part of the variations in WIPOEV.[12]

We also note that ENVRRI, GNPPPC, and FPIIND move directly whereas DCPOUP goes inversely with economic development.[13] In view of their association and concurrent changes with the process of development, the exogenous factors themselves are related. This fact taken with the relative magnitude and direction of the effects of variables identified by both the simple and step-wise OLS procedures implies that the economic, technical, institutional, and demographic changes associated with the process of development have a positive influence on the performance of water institution. It is also possible to infer that the exogenous factors associated with the process of development enhance water institution performance mainly through their favorable effects on institutional density and linkages. This is actually the corollary of the well-known fact that water institution benefits from autonomous changes in the overall institutional environment as induced by various factors associated with economic development.

Turning now to the nature of the relationship between exogenous variables and the component-specific performance of water institution, the most immediate aspect to note is that the configurations of exogenous factors identified to be significant by both estimation procedures vary considerably across water institution components. In the case of simple OLS results, while GNPPPC has a uniform positive effect on the performance of all three water institution components, it has a dominant effect only on the effectiveness of water policy (POEFWP). The exogenous factor having the most dominant effect on the overall effectiveness of water law (LOEFWL) is per capita arable land (ALANDC) followed by ENVRRI.[14] While the former has a negative effect, the latter has a positive effect. Notably, the dominant role of these two variables remains

[12] As the R^2 for simple OLS shows that all the 12 variables taken together explain only 45 percent of the variations in WIPOEV whereas the same for the step-wise OLS shows that just these four variables explain 37 percent of the variations. As noted already, the greater explanatory power in the latter case is due to the fact that the step-wise procedure, unlike its counterpart, takes into account both the individual and joint effects of the significant independent variables. While this results in econometric bias, it does capture the explanatory power of the economically relevant linkages among independent variables.

[13] As a point of clarification, let us note that the direction relation between ENVRRI and economic development is explained by the fact that since development enhances the value of environment, there emerges an economic necessity for a more effective regulatory regime for protecting environment. Similarly, the inverse relationship between DCPOUP and development can be understood by distinguishing the proportion of urban population from recent changes in it and comparing the two between developed and developing countries.

[14] Notably, in the case of step-wise estimates, GNPPPC becomes insignificant possibly due to the overpowering influence of two other significant variables, i.e., international credit rating index (ININCR) and ENVRRI both of which also have a strong positive association with GNPPPC.

unchanged across the estimation procedures. The negative effect of ALANDC suggests, in fact, the positive association of resource scarcity and land inequity with legal performance. The positive effect of ENVRRI is understandable as effective regulatory regimes also imply effective legal systems. In general terms, the performance of water law is affected not only by the effectiveness its constituent legal aspects but also by resource scarcity and effectiveness of institutional and regulatory arrangements in related sectors.

As to the exogenous variables having a significant effect on the performance of water policy, only two of the 12 are significant as per the simple OLS estimates but three are significant as per the step-wise estimates. While GNPPPC and the proportion of natural capital in national wealth (NCNATW) are significant under both estimates, the proportion of water withdrawal used in agriculture (PWATAG) is significant only under the step-wise estimates. GNPPPC has the expected positive effect on POEFWP suggesting that the overall performance of water policy will improve with economic development. On the other hand, NCNATW has a negative effective implying a poor performance of water policy in countries having a greater share of natural capital in their total wealth. This result is, of course, consistent with intuition because water policy tends to perform poorly in areas with a better resource endowment as indicated by a higher value of NCNATW. This fact also implies the direct association between resource scarcity and water policy performance. But, the positive coefficient associated with PWATAG in step-wise results is rather inconsistent with reality because the performance of water policy is often poor when the water sector is dominated by irrigation demand and water policy becomes subservient to agricultural policies.

As per the simple OLS results, the overall effectiveness of water administration (AOEFWA) is influenced by five exogenous variables. These variables listed in the order of their relative impact are ALANDC, EXPEDU, GNPPPC, FPIIND, and POPDEN. As in the case of LOEFWL, ALANDC dominates with a negative effect suggesting that the socio-economic values of effective water administration increase with resource scarcity as reflected by per capita arable land. Since such pressure is also more in developing countries as compared to other areas, the negative effect of ALANDC also suggests the positive influence of economic development on the performance of water administration. This is supported further by the positive effect of GNPPPC and the proportion of GNP spent on education (EXPEDU) both of which vary directly with economic growth and development. Notably, the effective combination of exogenous variables, as identified by the step-wise procedure, includes only two of the five variables noted above, i.e., ALANDC and GNPPPC. The other two variables in the combination are DCPOUP and ENVRRI. While DCPOUP has a negative effect indicating that areas with a recent surge in urbanization are have a poor performing water administration as compared to other areas, the ENVRRI has a positive and the second most dominant effect concurring the argument advanced earlier. That is, an effective regulatory regime implies not just an effective legal system but equally also an efficient administrative apparatus.

Effects on the Evaluation of Water Sector Performance

The configuration and relative influence of exogenous variables in the context of the overall and dimension-specific performance of water sector can be evaluated by estimating the remaining five equations of Model C. The simple and stepwise OLS estimates for these equations are presented in Table 8.4b. Considering first the simple OLS results showing how the individual variations in each of the exogenous factors affect the evaluation sectoral performance, we find only three factors have a significant effect on the overall performance of water sector (WSPOEV). They are GNPPPC, NCNATW, and FPIIND. In the step-wise estimates that account for the effects of both the individual and joint variations of the exogenous variables on WSPOEV, both GNPPPC and NCNATW continues to have a dominant role. However, the configuration of exogenous factors that jointly explain the variations in WSPOEV includes now DCPOUP instead of FPIIND. Considering the direction of the effects of the dominant variables, it is clear that economic development has a positive effect whereas better endowment of natural resources has a negative effect on the overall performance of water sector.

Turning now to the relative significance of exogenous factors on the dimension-specific performance of water sector, regardless of the estimation procedure, the physical performance of water sector (WSPPHY) is affected only by NCNATW and DCPOUP. These variables also have the expected negative effect suggesting the kind of role that natural resource endowment and urbanization play on the physical dimension of water sector performance. As per simple OLS estimates, on the other hand, four exogenous factors have a significant effect on the financial dimension of water sector performance (WSPFIN). In the order of their relative impact, they are ALANDC, GNPPPC, FPIIND, and freshwater withdrawal per capita (FWATWC). The configuration of exogenous factors having a joint impact on WSPFIN includes not only these four variables but also the education variable EXPEDU, which has the second most dominant impact on financial performance. The positive effects of GNPPPC, FPIIND, and EXPEDY suggest the direct association that financial performance has with economic development and agricultural prosperity whereas the negative effects of ALANDC and FWATWC underline the positive effect that resource scarcity has on the financial dimension of water sector performance.

The simple OLS results indicate that the economic dimension of water sector performance (WSPECO) is affected by four exogenous variables: FPIIND, ININCR, POPDEN, and FWATWC. Considering their direction of effect, the result is rather consistent with expectation as agricultural prosperity, international economic rating, demographic pressure, and water scarcity all have a positive impact on the economic performance of water sector. However, the step-wise estimates indicate that the individual and joint variations in only two of these four factors, i.e., ININCR and FWATWC, explain the variations in economic performance. In any case, given the

Table 8.4.b. Influence of Exogenous Variables on the Perceptional Evaluation of Water Sector Performance.

Independent Variables	Equation Numbers/Dependent Variables									
	[C5]/WSPPHY		[C6]/WSPFIN		[C7]/WSPECO		[C8]/WSPEQU		[C9]/WSPOEV	
	Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio	Coeffi -cient[a]	t-Ratio
(Simple OLS Estimates of Model C)										
GNPPPC	0.050	0.673	**0.178**	2.606	0.080	0.985	0.081	0.978	**0.097**	**1.429**
POPDEN	0.002	1.018	0.001	0.915	**0.003**	1.484	0.001	0.614	0.002	1.136
DCPOUP	**-0.067**	-1.822	-0.040	-1.197	-0.007	-0.177	-0.039	-0.938	-0.038	-1.138
FWATWC	0.000	0.023	**-0.001**	-1.641	**-0.001**	-1.339	0.000	-0.473	-0.001	-0.948
PWATAG	0.007	0.419	0.012	0.802	-0.005	-0.298	0.013	0.730	0.007	0.450
ALANDC	0.187	0.270	**-1.130**	-1.780	-0.395	-0.526	-0.341	-0.443	-0.420	-0.664
FPIIND	0.014	0.552	**0.058**	2.438	**0.054**	1.916	0.028	0.988	**0.039**	**1.633**
EXPEDU	0.088	0.476	0.185	1.091	0.163	0.812	0.030	0.147	0.117	0.690
GININD	0.024	0.669	0.018	0.553	0.030	0.766	-0.032	-0.786	0.010	0.309
NCNATW	**-0.103**	-1.905	-0.012	-0.249	-0.030	-0.505	**-0.137**	-2.265	**-0.071**	**-1.425**
ENVRRI	-0.089	-0.238	-0.013	-0.039	-0.408	-1.010	**-0.680**	-1.640	-0.297	-0.875
ININCR	0.003	0.148	0.016	0.796	**0.041**	1.670	0.019	0.742	0.020	0.963
Constant	2.075	0.491	**-5.334**	-1.375	-5.884	-1.282	1.900	0.403	-1.809	-0.468
R^2	0.377		0.601		0.513		0.473		0.488	
(Step-wise OLS Estimates of Model C)										
GNPPPC	-	-	0.195	5.618	-	-	-	-	0.066	2.258
POPDEN	-	-	-	-	-	-	-	-	-	-
DCPOUP	-0.077	-2.646	-	-	-	-	-0.050	-1.444	-0.041	-1.365
FWATWC	-	-	-0.001	-1.561	-0.001	-1.554	-	-	-	-
PWATAG	-	-	-	-	-	-	-	-	-	-
ALANDC	-	-	-1.383	-2.576	-	-	-	-	-	-
FPIIND	-	-	0.052	2.675	-	-	-	-	-	-
EXPEDU	-	-	0.204	1.613	-	-	-	-	-	-
GININD	-	-	-	-	-	-	-0.044	-1.340	-	-
NCNATW	-0.114	-3.293	-	-	-	-	-0.157	-3.723	-0.073	-1.846
ENVRRI	-	-	-	-	-	-	-0.501	-1.511	-	-
ININCR	-	-	-	-	0.054	4.906	-	-	-	-
Constant	6.791	16.100	-2.874	-1.095	2.023	3.138	8.787	7.094	5.334	7.957
R^2	0.313		0.536		0.402		0.391		0.384	

Note: In the case of simple OLS estimates, bolded coefficients are significant at 20 percent or better. In the case of step-wise OLS estimates, on the other hand, all the variables with reported coefficients are significant at 20 percent or better and those with '-' were automatically excluded by the step-wise estimation process.

positive association between ININCR and the overall economic performance of countries, this result again underlines the dominant role that economic development and resource scarcity play in influencing the economic dimension of water sector. The equity dimension of water sector performance (WSPEQU) is affected, on the other hand, by two exogenous factors, i.e., ENVRRI and NCNATW, capturing respectively the effectiveness of regulatory institutions and composition of national wealth. The negative effects of both factors suggest that equity performance of water sector is likely to be higher in areas with more effective regulatory arrangements but lesser share of natural capital in their total wealth. Besides these factors, the configuration of exogenous factors identified by the step-wise procedure as having the dominant joint effect on equity performance also includes GININD, and DCPOUP. Interestingly, the negative effect of GININD indicates the fact that the overall inequity in the economy also gets spilled into the water sector.

Despite its simplicity and crude nature, the evaluation of the configurations and relative significance of the exogenous factors affecting the performance of water institution, water sector, and their components provides some useful insights into the nature and pattern of exogenous influence on the subjective evaluation of institution-performance interaction. Generally, factors associated with economic development, regulatory institutions, and education have a positive influence as they generate some autonomous changes in the institutional sphere to which water institution is not an exception. In view of the phenomenon of institutional creation and thickening usually associated with process of economic development, institutional linkages tend to be strengthened contributing, thereby, to improved institutional performance. Demographic changes, resource scarcity, and increasing socio-economic inequity also tend to have a similar effect as they enhance the economic value of effective institutional arrangements in all sectors including water sector. From this perspective, therefore, the evaluation of institution-performance interaction—both in general and in water sector contexts—cannot be free from the overall socio-economic, demographic, institutional, and resource-related environment. In fact, as implied in our evaluation of the relative impact of the exogenous factors, the subjective process of institution-performance evaluation should have captured most part of the exogenous influence from the general environment.

ALL-SAMPLE RESULTS: CONSISTENCY AND RELIABILITY

Having evaluated the effects of factors both endogenous and exogenous to our sample and evaluation contexts, we are now endowed with an overall idea as to the consistency and reliability of the all-sample results. Since the process of institution-performance interaction is evaluated not directly in terms of observed information but only indirectly in terms of the subjective perception of such interaction, the analysis of our model results across sample contexts has enabled us to infer about the convergence and stability properties of the results. As these properties pivotal both to support and supplement the conclusions derived in Chapter 7 as well as to support the exercise on institutional prioritization, sequencing and packaging to be attempted in Chapter 9, it is useful to recount them this stage. Our analysis of the robustness properties has indicated that with some notable caveats, the behavior of institutional aspects and their implications for institution-performance linkages have shown a considerable degree of stability and consistency in the face of sample size variations. In addition to the overall robustness and consistency in the behavior of institutional aspects and relevance of institution-performance linkages, there are also three other important factors that support the reliability of all-sample results discussed rather elaborately in Chapter 7.

First, in comparison to results obtained in various sub-sample contexts, the all-sample results show the same or more institutional variables to be significant in the case of almost all equations. This means that the institutional and performance linkages that are characterized by different equations in model B tend to become stronger with the enlargement of sample size, expertise mix, and country coverage. Second, the all-sample results tend to balance the differences or extremities in the behavior of institutional aspects observed in sub-sample contexts. While sub-sample results are indeed valuable to identify useful caveats and understand, thereby, the role of context-specific factors, the all-sample context with its normalizing property help to identify generic features both in institutional configuration and institution-performance linkages. And, finally, the all-sample results also display some superior econometric properties. Although R^2 tends to decline marginally with an increase in sample size, both the χ^2 and Breusch-Pagan test statistics tend to improve tremendously with sample size. The behavior of the latter two statistics suggests that the results from the all-sample context tend to become increasingly free of the noises from both auto-correlation and heteroskedasticity.

Although the influence of disciplinary bias and ideological aspects is strong at the individual layers of institutional and performance linkages, it tends to become weak from an overall or macro perspective of the process of institution-performance interaction. The effects of the group and area-specific bias at the micro levels as well as its remaining vestiges at the macro level can be reduced considerably by increasing the number of experts and countries and the evaluation is performed from a general rather than a group-specific perspective. This clearly implies that the results from the all-sample context are likely to be free from the bias and will provide a more reliable picture on the nature and strength of institution-performance linkages. As we can see from tables 8.2a and 8.2b, the all-sample results have indeed removed the extremities observed in group-specific results and provided a more balanced and generalizable evaluation of institution-performance interaction. As instances for the normalization properties of the all-sample context, we can note the cases of POPAWE in equation [3] and AIBDWP in equation [8]—both with a differential sign across expert groups—becoming insignificant in the all-sample context. Similarly, as we can see from tables 8.3a and 8.3b, the all-sample results also exclude those institutional variables having different signs across country groups (e.g., POPAWE in equation [3], and AORGBA and AIBDWP in equation [8]). The set of significant institutional aspects in the all-sample results, therefore, excludes those with inconsistent behavior despite the agreement as to their importance but includes some of those lacking agreement as to their significance.

Notably, the set of institutional aspects that are significant in the all-sample context does not include all the institutional aspects that are identified as significant only by one expert or country group but include those which are considered insignificant by both expert or country groups. For instance, in equation [5] of table 8.2a, while engineers and social scientists consider three institutional variables each to be significant, the all-sample context shows four institutional variables to be significant. Of these four variables, LOEPRV and PCOREC are considered to be significant by both groups whereas POELWL is considered significant only by social scientists. In contrast, the last of the four variables, i.e., LPRSRF, is considered to be insignificant by both groups. Notably, while the set of significant institutional variables in the all-sample context includes POELWL identified as significant by social scientists, it excludes AACCME identified as significant by engineers. These and other similar instances in tables 8.2a, 8.2b, 8.3a, and 8.3b suggest that the all-sample results highlight only those institutional variables with enough agreement as to their significance and consistent behavior.

Even though an institutional variable may be insignificant in a group-specific context, it can become significant when there are enough number of experts in both who consider it to be significant.[15] Thus, with an enlarged and diverse sample, the scope for convergence and consensus as to perception of institution-performance linkages will increase as does the overall reliability and credibility of the results. It is this ability to capture the overall consensus as to the role and behavior of institutional aspects that make the all-sample results more realistic, reliable, and generalizable. In view of these properties, the all-sample results can be a reasonable basis for understanding the nature of the process of institution-performance interaction from a global perspective. But, at the same time, the exceptions and caveats emerged from sub-sample contexts provides very valuable insights allow us to understand the local and contextual aspects of the same process. In this sense, the area and group-specific analysis both supports and qualifies our conclusions in Chapter 7 on the process of institution-performance interaction.

[15] On similar reasoning, an institutional aspect that is significant (insignificant) for a group can become insignificant (significant) if the number of experts considering it to be insignificant (significant) in both groups is more (less) than those considering it to be significant (insignificant) in a single group.

Chapter 9

INSTITUTIONAL SEQUENCING AND PACKAGING

Our analysis in the two previous chapters show clearly that our model of institution-performance interaction cast within a simultaneous equation framework is resilient and its empirical results obtained in different estimation contexts are robust. Such an analytical and empirical strength of our approach allow us to take the analysis to its next logical level that is still more insightful both from theoretical and policy perspectives. The initial focus of our analysis has mainly been on the relative role and significance of institutional aspects based on their local effects within a given equation. The attention has then shifted to the formalization of various layers of institution-performance linkages utilizing the relationship among variables across equations within the simultaneous system framework. The evaluation of the local effects of institutional variables within different equations and the strength of institutional intra and inter-linkages provides a basis for understanding the system-wide impacts of a marginal change associated with a variable in any given equation within the system. The present chapter makes an attempt to evaluate the nature, pattern, and implications of the system-wide or global impacts initiated by local changes in the institutional variables and address some key issues surrounding institutional design and reform implementation in practical contexts.

With the quantification of different layers of linkages among institutional and performance variables, it is now possible to quantitatively trace out the multifarious routes through which the effects of a marginal change in an institutional variable get transmitted and reflected ultimately on water sector performance. By tracing out all the routes of impact transmission associated with all the institutional variables that are amenable for deliberate policy intervention, we can numerically evaluate them in terms of their relative performance contributions. The insights from such an evaluation exercise are very valuable both for understanding the inner dynamics of the process of institution-performance interaction as well as for addressing the practical issues of prioritization, sequencing, packaging, and, even, timing within an institutional reform program. How valuable is the tracing exercise for designing both generic and context-specific institutional reform programs is illustrated in this chapter with empirically derived numerical results from the estimation of the system version of model B.

APPROACH AND FRAMEWORK

For facilitating a better appreciation of the way the results are derived, presented, and interpreted, it is instructive to begin with the specification of the approach being adopted for tracing all the impact transmission channels and the framework being used for evaluating their relative performance significance.

Tracing the Impact Transmission Channels

The approach adopted for tracing all the impact transmission channels is rather simple and straightforward. Notice that of the 26 institutional and performance variables in the system, only 16 institutional variables (those enclosed within ellipsoids in Figure 4.3) are truly exogenous to the model.[1] As per our model specification, it is only these exogenous institutional variables that are amenable for deliberate policy intervention. Obviously, our tracing exercise will involve only the effects of a marginal change in each of these 16 institutional variables. Given the estimated coefficients for the 16 exogenous variables as well as those for the inter-linked equation system, we trace out all the channels through which the effects of these institutional variables are transmitted through the system. As can be seen in Figure 4.3, these effects are transmitted through a variety of channels involving different sets of institutional/performance variables. It is easy to identify these channels by following through the arrows that originate from each of the exogenous variables and end up with WSPOEV, the ultimate dependent variable of the system. Having identified all these channels, we then characterize them by the number and configuration of institutional/performance variables involved in their impact transmission.

As we trace out all the routes through which the effects of the 16 exogenous variables are transmitted on WSPOEV, we can identify 63 distinct impact transmission channels[2], each of which is described by its underlying linkage chain. These channels and their linkage chains, in fact, characterize different layers of institution-performance linkages (that are discussed extensively in the two previous chapters) and are defined by varying number and configuration of exogenous and en route variables. The en route variables are obviously those that lie between an exogenous variable and the ultimate dependent variable of the system. Table 9.1 depicts these channels, their linkage chains and en route variables, and the set of equations through which they operate. Of the 63 channels, 15 are associated with five law-related exogenous variables, 25 are associated with five policy-related exogenous variables, and 23 are associated with six administration-related exogenous variables. As can be seen, the number of impact transmission channels differs across exogenous variables, as does the number of en route variables across the impact transmission channels. Of the 16 institutional variables, the policy-related institutional variable of PGPIUP has the highest number of impact transmission channels (11). This is followed by the exogenous variables LPRSRF with

[1] Although some of the remaining 10 variables appear as independent variables in one or more equations, they are still dependent on the behavior of different subsets of only these 16 exogenous variables.

[2] This list includes the channels conveying the direct effects of POPAWE, AEXTST, and AARINF in equation [10]. But, it excludes the two channels involving the direct effects of PCOREC and ASBUDC—included as proxies for general cost recovery policy and fiscal health—in the same equation because they are actually the endogenous variables in equations [3] and [4] respectively.

10 transmission channels and POPAWE and AIBDWP having eight transmission channels each.

The number of impact transmission channels associated with each of the exogenous variables is indicative of the level and intensity of their linkage with others within the system. But, the number of en route variables associated with each of the impact transmission channels is indicative of the length of the linkage chain and has implications for the speed and effectiveness of impact transmission. Despite the fact that they enter as independent variables in one or more equations in the simultaneous system, all the en route variables are essentially endogenous in nature conveying only the effects initiated by changes in the 16 exogenous variables across the equation system. The number of en route variables also distinguishes the direct effects from the indirect effects of institutional variables. Obviously, the direct effects involve no en route variable as they are transmitted directly on WSPOEV whereas the indirect effects are transmitted via one or more en route variables. As can be seen in Table 9.1, only three of the 63 channels have direct effect. But, all the remaining channels convey indirect effects with en route variables ranging from one to four. The frequency distribution of the channels in terms of their en route variables show that those with two and three variables are more in number (each with 20 channels) as compared to those with variables of one (7) and four (13). A longer chain of en route variables means the indirect effects are to be transmitted through many institutional/performance variables. As such, they are prone to both distortions and delays because their ultimate strength depends on the effectiveness of en route variables taken both individually and collectively.

Evaluating the Impact Transmission Channels

Having traced all the impact transmission channels associated with each of the exogenous variables, the next step is to quantify the impact being transmitted by them and then, rank them in terms of their relative performance significance. For calculating the relative level of impact being transmitted by various channels, we rely on the following procedure. First, we partially differentiate the relevant equations of the system version of Model B with respect to each of the 16 exogenous variables. Since some of the exogenous variables appear in more than one equation and also some of them affect the endogenous variables appearing as exogenous variables in other equations, the differentiation process leads to different sets of differential chains. These sets of differential chains associated with all the exogenous variables are given in Appendix-C. It is rather obvious that the differential chains listed in Appendix-C are basically the mathematical analogue for all the 63 channels listed in Table 9.1.

With the identification all the differential chains, it is rather straightforward to calculate the value of impact being transmitted by each channel in terms of the value(s) of the partial differential(s) associated with it. As can be seen in Appendix-E, the value of the impact transmitted by the channels involving direct effects is simply the value of the

Table 9.1. Impact Transmission Channels and Linkage Chains associated with 16 Exogenous Variables.

Sl. No.	Impact Transmission Channels/Linkage Chains						Enroute Variables	Equations via the Impact is Transmitted				
1	LINTRE	LOEFWL	WIPOEV	WSPOEV			2	[6]	[9]	[10]		
2	LOECEN	LOEFWL	WIPOEV	WSPOEV			2	[6]	[9]	[10]		
3	LOEPRV	LACPRE	LOEFWL	WIPOEV	WSPOEV		3	[5]	[6]	[9]	[10]	
4		LOEFWL	WIPOEV	WSPOEV			2	[6]	[9]	[10]		
5	LPRSRF	LACPRE	LOEFWL	WIPOEV	WSPOEV		3	[5]	[6]	[9]	[10]	
6		LCRMEE	LOEFWL	WIPOEV	WSPOEV		3	[1]	[6]	[9]	[10]	
7		LOEFWL	WIPOEV	WSPOEV			2	[6]	[9]	[10]		
8		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	4	[3]	[4]	[8]	[9]	[10]
9		PCOREC	ASBUDC	WSPOEV			2	[3]	[4]	[10]		
10		PCOREC	LACPRE	LOEFWL	WIPOEV	WSPOEV	4	[3]	[6]	[9]	[10]	
11		PCOREC	POEFWP	WIPOEV	WSPOEV		3	[3]	[7]	[9]	[10]	
12		PCOREC	WSPOEV				1	[3]	[10]			
13		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	4	[1]	[2]	[7]	[9]	[10]
14		PIRSWE	POEFWP	WIPOEV	WSPOEV		3	[2]	[7]	[9]	[10]	
15	LTRWSA	LOEFWL	WIPOEV	WSPOEV			2	[6]	[9]	[10]		
16	PGPIPP	ASBUDC	AOEFWA	WIPOEV	WSPOEV		3	[1]	[8]	[9]	[10]	
17		ASBUDC	WSPOEV				1	[4]	[10]			
18		POEFWP	WIPOEV	WSPOEV			2	[7]	[9]	[10]		
19	PGPIUP	ASBUDC	AOEFWA	WIPOEV	WSPOEV		3	[4]	[8]	[9]	[10]	
20		ASBUDC	WSPOEV				1	[4]	[10]			
21		LCRMEE	LOEFWL	WIPOEV	WSPOEV		3	[1]	[6]	[9]	[10]	
22		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	4	[3]	[4]	[8]	[9]	[10]
23		PCOREC	ASBUDC	WSPOEV			2	[3]	[4]	[10]		
24		PCOREC	LACPRE	LOEFWL	WIPOEV	WSPOEV	4	[3]	[5]	[6]	[9]	[10]
25		PCOREC	POEFWP	WIPOEV	WSPOEV		3	[3]	[7]	[9]	[10]	
26		PCOREC	WSPOEV				1	[3]	[10]			
27		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	4	[1]	[2]	[7]	[9]	[10]
28		PIRSWE	POEFWP	WIPOEV	WSPOEV		3	[2]	[7]	[9]	[10]	
29		POEFWP	WIPOEV	WSPOEV			2	[7]	[9]	[10]		
30	POELWL	LACPRE	LOEFWL	WIPOEV	WSPOEV		3	[5]	[6]	[9]	[10]	
31		POEFWP	WIPOEV	WSPOEV			2	[7]	[9]	[10]		
32	POPAWE	LCRMEE	LOEFWL	WIPOEV	WSPOEV		3	[1]	[6]	[9]	[10]	
33		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	4	[3]	[4]	[8]	[9]	[10]
34		PCOREC	ASBUDC	WSPOEV			2	[3]	[4]	[10]		
35		PCOREC	POEFWP	WIPOEV	WSPOEV		3	[3]	[7]	[9]	[10]	
36		PCOREC	WSPOEV				1	[3]	[10]			
37		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	4	[1]	[2]	[7]	[9]	[10]
38		POEFWP	WIPOEV	WSPOEV			2	[7]	[9]	[10]		
39		WSPOEV					0	[10]				
40	PPSCRI	POEFWP	WIPOEV	WSPOEV			2	[7]	[9]	[10]		
41	AACCME	AOEFWA	WIPOEV	WSPOEV			2	[8]	[9]	[10]		
42		LACPRE	LOEFWL	WIPOEV	WSPOEV		3	[5]	[6]	[9]	[10]	
43	AARINF	AOEFWA	WIPOEV	WSPOEV			2	[8]	[9]	[10]		
44		LCRMEE	LOEFWL	WIPOEV	WSPOEV		3	[1]	[6]	[9]	[10]	
45		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	4	[1]	[2]	[7]	[9]	[10]
46		WSPOEV					0	[10]				
47	ABALFS	AOEFWA	WIPOEV	WSPOEV			2	[8]	[9]	[10]		
48		LCRMEE	LOEFWL	WIPOEV	WSPOEV		3	[1]	[6]	[9]	[10]	
49		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	4	[1]	[2]	[7]	[9]	[10]
50	AEXTST	AOEFWA	WIPOEV	WSPOEV			2	[8]	[9]	[10]		
51		LCRMEE	LOEFWL	WIPOEV	WSPOEV		3	[1]	[6]	[9]	[10]	
52		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	4	[1]	[2]	[7]	[9]	[10]
53		PIRSWE	POEFWP	WIPOEV	WSPOEV		3	[2]	[7]	[9]	[10]	
54		WSPOEV					0	[10]				
55	AIBDWP	AOEFWA	WIPOEV	WSPOEV			2	[8]	[9]	[10]		
56		ASBUDC	AOEFWA	WIPOEV	WSPOEV		3	[4]	[8]	[9]	[10]	
57		ASBUDC	WSPOEV				1	[4]	[10]			
58		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	4	[3]	[4]	[8]	[9]	[10]
59		PCOREC	ASBUDC	WSPOEV			2	[3]	[4]	[10]		
60		PCOREC	LACPRE	LOEFWL	WIPOEV	WSPOEV	4	[3]	[5]	[6]	[9]	[10]
61		PCOREC	POEFWP	WIPOEV	WSPOEV		3	[3]	[7]	[9]	[10]	
62		PCOREC	WSPOEV				1	[3]	[10]			
63	AORGBA	AOEFWA	WIPOEV	WSPOEV			2	[8]	[9]	[10]		

partial differential of equation [10] with respect to the relevant exogenous variable. Obviously, the value of the partial differentials in these cases is nothing but the coefficient for the concerned exogenous variables in equation [10]. In contrast, the value of impact being transmitted by the channels involving indirect effects is the product of the partial differentials of relevant equations with respect to relevant exogenous and endogenous variables. Again, the product of the partial differentials in these cases is actually the product of the coefficients for the exogenous and en route variables in the concerned linkage chains.

Since the indirect effects transmitted by the channels are calculated as a product of the coefficients of the variables in their linkage chains, both the number of variables and the size of their coefficients play a key role in determining the relative level of impact transmission. Thus, when the linkage chains are lengthy and most coefficients have a value of less than one, the level of impact transmission can be lower than in contrary cases.[3] However, this does not necessarily mean that the channels with direct effects where there is no en route variable will invariably have a larger value as compared to the channels having lengthy linkage chains and variables with fractional values. Note that the value of the impact being transmitted by an individual channel can be lower when its linkage chain is lengthy and the variables have fractional coefficients. But, the total impact due to a change in an exogenous variable can still be larger when its effects get transmitted though more number of channels. This is due to the fact the total impact due to a marginal change in an exogenous variable is the sum of the values associated with all its impact transmission channels. It is on this logic that we consider the exogenous variables having more intricate linkages with other variables and linkage chains with variables having larger coefficients are more important from the perspective of both institutional building and performance improvement.

While both the nature and implications of the procedure used for quantifying the level of impact being transmitted by various channels are clear, we need to be careful as to the kind of coefficients to be used for impact quantification. Although the estimated coefficients of Model B can be used straightforward to quantify the value of various impact transmission channels, they are likely to bias the evaluation of the relative significance of the channels. The bias originates from the fact that both the exogenous and endogenous variables in the system vary not only in terms of the sign and significance of their coefficients but also in terms of the value of their mean and standard deviation. To correct for the bias emanating from the latter variations, it is necessary to standardize the coefficients. There are two econometric approaches for standardizing the coefficients. The first approach involves the use of the concept of "elasticity at means"

[3] The size of the coefficient associated with en route variables is indicative of their transmission ability. Thus, when the coefficient of an en route variable has a value of less than one, it means that the impact transmission is less than proportionate due to institutional distortion and dilution. Obviously, when there are more en route variables in the chains all having fractional coefficients, they tend to dilute even a larger and more than proportionate impact of the exogenous variable involved.

wherein the coefficient of an independent variable is multiplied by the ratio of its mean value to the mean value of the dependent variable in question. The other approach involves the concept of "standardized coefficients" wherein the coefficient of the independent variable is weighted by the ratio of its standard deviation to the standard deviation of the dependent variable. While the former approach adjusts the coefficients for their relative levels, the latter approach adjusts the coefficients for their relative variability. Since we are interested in comparing how a marginal change in different independent variables alters the value of their dependent variable, it is more reasonable to adjust the coefficients for their variability rather than for their mean levels.[4] It is on this reasoning that we use the standardized coefficients for calculating the value of various impact transmission channels.

In order to correct for the bias possible from the variations in the signs of coefficients, we use the absolute value of the coefficients for the following three reasons. First, as argued in several places in chapters 7 and 8, the negative coefficients in many cases are actually indicative of only a positive effect.[5] Second, since majority of the channels involve indirect effects with values obtained by multiplying the relevant coefficients of variables in the linkage chains, sign differences will not allow any clear inference as to the direction of the aggregate impact being transmitted.[6] And, third, in the light of the two points just noted, the magnitude is more important than the direction when comparing the relative levels of impacts being transmitted by different channels. On these grounds, we use only the absolute values of the coefficients for calculating the magnitude of impact being transmitted by various channels.

Instead of viewing the bias due to variations in the significance of coefficients as a problem, we consider it as an opportunity to illustrate why some of the impact transmission channels become insignificant and how this fact can be exploited to

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[4] Besides the justification in terms of our interest on variability rather than the level of a variable, there is an additional factor that specifically requires the use of standardized coefficients instead of elasticity at mean values. This factor relates to the potential bias in using the ratio of means as a weighting factor when the model variables vary in terms of their unit of measurement. Obviously, such a bias will be at its minimum when the ratio of standard deviations is used as the weighting factor.

[5] This is partly because of the negative way in which some of the variables (e.g., ASBUDC capturing the seriousness of budget constraint) are formulated and partly because institutional constraints, even though negative in format, will actually have a positive performance effect. Besides, there is also the argument based on two-way flow of effects. According to this argument, a negative association between PCOREC and WSPOEV, for instance, should not be interpreted as an inverse relation between cost recovery and water sector performance but as an indication of poor performing water sector putting a pressure for improving cost recovery.

[6] For instance, one negative coefficient in the case of a channel involving more than two variables can make the value of the impact to be negative whereas two negative coefficients can make the same positive. While this is mathematically correct, from the perspective of evaluating the direction of the impact flow, the result can be really complicated and confusing.

determine the thrust of institutional reform programs. The approach here involves a comparison of the values of the impact transmission channels calculated using all the coefficients with those obtained using only the significant coefficients. It is important to recognize that in the case of calculation involving only the significant coefficients, the values of the impact transmission channels will be positive only when all the variables of their underlying linkage chains have a significant coefficient. Otherwise, their values will be zero. The zero value for the ineffective channels is due to the fact that if one or more variables in the linkage chain have insignificant coefficients, then the variables in question fail to convey even the effects of other significant variables there.

As to the issue of how the evaluation of the relative impact transmission by channels is used to derive policy inferences related to institutional prioritization, sequencing, and packaging, let us note the following. Given the value and significance of the channels, it is possible to distinguish the significant or effective impact transmission channels from their insignificant or ineffective counterparts. Such a distinction can serve two very important purposes. The first is to indicate the magnitude of performance loss caused by the insignificance of some of the institutional and performance variables. And the second is to identify the channels and the underlying variables that suffer from the problem of such insignificance. From the perspective of institutional reform, it is these channels with one or more insignificant variables that should receive priority. The comparative analysis of the impact transmission channels will identify these channels and use them to show how their performance impact can be enhanced by targeting the reform effort on the insignificant institutional and performance variables involved. There are also some additional aspects, especially related to institutional sequencing, timing, and scale of institutional reform. Since they can be appreciated better only after the comparative analysis of the channels, the discussion on these aspects is reserved till a later section.

Finally, let us have a few words on the presentation of results and structure of our analysis. Since the impact transmission channels are large in number, there is difficulty in presenting their relative contribution in a single table within the same page. For presentation convenience, therefore, we break the tables into three parts, each giving the information on the channels related respectively to the law, policy, and administration-related institutional variables. The relative performance contributions of the individual impact transmission channels and exogenous variables are evaluated both in the all-sample context as well as in the context of two country groups defined in terms of their status of recent reforms. The latter is essentially to check for the robustness and contextuality of the results across countries differing in terms of the extent of recent reform initiatives. Within this analytical framework, first we evaluate the relative proportion of impact being transmitted by various channels associated with each of the exogenous variables and then consider the total impact being transmitted by all the exogenous variables. With these observations on our approach and evaluation framework, let us now begin with the analysis of the results.

Relative Contribution of Channels: Overall Perspective

The relative importance of each channel is evaluated in terms of the magnitude and share of its impact transmission relative to others both within each of the three channel groups (i.e., law, policy, and administration-related channels) as well as across all the 63 channels. The values of the impact being transmitted by the channels are calculated using both all the coefficients irrespective of their significance as well as only the significant coefficients. While presenting the results, the significant channels (i.e., those having significant coefficients for all their linkage variables) are distinguished by bold values. In addition to the value of impact transmission, the relative shares of the channels in total impact obtained both at the level of the three channel groups as well as at the level of all 63 channels are also calculated to allow their ranking and facilitate an easier comparison. With these observations, all the tables that will show the relative importance and significance of the channels in different contexts (all-sample, reform areas, and other areas) will become self-explanatory. Let us now evaluate the relative performance of the impact transmission channels from an overall perspective using the results obtained at the all-sample context.

Relative Importance of Law-related Channels

Table 9.2a shows the value, relative share, and rank of 15 impact transmission channels associated with five law-related exogenous variables. Most of the channels are associated with LPRSRF representing the legal aspect of property rights format. As we consider their values calculated using all the coefficients, these channels have lower individual values and shares as compared to the channels associated with LINTRE, LOECEN, and LOEPRV representing respectively the institutional aspects of internal consistency, centralization tendency, and privatization provisions within water law. However, since LPRSRF has 10 channels as against others with just two or less channels, it has a larger impact as compared to all the other law-related exogenous variables. Specifically, these ten channels taken together accounts for about 44 percent of the impact being transmitted by the law-related channels and about 8 percent of the same being transmitted by all the 63 channels. But, if we take together the four channels associated with LINTRE, LOECEN, and LOEPRV, they still dominate with a combined share of over 50 percent of the total impact being transmitted through all the law-related channels and close to 9 percent of the same transmitted through all the 63 channels.

If we consider the channels in terms of their values calculated using only the significant coefficients, only four become significant. They are the two single channels associated each with LINTRE and LOECEN and two of the 10 channels associated with LPRSRF. These significant channels account for only 44 percent of the total impact in the context of law-related channels and 8 percent of the total impact in the context of all 63 channels. Notably, the impact of LPRSRF that has a larger share when calculated

Table 9.2a. Law-related Channels: Relative Share and Significance of Impact in All-sample Context.

Sl. No.	Impact Transmission Channels/Linkage Chains						Value	Share (%)		Rank	
								Within Law	Overall	Within Law	Overall
1	LINTRE	LOEFWL	WIPOEV	WSPOEV			**0.061**	**17.43**	**3.09**	**1**	**7**
2	LOECEN	LOEFWL	WIPOEV	WSPOEV			**0.043**	**12.20**	**2.17**	**2**	**10**
3	LOEPRV	LACPRE	LOEFWL	WIPOEV	WSPOEV		0.036	10.21	1.81	3	13
4		LOEFWL	WIPOEV	WSPOEV			0.034	9.64	1.71	4	14
5	LPRSRF	LACPRE	LOEFWL	WIPOEV	WSPOEV		0.014	3.98	0.71	10	39
6		LCRMEE	LOEFWL	WIPOEV	WSPOEV		0.007	2.09	0.37	12	50
7		LOEFWL	WIPOEV	WSPOEV			0.027	7.78	1.38	6	21
8		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	0.017	4.96	0.88	10	34
9		PCOREC	ASBUDC	WSPOEV			**0.022**	**6.17**	**1.10**	**8**	**27**
10		PCOREC	LACPRE	LOEFWL	WIPOEV	WSPOEV	0.019	5.32	0.94	9	32
11		PCOREC	POEFWP	WIPOEV	WSPOEV		0.006	1.71	0.30	14	53
12		PCOREC	WSPOEV				**0.029**	**8.32**	**1.48**	**5**	**20**
13		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.002	0.69	0.12	15	63
14		PIRSWE	POEFWP	WIPOEV	WSPOEV		0.009	2.64	0.47	13	46
15	LTRWSA	LOEFWL	WIPOEV	WSPOEV			0.024	6.85	1.22	7	25
Sub-Total		All Coefficients					0.350	100.00	17.75		
		Only Significant Coefficients					0.154	44.118	7.832		

with all the coefficients has only the second largest share when evaluated with the significant coefficients. This clearly suggests that although exogenous variables with more channels have stronger institutional and performance linkages, they need not necessarily produce stronger performance impact. Much depends not only on the strength and effectiveness of the channels as reflected by the magnitude and significance of the coefficients related to the variables in their linkage chains but also on the possibility of strengthening some of the key channels through suitable reform. Thus, for instance, if it is possible to strengthen the two channels associated with LOEPRV as well as some of the channels of LPRSRF with relatively larger share of impact, then the relative importance and significance of both the channels and exogenous variables can be altered through policy means. The information in Table 9.2a can, therefore, be used to identify the channels as well as the variables in their linkage chains that has to receive priority in such potential program of institutional reform.

Relative Importance of Policy-related Channels

The relative role and significance of the policy-related impact transmission channels can be evaluated from Table 9.2b giving their values, relative shares, and ranks. Of the 25 channels associated with five policy-related exogenous variables, 11 are related to PGIPUP representing the effectiveness of user participation policy and eight are related to

Table 9.2b. Policy-related Channels: Relative Share and Significance of Impact in All-sample Context.

Sl. No.	Impact Transmission Channels/Linkage Chains						Value	Share (%)		Rank	
								Within Policy	Overall	Within Policy	Overall
16	PGPIPP	ASBUDC	AOEFWA	WIPOEV	WSPOEV		0.003	0.83	0.17	24	60
17		ASBUDC	WSPOEV				0.006	1.40	0.29	19	54
18		POEFWP	WIPOEV	WSPOEV			0.012	3.00	0.62	12	41
19	PGPIUP	ASBUDC	AOEFWA	WIPOEV	WSPOEV		0.022	5.26	1.10	6	26
20		ASBUDC	WSPOEV				**0.036**	**8.88**	**1.85**	**3**	**12**
21		LCRMEE	LOEFWL	WIPOEV	WSPOEV		**0.044**	**10.74**	**2.24**	**2**	**9**
22		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	0.012	2.85	0.59	14	43
23		PCOREC	ASBUDC	WSPOEV			**0.020**	**4.81**	**1.00**	**7**	**29**
24		PCOREC	LACPRE	LOEFWL	WIPOEV	WSPOEV	0.013	3.05	0.64	11	40
25		PCOREC	POEFWP	WIPOEV	WSPOEV		0.004	0.98	0.20	22	58
26		PCOREC	WSPOEV				**0.020**	**4.78**	**0.99**	**8**	**30**
27		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.015	3.57	0.74	10	38
28		PIRSWE	POEFWP	WIPOEV	WSPOEV		0.012	2.88	0.60	13	42
29		POEFWP	WIPOEV	WSPOEV			0.007	1.65	0.34	18	51
30	POELWL	LACPRE	LOEFWL	WIPOEV	WSPOEV		0.024	5.84	1.22	5	24
31		POEFWP	WIPOEV	WSPOEV			0.017	4.07	0.85	9	37
32	POPAWE	LCRMEE	LOEFWL	WIPOEV	WSPOEV		0.010	2.53	0.53	15	44
33		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	0.005	1.26	0.26	20	56
34		PCOREC	ASBUDC	WSPOEV			0.009	2.13	0.44	16	47
35		PCOREC	POEFWP	WIPOEV	WSPOEV		0.003	0.75	0.16	25	61
36		PCOREC	WSPOEV				0.009	2.12	0.44	17	48
37		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.003	0.84	0.17	23	59
38		POEFWP	WIPOEV	WSPOEV			0.004	0.99	0.21	21	57
39		WSPOEV					0.068	16.57	3.45	1	6
40	PPSCRI	POEFWP	WIPOEV	WSPOEV			0.034	8.22	1.71	4	15
Sub-Total		All Coefficients					0.410	100.00	20.83		
		Only Significant Coefficients					0.120	29.21	6.08		

POPAWE representing the influence that other sectoral policies have on water policy. As can be seen from the linkage chains associated with their channels, these two variables have stronger linkages with many institutional and performance variables. In terms of the values calculated with all the coefficients, the 11 channels associated with PGIPUP taken together account for about 50 percent of the total impact transmitted by all the 25 policy-related channels. But, they account for only about 10 percent of the total impact transmitted by all the 63 channels. The corresponding figures associated with POPAWE are 27 and 6 percent. As we evaluate the channels on the basis of only the significant coefficients, only four of the 25 channels remain significant and all these significant channels are related to PGIPUP. The significant channels account for only 29 percent of the total impact being transmitted by all policy-related channels.

Interestingly, although policy-related channels are more with larger impact as compared to the law-related channels, in terms of the value of significant channels, the latter channels, as a group, do far better than the former. As we screen all the policy-related channels, we find some channels with a relatively larger but insignificant performance impact. While there are a number of channels with this particular property, the most important among them is the channel POPAWE-WSPOEV that conveys the direct effects of other sectoral policies on water sector performance. This channel has the largest share both among the channels associated with POPAWE (about 62 percent) as well as among all policy-related channels (17 percent). If institutional reform is designed to effect changes in other sectoral policies in such a way as to make this channel (and also other related channels) significant and effective, there is the scope for enhancing water sector performance to the tune of 4 to 6 percent. Since this kind of reform effort is also likely to create favorable changes in all channels involving POPAWE, the performance impact of the reform can be far larger than that noted above.

It is also not out of place to note that the insignificance of a larger number of policy-related channels is in a way consistent with the stronger role of legal and administrative performance that we have obtained in the context of Chapter 7 and evaluated further in Chapter 8. But, the information in Table 9.2b adds an additional insight. As can be seen from the four channels with a significant and relatively a larger impact, the variable PGIPUP has stronger linkages with legal and administrative aspects either directly or indirectly through variables such as PCOREC representing cost recovery status. As such, it has an influence on LCRMEE and LACPRE representing respectively the legal aspects of conflict resolution mechanisms and accountability provisions as well as on ASBUDC representing the administrative aspects of the seriousness of budget constraint. This provides some evidence that although the water policy may not have any significant effect on the performance of water institution and hence, water sector performance, some of the policy-related variables does have a key role in indirectly strengthening the performance contributions of water law and water administration.

Relative Importance of Administration-related Channels

The values, relative shares, and ranks of 23 administration-related channels are listed in Table 9.2c. These channels are associated with six exogenous variables related to water administration. These channels account for 61 percent of the total impact of all 63 channels calculated from all the coefficients and 52 percent of the same calculated using only the significant coefficients. Their largest combined share of the total impact clearly suggests that these administration-related channels are relatively more important for performance improvement as compared to their law and policy-related counterparts. Moreover, unlike the case of law and policy-related exogenous variables, four of the six administration-related exogenous variables have two or more significant channels. While

Table 9.2c. Admin-related Channels: Relative Share and Significance of Impact in All-sample Context.

Sl. No.	Impact Transmission Channels/Linkage Chains						Value	Share (%)		Rank	
								Within Admin	Overall	Within Admin	Overall
41	AACCME	AOEFWA	WIPOEV	WSPOEV			0.025	2.08	1.28	13	23
42		LACPRE	LOEFWL	WIPOEV	WSPOEV		0.002	0.20	0.12	23	62
43	AARINF	AOEFWA	WIPOEV	WSPOEV			**0.164**	**13.53**	**8.31**	**3**	**3**
44		LCRMEE	LOEFWL	WIPOEV	WSPOEV		**0.017**	**1.39**	**0.86**	**18**	**36**
45		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.006	0.46	0.28	22	55
46		WSPOEV					**0.136**	**11.24**	**6.91**	**4**	**4**
47	ABALFS	AOEFWA	WIPOEV	WSPOEV			**0.176**	**14.54**	**8.93**	**2**	**2**
48		LCRMEE	LOEFWL	WIPOEV	WSPOEV		**0.026**	**2.14**	**1.32**	**12**	**22**
49		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.009	0.71	0.44	20	49
50	AEXTST	AOEFWA	WIPOEV	WSPOEV			**0.234**	**19.37**	**11.90**	**1**	**1**
51		LCRMEE	LOEFWL	WIPOEV	WSPOEV		**0.018**	**1.46**	**0.90**	**16**	**33**
52		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	**0.031**	**2.56**	**1.57**	**11**	**19**
53		PIRSWE	POEFWP	WIPOEV	WSPOEV		**0.101**	**8.36**	**5.13**	**5**	**5**
54		WSPOEV					0.041	3.39	2.08	7	11
55	AIBDWP	AOEFWA	WIPOEV	WSPOEV			0.017	1.40	0.86	17	35
56		ASBUDC	AOEFWA	WIPOEV	WSPOEV		0.032	2.63	1.62	10	18
57		ASBUDC	WSPOEV				**0.054**	**4.44**	**2.73**	**6**	**8**
58		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	0.019	1.60	0.98	15	31
59		PCOREC	ASBUDC	WSPOEV			**0.033**	**2.71**	**1.66**	**8**	**16**
60		PCOREC	LACPRE	LOEFWL	WIPOEV	WSPOEV	0.021	1.72	1.06	14	28
61		PCOREC	POEFWP	WIPOEV	WSPOEV		0.007	0.55	0.34	21	52
62		PCOREC	WSPOEV				**0.033**	**2.69**	**1.65**	**9**	**17**
63	AORGBA	AOEFWA	WIPOEV	WSPOEV			0.010	0.81	0.49	19	45
Sub-Total		All Coefficients					1.209	100.00	61.41		
		Only Significant Coefficients					1.021	84.44	51.86		
Grand Total		All Coefficients					1.969	-	100.00		
		Only Significant Coefficients					1.295	-	65.78		

the number of significant channels is four each in the case of law and policy-related channels, it is 10 in the case of administration-related channels. Interestingly, the 10 significant channels account together for 84 percent of the total impact of all 23 administration-related channels calculated with all the coefficients. This means that most of the significant channels also have a larger magnitude and share of performance impact not only within the context of Table 9.2c but also across tables 9.2a, 9.2b, and 9.2c. This result suggests clearly the dominant role of the channels associated with administration-related exogenous variables, as a group, in determining the overall institutional and sectoral performance.

As we look through the administration related channels with larger and more significant impact, we find they are related to the four variables: AEXTST, AARINF, ABALFS, and AIBDWP. These variables represent respectively the extensiveness of science & technology application, adequacy/relevance of information, balanced functional specialization, and existence of independent water pricing body. Importantly, AEXTST—with four of its five channels being significant—has the largest share of 20 percent of the total impact irrespective of whether the impact is calculated with all or significant coefficients. Although AIBDWP has more channels as compared to other administration-related exogenous variables, its share of the impact is still lower as compared to the shares of AEXTST, AARINF, and ABALFS with far fewer channels. This suggests, once again, that the magnitude and share of their impact may not necessarily be related to the number of channels associated with exogenous variables. In any case, all the four exogenous variables noted above have a larger share of impact as compared to all the law and policy-related exogenous variables.

As we have noted in the cases of tables 9.2a and 9.2b, as we go through the variables in the linkage chains associated with all the significant channels, we find that the effects of administration-related exogenous variables are also transmitted through law and policy-related institutional and performance variables. This clearly suggests that administrative reforms have a larger performance impact mainly in view of their implications not only for administrative performance but also for the performance of water law and policy. The results provide a strong evidence for giving a top priority to administrative aspects in institutional reform programs. Specifically, the immediate priority should be on the application of science & technology, strengthening of information base, broadening the disciplinary background of personnel, and creating an independent body for water pricing. Notably, these administrative reforms are politically neutral and also have extensive forward and backward linkages conducive for both immediate and long-term institutional and sectoral performance. Although these reforms are investment-wise relatively costlier, in view of their role to improve the capability and outlook of water administration, they can initiate both an immediate and long-term flow of benefits far greater in magnitude than the investment costs.

Relative Contribution of Channels: Role of Recent Reforms

The role of recently undertaken reforms in determining the relative share and significance of different channels associated with the exogenous variables can be evaluated by comparing the results obtained in the context of reform countries with those obtained under other countries. As we did in the all-sample context, the results are presented and analyzed by distinguishing the channels in terms of their association with law, policy, and administration-related exogenous variables. The analysis will proceed by comparing the relative importance of the channels both within each of the three components as well as across the two contexts defined by the country groups.

Relative Importance of Law-Related Channels

Table 9.3a depicts the value, relative share, and rank of the 15 channels associated with five law-related exogenous variables as obtained in the context of reform areas and other areas. The most immediate aspect to be noted here is that the behavior of the channels in terms of the relative size and significance of their impact shows an entirely different pattern across the two country groups. Notably, both the channels that are significant as well as their relative share in total impact are different across the country groups. For instance, the single channels associated both with LINTRE and LTRWSA that are insignificant with only a marginal impact in the context of reform countries are significant with substantial impact in the context of other countries. While none of the channels associated with LPRSRF is significant in the context of reform countries, one of them that transmits the effects of property rights via cost recovery and legal provisions for accountability is significant with considerable share of total impact transmitted by all law-related channels.

Of the two channels associated with LOEPRE, the first one transmitting its effects indirectly via the variable representing the effectiveness of the legal provisions for accountability is significant in the context of other countries. But, in the context of the reform countries, it is the second of these channels transmitting the effects of privatization provision directly on the overall performance of water law that is significant. Notably, this channel accounts for the largest share of the total impact being transmitted by all law-related channels. Notably, the total impact of the law-related channels—calculated either with all the coefficients or with only the significant among them—is far lower in the context of reform countries as compared to that in other countries. Similarly, the number of significant channels is only two in the context of reform countries whereas it is four in the context of other countries. These results tend to give an impression that it is the law-related exogenous variables that seem to play a major role in countries lacking recent reform. The relative size and significance of the channels observed in the context of these countries also suggest that internal consistency, effective accountability provisions, and integrated treatment of water sources turn out to be the key reform issues here.

Since the countries that have recently undertaken substantial institutional reform have also a relatively mature water sector, the major focus for them is on privatization and adding a dose of centralization within their water laws. Even though only two of the 15 channels are significant in the case of these reform countries, they account for 67 percent of the total impact (as compared to the case of other countries with four significant channels accounting for only 66 percent) observed in the context of Table 9.3a. However, it is important to note that in the case of both country groups, there is a considerable scope for enhancing institutional and sectoral performance by strengthening some of the channels—especially, the third one—associated with LPRSRF. Although the

Table 9.3a. Law-related Channels: Relative Share and Significance of Impact across Country Groups.

Sl. No.	Impact Transmission Channels/Linkage Chains						Reform Areas					Other Areas				
							Value	Share (%)		Rank		Value	Share (%)		Rank	
								Within Law	Overall	Within Law	Overall		Within Law	Overall	Within Law	Overall
1	LINTRE	LOEFWL	WIPOEV	WSPOEV			0.001	0.33	0.05	13	58	**0.103**	**27.58**	**6.13**	**1**	**5**
2	LOECEN	LOEFWL	WIPOEV	WSPOEV			**0.083**	**28.84**	**4.46**	**2**	**7**	0.020	5.38	1.20	6	20
3	LOEPRV	LACPRE	LOEFWL	WIPOEV	WSPOEV		0.010	3.60	0.56	5	31	**0.067**	**17.97**	**3.99**	**2**	**10**
4		LOEFWL	WIPOEV	WSPOEV			**0.111**	**38.33**	**5.93**	**1**	**6**	0.028	7.37	1.64	5	17
5	LPRSRF	LACPRE	LOEFWL	WIPOEV	WSPOEV		0.003	0.87	0.13	11	51	0.006	1.48	0.33	10	38
6		LCRMEE	LOEFWL	WIPOEV	WSPOEV		0.004	1.39	0.21	8	45	0.005	1.45	0.32	11	39
7		LOEFWL	WIPOEV	WSPOEV			0.039	13.60	2.10	3	14	0.040	10.63	2.36	4	14
8		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	0.006	1.91	0.29	6	40	0.014	3.79	0.84	8	27
9		PCOREC	ASBUDC	WSPOEV			0.003	0.90	0.14	10	50	0.001	0.29	0.07	15	61
10		PCOREC	LACPRE	LOEFWL	WIPOEV	WSPOEV	0.001	0.42	0.06	12	57	**0.016**	**4.17**	**0.93**	**7**	**26**
11		PCOREC	POEFWP	WIPOEV	WSPOEV		0.001	0.22	0.03	14	61	0.006	1.72	0.38	9	35
12		PCOREC	WSPOEV				0.004	1.28	0.20	9	48	0.004	1.09	0.24	12	47
13		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.000	0.14	0.02	15	62	0.003	0.75	0.17	13	52
14		PIRSWE	POEFWP	WIPOEV	WSPOEV		0.005	1.74	0.27	7	42	0.002	0.45	0.10	14	57
15	LTRWSA	LOEFWL	WIPOEV	WSPOEV			0.019	6.45	1.00	4	22	**0.059**	**15.87**	**3.53**	**3**	**12**
Sub-Total		All Coefficients					0.289	100.00	15.46			0.374	100.00	22.23		
		Only Significant Coefficients					0.194	67.167	10.382			0.245	65.60	14.58		

institutional reforms related to property rights have substantial forward linkages, they also require the prior creation of a strong institutional and technical foundation. Since the reform countries either have or could create fast most of the institutional and technical prerequisites, the property rights reforms are more likely and effective in these countries than in others.

Relative Importance of Policy-related Channels

The value, relative share, and rank of the 25 channels associated with the five policy-related exogenous variables obtained in the context of two country groups are given in Table 9.3b. As we consider the impact of these channels calculated with all the coefficients, those associated with POPAWE representing the impact of other sectoral policies on water policy have the largest share in the case of both country groups. But, their share in the context of reform countries (54 percent) is substantially larger than that (37 percent) in the context of other countries. Even though PGPIUP representing the effectiveness of user participation policy has more channels as compared to other exogenous variables, it has only the second largest share in reform countries (28 percent) and third largest share in other countries (20 percent). Interestingly, the two channels associated with POELWL that represents the overall linkages between water law and water policy have only a marginal share in the context of reform countries but the second largest share in the context of other countries (26 percent). The combined share of the three channels associated with PGPIPP representing the effectiveness of private participation policy is also larger in other countries (12 percent) than that in reform countries (6 percent).

As we consider the impact of channels in terms of only the significant coefficients, of the 25 channels, three are significant in reform countries but only one is significant in other countries. Looking at the three channels that are significant in the context of reform countries, we can also identify the relative importance of different sources and patterns of impact transmission. The channel capturing the impact of other sectoral policies directly on water sector performance has the largest share (32 percent). The channel that conveys the performance effects of user participation policy through conflict resolution and legal performance has the next largest share (15 percent) followed by the channel transmitting the indirect effects of other sectoral policies via cost recovery and budget constraint (7 percent). This clearly suggests that the two key factors having a dominant performance implication in the context of reform countries are the user participation policy and other sectoral policies. Notably, other sectoral policies mostly have a negative effect on cost recovery (due to subsidized water rates) and contributed to budget constraint (due to poor recovery and lower budgetary allocation). This fact is actually observed in several of our sample countries.

In the context of other countries, the only channel that is significant points to the role that effective law-policy linkages can play in improving the overall performance of

Table 9.3b. Policy-related Channels: Relative Share and Significance of Impact across Country Groups.

Sl. No.	Impact Transmission Channels/Linkage Chains						Reform Areas					Other Areas				
							Value	Share (%)		Rank		Value	Share (%)		Rank	
								Within Policy	Overall	Within Policy	Overall		Within Policy	Overall	Within Policy	Overall
16	PGPIPP	ASBUDC	AOEFWA	WIPOEV	WSPOEV		0.015	3.58	0.78	7	26	0.033	8.80	1.96	3	15
17		ASBUDC	WSPOEV				0.012	2.88	0.62	8	28	0.003	0.86	0.19	19	48
18		POEFWP	WIPOEV	WSPOEV			0.004	1.10	0.24	18	44	0.008	2.11	0.47	12	33
19	PGPIUP	ASBUDC	AOEFWA	WIPOEV	WSPOEV		0.011	2.70	0.58	9	30	0.029	7.63	1.70	4	16
20		ASBUDC	WSPOEV				0.009	2.17	0.47	10	33	0.003	0.75	0.17	21	53
21		LCRMEE	LOEFWL	WIPOEV	WSPOEV		**0.062**	**15.26**	**3.31**	**2**	**8**	0.011	2.87	0.64	8	28
22		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	0.008	1.90	0.41	12	35	0.005	1.40	0.31	15	40
23		PCOREC	ASBUDC	WSPOEV			0.006	1.52	0.33	16	39	0.001	0.14	0.03	25	63
24		PCOREC	LACPRE	LOEFWL	WIPOEV	WSPOEV	0.002	0.42	0.09	22	56	0.006	1.54	0.34	13	36
25		PCOREC	POEFWP	WIPOEV	WSPOEV		0.001	0.22	0.05	23	59	0.002	0.63	0.14	22	54
26		PCOREC	WSPOEV				0.005	1.27	0.28	17	41	0.002	0.40	0.09	24	60
27		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.006	1.56	0.34	15	38	0.006	1.49	0.33	14	37
28		PIRSWE	POEFWP	WIPOEV	WSPOEV		0.004	0.99	0.21	19	46	0.003	0.84	0.19	20	49
29		POEFWP	WIPOEV	WSPOEV			0.002	0.48	0.11	21	53	0.008	2.21	0.49	11	32
30	POELWL	LACPRE	LOEFWL	WIPOEV	WSPOEV		0.000	0.03	0.01	25	63	**0.070**	**18.75**	**4.18**	**2**	**9**
31		POEFWP	WIPOEV	WSPOEV			0.003	0.69	0.15	20	49	0.027	7.20	1.60	5	18
32	POPAWE	LCRMEE	LOEFWL	WIPOEV	WSPOEV		0.008	1.86	0.40	13	36	0.008	2.23	0.50	10	31
33		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	**0.027**	**6.60**	**1.43**	**4**	**17**	0.017	4.62	1.03	7	23
34		PCOREC	ASBUDC	WSPOEV			0.021	5.30	1.15	5	19	0.002	0.45	0.10	23	56
35		PCOREC	POEFWP	WIPOEV	WSPOEV		0.008	2.03	0.44	11	34	0.005	1.28	0.28	17	43
36		PCOREC	WSPOEV				0.018	4.43	0.96	6	23	0.005	1.33	0.30	16	42
37		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.001	0.19	0.04	24	60	0.004	1.16	0.26	18	46
38		POEFWP	WIPOEV	WSPOEV			0.007	1.64	0.36	14	37	0.009	2.48	0.55	9	29
39		WSPOEV					**0.129**	**31.82**	**6.90**	**1**	**5**	0.087	23.20	5.17	1	8
40	PPSCRI	POEFWP	WIPOEV	WSPOEV			0.038	9.36	2.03	3	15	0.021	5.65	1.26	6	19
Sub-Total		All Coefficients					0.405	100.00	21.68			0.375	100.00	22.28		
		Only Significant Coefficients					0.218	53.69	11.64			0.070	18.75	4.18		

water law by strengthening the legal aspects of accountability in these countries. The channel under consideration accounts for 19 percent of the total impact of all policy-related channels and 4 percent of the total impact of all 63 channels. The insignificance of the remaining channels in the context of both country groups does not mean that the exogenous variables associated with them are of no consequence. As we have noted already, the ineffectiveness of the remaining channels is essentially due to the insignificance of one or more of the en route variables underlying these channels. When this bottleneck can be eliminated by targeting the reform on the en route variables underlying the channels with substantial but insignificant share of total impact, the performance contributions of the remaining channels can be enhanced considerably. Since only 19 percent of the total impact that is being transmitted by all policy-related channels is significant in countries lacking recent reforms, the magnitude of the reform task in the sphere of water policy is far greater in these countries than in reform countries.

In the context of other countries, the reform should focus especially on the variables underlying the channels having a substantial share in the total impact of all policy-related channels. As we screen all insignificant policy-related channels in the context of reform countries, we can identify six channels with a share of four or more percent. These are the two channels associated with POPAWE with a combined impact share of 28 percent and one each related respectively to PGPIPP (9 percent), PGPIUP (8 percent), POELWL (7 percent) and PPSCRI (6 percent). It is the configuration and sequencing of variables in the linkage chains underlying these channels that provide the basis for deciding institutional priority within the reform program targeting the policy sphere in countries lacking recent reforms. Even though the significant channels has a 54 percent share in the total impact of policy-related channels in reform countries, these countries also need additional reform both to enhance and consolidate the already achieved performance gains. In this respect, the reform countries can focus especially on the four channels that currently insignificant but having an individual share of four or more percent and combined share of about 24 percent. They are the two associated with POPAWE and one each associated with PGPIPP and PPSCRI.

Relative Importance of Administration-related Channels

The relative level and share of impact being transmitted by the 23 channels associated with six administration-related exogenous variables obtained across country groups are given in Table 9.3c. Irrespective of country group, the administration-related channels, as a group, are far more critical than their legal and policy counterparts for enhancing the performance of both water institution and water sector. For, they together account for a predominant share of the total impact transmitted by all 63 channels. However, the share of these channels is considerably more in the context of reform countries (63 percent) than that in other countries (56 percent). The gap between the country groups in terms of the share of significant channels is still wider as the share in the context of the reform

Table 9.3c. Administration-related Channels: Relative Share and Significance of Impact across Country Groups.

Sl. No.	Impact Transmission Channels/Linkage Chains						Reform Areas					Other Areas				
							Value	Share (%)		Rank		Value	Share (%)		Rank	
								Within Admin	Overall	Within Admin	Overall		Within Admin	Overall	Within Admin	Overall
41	AACCME	AOEFWA	WIPOEV	WSPOEV			0.009	0.75	0.47	18	32	0.005	0.55	0.31	15	41
42		LACPRE	LOEFWL	WIPOEV	WSPOEV		0.005	0.41	0.26	19	43	0.018	1.93	1.07	10	22
43	AARINF	AOEFWA	WIPOEV	WSPOEV			**0.136**	**11.58**	**7.28**	**3**	**3**	**0.111**	**11.91**	**6.61**	**3**	**3**
44		LCRMEE	LOEFWL	WIPOEV	WSPOEV		0.021	1.75	1.10	12	20	0.003	0.33	0.18	19	51
45		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.002	0.18	0.11	21	52	0.002	0.17	0.10	21	58
46		WSPOEV					**0.307**	**26.12**	**16.42**	**1**	**1**	0.110	11.78	6.54	4	4
47	ABALFS	AOEFWA	WIPOEV	WSPOEV			**0.135**	**11.50**	**7.23**	**4**	**4**	**0.099**	**10.61**	**5.89**	**5**	**6**
48		LCRMEE	LOEFWL	WIPOEV	WSPOEV		0.018	1.51	0.95	14	24	0.009	0.98	0.54	13	30
49		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.002	0.15	0.10	23	55	0.005	0.51	0.28	16	44
50	AEXTST	AOEFWA	WIPOEV	WSPOEV			**0.149**	**12.69**	**7.98**	**2**	**2**	**0.172**	**18.40**	**10.21**	**1**	**1**
51		LCRMEE	LOEFWL	WIPOEV	WSPOEV		0.020	1.69	1.06	13	21	0.001	0.12	0.06	23	62
52		LCRMEE	PIRSWE	POEFWP	WIPOEV	WSPOEV	0.025	2.14	1.34	11	18	0.003	0.33	0.19	18	50
53		PIRSWE	POEFWP	WIPOEV	WSPOEV		**0.052**	**4.41**	**2.77**	**8**	**12**	**0.117**	**12.53**	**6.95**	**2**	**2**
54		WSPOEV					0.056	4.76	2.99	7	11	0.097	10.39	5.76	6	7
55	AIBDWP	AOEFWA	WIPOEV	WSPOEV			**0.057**	**4.88**	**3.07**	**6**	**10**	**0.067**	**7.14**	**3.96**	**7**	**11**
56		ASBUDC	AOEFWA	WIPOEV	WSPOEV		**0.041**	**3.53**	**2.22**	**9**	**13**	0.020	2.13	1.18	9	21
57		ASBUDC	WSPOEV				0.033	2.83	1.78	10	16	0.002	0.21	0.12	20	55
58		PCOREC	ASBUDC	AOEFWA	WIPOEV	WSPOEV	**0.017**	**1.44**	**0.90**	**15**	**25**	0.016	1.68	0.93	12	25
59		PCOREC	ASBUDC	WSPOEV			0.014	1.15	0.72	16	27	0.002	0.16	0.09	22	59
60		PCOREC	LACPRE	LOEFWL	WIPOEV	WSPOEV	0.004	0.32	0.20	20	47	**0.017**	**1.85**	**1.03**	**11**	**24**
61		PCOREC	POEFWP	WIPOEV	WSPOEV		0.002	0.16	0.10	22	54	0.007	0.76	0.42	14	34
62		PCOREC	WSPOEV				0.011	0.96	0.61	17	29	0.005	0.48	0.27	17	45
63	AORGBA	AOEFWA	WIPOEV	WSPOEV			**0.060**	**5.10**	**3.21**	**5**	**9**	**0.047**	**5.03**	**2.79**	**8**	**13**
Sub-Total		All Coefficients					1.18	100.00	62.86			0.934	100.00	55.49		
		Only Significant Coefficients					0.95	81.24	51.07			0.630	67.47	37.44		
Grand Total		All Coefficients					1.870	-	100.00			1.683	-	100.00		
		Only Significant Coefficients					1.367	-	73.09			0.946	-	56.20		

countries is 51 percent whereas the same in the context of other countries is only 37 percent. Notably, most of the administration-related channels with a larger share of the impact are also significant in the context of both country groups and all the exogenous variable with the exception of AACCME representing the effectiveness of administrative accountability have at least one significant channel.

Considering the share of the channels associated with each of the exogenous variables across country groups, those associated with AARINF accounts for the largest share (40 percent) followed by those associated with AEXTST with the second largest share (26 percent) among reform countries. In the context of other countries, however, the channels associated with AEXTST have the largest share (42 percent) followed by those associated with AARINF with the second largest share (24 percent). The relative shares of the remaining variables except ABALFS remain more or less the same across country groups. The share of the channels associated with AIBDWP representing the existence of independent water pricing body (around 15 percent) and those associated with AORGBA representing the geographical basis of water organization (around 5 percent) remain consistent across country groups. But, ABALFS representing the level of balance in functional specialization within water administration has a considerably larger share in reform countries (13 percent) than in other countries (8 percent).

The administration-related exogenous variables except those with a dominant share of total impact display somewhat a similar pattern of behavior across country groups. But, we do not fail to notice the fact that most of the country-specific variations actually lie both in the relative share of as well as in the number and configuration of linkage chains underlying the significant channels. For instance, as we compare the linkages chains underlying the significant channels associated with AIBDWP across country groups, the impact of this variable in the context of reform countries is conveyed essentially through cost recovery (PCOREC), budget constraint (ASBUDC), and the overall performance of water administration (AOEFWA). In contrast, in the context of other countries, although the effects of AIBDWP as conveyed through AOEFWA is dominant, the same conveyed through PCOREC, legal provisions for accountability (LACPRE), and the overall performance of water law (LOEFWL) are also substantial and significant.

Similarly, the channel conveying the direct performance effects of informational adequacy and relevance (AARINF) has the largest impact (26 percent) in reform countries. But, the same channel in the case of other countries, though has a substantial share (12 percent), remains, however, insignificant. Even though both the significant channels associated with the exogenous variable AEXTST representing the extent of science & technology application within water administration are important in both country groups, they have a larger share in other countries than in reform countries. As noted already, the channel conveying the indirect effects of AEXTST via the performance of water administration has, in fact, the largest impact in the context of other countries.

Relative Importance of Exogenous Variables

The relative value and share of various channels discussed in the previous section do provide an idea as to the relative role and significance of the exogenous variables with which those channels are associated. A closer evaluation of the relative role and significance of the exogenous variables in term of their share both in total and significant impact is, however, essential to identify the institutional aspects that have to be prioritized within an institutional reform program. Since the channels associated with a given exogenous variable only transmit the impact due to a marginal change in that exogenous variable, the sum of the impact being transmitted by all channels in this case represents actually the system-wide impact of the marginal change in the exogenous variable under consideration. As we have noted already, the relative importance of the exogenous variables depends on three aspects, i.e., the number of their impact transmission channels, length of the linkage chains underlying these channels, and the size of the coefficients for the variables in the linkage chains. Thus, an exogenous variable having more channels with shorter linkage chains and larger coefficients for the variables in the linkage chains is likely to have a larger share of impact than another having fewer channels with longer linkage chains and smaller coefficients for the variables in the linkage chains. The relative importance of an exogenous variable depends not just on the sum of the magnitude of the impact being transmitted by its channels but equally also on the proportion this impact that is significant. The significant impact of an exogenous variable is just the sum of the impact being transmitted by its significant channels.

Overall Perspective

The all-sample results pertaining to the values and relative shares of the 16 exogenous variables are given in Table 9.4a. The number of all and significant channels associated with each of the exogenous variables can also be seen in the table. As we consider the performance impact calculated using all the coefficients, AEXTST has the dominant share of performance impact (22 percent) followed by AARINF (16 percent), AIBDWP (11 percent), ABALFS (11 percent), and PGPIUP (10 percent). Among the remaining exogenous variables, those having a notable share of performance impact are LPRSRF (8 percent) and POPAWE (6 percent). Although the most dominant among the exogenous variables are related mostly to administration-related institutional aspects, as we have noted in the previous section, all of them have powerful effects also on law and policy related institutional and performance variables operating in the linkage chains underlying their impact transmission channels.

Even when we consider the performance impact in terms of only the significant channels, the top five exogenous variables listed above, once again, fare far better than others do. However, the value of the impact associated with all these variables has

Table 9.4a. Exogenous Variables: Relative Share and Significance of Impact in All-sample Context.

Sl. No.	Exogenous Variables	All Coefficients				Only Significant Coefficients			
		Channels	Value	Share	Rank	Channels	Value	Share	Rank
1	LINTRE	1	0.061	3.09	9	1	0.061	4.71	6
2	LOECEN	1	0.043	2.17	10	1	0.043	3.29	8
3	LOEPRV	2	0.069	3.50	8	-	-	-	-
4	LPRSRF	10	0.153	7.75	6	2	0.051	3.91	7
5	LTRWSA	1	0.024	1.22	14	-	-	-	-
6	PGPIPP	3	0.021	1.09	15	-	-	-	-
7	PGPIUP	11	0.203	10.30	5	4	0.120	9.26	4
8	POELWL	2	0.041	2.07	11	-	-	-	-
9	POPAWE	8	0.112	5.67	7	-	-	-	-
10	PPSCRI	1	0.034	1.71	12	-	-	-	-
11	AACCME	2	0.028	1.40	13	-	-	-	-
12	AARINF	4	0.322	16.36	2	3	0.317	24.45	2
13	ABALFS	3	0.210	10.69	4	2	0.201	15.53	3
14	AEXTST	5	0.425	21.59	1	4	0.384	29.67	1
15	AIBDWP	8	0.215	10.90	3	3	0.119	9.19	5
16	AORGBA	1	0.010	0.50	16	-	-	-	-
Total		63	1.969	100.00	-	20	1.295	100.00	-

declined due to the insignificance of some of their channels. In any case, the EXTST, once again, has the top share of performance impact (30 percent) followed by AARINF (24 percent), ABALFS (16 percent), PGPIUP (9 percent), and AIBDWP (9 percent). Of the remaining exogenous variables, the three legal variables, i.e., LINTRE, LOECEN, and LPRSRF, show a significant positive contribution as they have, at least, one significant channel. These three law-related exogenous variables have a combined share of about 12 percent. Among all the variables having two or more significant channels, the proportion of insignificant channels is rather high for LPRSRF, PGPIUP, and AIBDWP. However, eight of the 16 exogenous variables are having a zero value as their channels are ineffective in transmitting the impact of these variables.

Effects of Reform Status of Countries

The evaluation of the relative role and significance of the exogenous variables at the all-sample context clearly identify the institutional aspects that should receive priority within an institutional reform program for a generic context. However, it is useful to check the robustness of the results by performing the same evaluation in the context of country groups defined in terms of their recent reform status. Such an evaluation also has the additional benefit of highlighting the kind of effects that recent institutional reforms have on the relative role and significance of the exogenous variables. Table 9.4b gives the comparative picture of the level, share, and significance of the impact of exogenous

Table 9.4b. Exogenous Variables: Relative Share and Significance of Impact across Country Groups.

Sl. No.	Exogenous Variables	All Coefficients							Only Significant Coefficients							
		Channels	Reform Countries			Other Countries			Reform Countries				Other Countries			
			Value	Share	Rank	Value	Share	Rank	Channels	Value	Share	Rank	Channels	Value	Share	Rank
1	LINTRE	1	0.001	0.05	16	0.103	6.13	6	-	-	-	-	1	0.103	10.91	3
2	LOECEN	1	0.083	4.46	8	0.020	1.20	16	1	0.083	6.10	7	-	-	-	-
3	LOEPRV	2	0.121	6.47	6	0.095	5.64	9	1	0.111	8.11	6	1	0.067	7.11	7
4	LPRSRF	10	0.065	3.47	9	0.097	5.74	8	-	-	-	-	1	0.016	1.65	10
5	LTRWSA	1	0.019	1.00	13	0.059	3.53	11	-	-	-	-	1	0.059	6.28	8
6	PGPIPP	3	0.031	1.64	12	0.044	2.62	13	-	-	-	-	-	-	-	-
7	PGPIUP	11	0.115	6.17	7	0.075	4.43	10	1	0.062	4.53	8	-	-	-	-
8	POELWL	2	0.003	0.16	15	0.097	5.78	7	-	-	-	-	1	0.070	7.43	6
9	POPAWE	8	0.218	11.68	3	0.138	8.19	3	2	0.156	11.40	3	-	-	-	-
10	PPSCRI	1	0.038	2.03	11	0.021	1.26	15	-	-	-	-	-	-	-	-
11	AACCME	2	0.014	0.73	14	0.023	1.38	14	-	-	-	-	-	-	-	-
12	AARINF	4	0.466	24.91	1	0.226	13.43	2	2	0.443	32.42	1	1	0.111	11.76	2
13	ABALFS	3	0.155	8.29	5	0.113	6.71	5	1	0.135	9.89	4	1	0.099	10.47	4
14	AEXTST	5	0.302	16.15	2	0.390	23.17	1	2	0.201	14.71	2	2	0.289	30.54	1
15	AIBDWP	8	0.179	9.60	4	0.135	8.00	4	3	0.116	8.46	5	2	0.084	8.88	5
16	AORGBA	1	0.060	3.21	10	0.047	2.79	12	1	0.060	4.39	9	1	0.047	4.97	9
Total		63	1.870	100.00	-	1.683	100.00	-	14	1.367	100.00	-	12	0.946	100.00	-

variables across the two country groups. As can be expect, the exogenous variables display some notable differences in terms of their value, relative share, and rank. While AARINF has the largest share in the reform countries, AEXTST has that distinction in other countries. The three variables that are next in line of importance, i.e., POPAWE, AIBDWP, and ABALFS, show a somewhat consistent behavior across the country groups. Notably, PGPIUP that had a fifth largest share in the all-sample context has a seventh largest share in reform countries but tenth largest share in other countries. In contrast, POPAWE that had a seventh largest share in the all-sample context has a third largest share in the context of both country groups.

Despite the variations in their values, relative shares, and ranks, most of the variables identified as having the top shares in the all-sample context continue to retain their relative importance irrespective of the reform status of countries. This is also true even when the relative importance of the exogenous variables are considered even in terms of the performance contributions of only their significant channels. But, there are notable differences in the significance of the performance contributions of a number of variables. While six institutional variables remain consistently significant in both country groups, others show inconsistency. As for instance, POPAWE, LOECEN, and PGPIUP having respectively the third, seventh, and eighth rank in the context of reform countries become all insignificant in the context of other countries. In contrast, LINTRE, POELWL, LTRWSA, and LPRSRF having respectively, the third, sixth, eighth, and tenth rank in the context of other countries become all insignificant in the context of reform countries. This suggests that although there is considerable amount of consistency in the relative importance and significance of the variables at the top of the scale of performance impact, there are notable differences in the same at the bottom of the scale.

Since most of the variables on the top having larger performance contributions show consistent behavior across country groups, the performance impact of country-specific variations found in the behavior of variables with smaller contributions is likely to be lower. But, this does not mean that institutional reform undertaken in the reform countries do not have any effect on the relative performance of the institutional variables. As we can note from Table 9.4b, the performance impact of all the six variable showing consistency in their significance is substantially higher in the reform countries as compared to that of their counterparts. The only exception in this respect related to AEXTST as its impact is larger in other countries than in reform countries. This clearly suggests that although there is a remarkable consistency in the relative importance and significance among the most importance institutional variables, there are substantial differences in their absolute contributions. These differences are obviously an outcome of the recently undertaken institutional reform.

IMPLICATIONS FOR INSTITUTIONAL DESIGN

The comparative analysis of the channels and exogenous variables in terms of their relative importance and significance in different estimation contexts has considerable implications for institutional design, especially for institutional prioritization, sequencing, and packaging. In order to appreciate well these implications, it useful to recall again the fact that underpins our evaluation method and empirical approach. That is, the relative size and significance of the coefficients associated with various variables and hence, the relative share and significance of different channels, are viewed as a quantitative representation of the overall consensus among the opinion-makers in global water sector. Since such consensus is not only on the perception of reality in the present but also on the expectation of the future direction of change, the results can be interpreted as a representation of both what has happened as well as what is being expected to happen. Thus, the relative shares of the channels and exogenous variables in total impact can be viewed as a consensual estimation of both actual as well as expected contributions. With this perspective, we can now identify some of the most important implications of our results for institutional prioritization, sequencing, and packaging as well as timing and scale aspects in reform programs.

Linkage Length and Impact Transmission

The relation between the number of en route variables and the level of impact of the channels can be quantified by correlating the two. Since the level of impact of the channels show some notable variations depending upon whether it is calculated in the all-sample context or in the context of country groups defined in terms of their recent reform status, we have attempted the correlation exercise in all these three contexts. The respective correlation coefficient obtained in the all-sample, reform, and other contexts are: -0.332, -0.454, and –0.330.[7] The negative but low value of the correlation coefficient obtained in all three different contexts suggests clearly that while channels with more en route variables can have a lower value, this need not necessarily be true always. However, a relatively larger value of the correlation coefficient for the reform regions suggests that longer chains are likely to contribute lesser than smaller chains. This fact provides some support, though weak and indirect, to our hypothesis pertaining to the

[7] We also note in passing that we have attempted the correlation exercise to see how the values of all channels obtained in different estimation contexts are related. In this attempt, we correlated the values of the channels obtained in the context of the all-sample, two country groups, and two expert groups (engineers and social scientists). While the correlation coefficient for reform countries is 0.763 and that for other countries is 0.816. The slightly higher coefficient in the later context suggests that the values of the channels obtained in the all-sample context are closer to those obtained in other countries as compared to those obtained in reform countries. Notably, the coefficient of correlation between reform countries and engineers is 0.834 the same between other countries and engineers is 0.686. In contrast, the same between reform countries and social scientists is 0.474 and that between other countries and social scientists is 0.825. The high correlation between the values of channels in reform (other) countries and that for engineers (social scientists) suggest that while the sample in reform countries is dominated by the perception of engineers, the same in other countries is dominated by the perception of social scientists. This is the reason why we have excluded the comparative analysis of the channels across the expert groups.

characteristics of the recent reform process and its impact pattern in the reform countries. That is, the reform process has, by and large, is notable more for its direct effect on water sector performance than for its effect on institutional performance. As a result, the performance gains realized in the reform countries cannot be sustained unless the reform is taken to the next stage where the focus has to be more on institutional strengthening by concentrating on longer chains characterizing institutional thickening and inter-linkages.

One of the main results is that the channels with a larger and more direct effect are likely to contribute to a better institutional functioning and hence, water sector performance. Larger chains, though good for institutional strengthening and institutional thickening, may not lead to any immediate impact on water sector performance. This is on account of, at least, two factors. First, in the case of channels involving longer institutional chains, the initial effect of a change in the exogenous variables (which are also policy or instrumental variables by their very nature) may be moderated or even distorted by the weakness or inefficiency of the en route variables. Second, there is also an implicit role of time as some or all of the en route variables may need differential time for capturing and transmitting the effects of an initial change in the exogenous variables. For instance, the performance impact of property rights on conflict resolution may take relatively more time as compared to its effects on, say, use efficiency. On the other hand, institutional aspects related to the application of science & technology and information may be relatively faster. In fact, the relative significance and larger performance contributions of channels related to these variables observed in all three contexts do provide some evidence for this fact.

From the perspective of designing institutional reform, the two factors noted above also points to yet another important aspect. That is, it is possible to enhance the performance impact not only by sequencing and packaging but also by giving special attention to the time-related dynamics of both institutional change and its performance impact. Thus, it is not enough to make changes just in one institutional component or aspect but also on others having critical linkages with others. This does not necessarily mean that the reform program should be all embracing to the point of being too large to the financial and implementation capabilities of the reform agency. The key is to identify and prioritize the institutional chains having the most dominant and immediate effect. Since the channels involving lower and slower performance impact are also essential for sustaining the operational capacity of water institutions, there needs to be a proper packaging of institutional variables covering those with a larger and most immediate performance impact and those with lower and slower performance impact. While the former has the tactical role of keeping the economic and political significance by bringing immediate performance returns, the latter is critical for ensuring the long-term sustainability of institutional reform through a gradual but concerted effort in strengthening the institutional linkages.

Institutional Prioritization, Sequencing, and Packaging

In terms of the relative share and significance of their impact, the channels can be categorized into those with larger and significant impact, those with larger but insignificant impact, those with smaller and significant impact, and those with smaller and insignificant impact. The number, sequence, and configuration of variables in the linkage chains underlying the first two categories of the channel provide very valuable information for designing the reform package complete with institutional priority, sequencing, and packaging. Based on the nature of the variables, we can also derive insights into the time that is potentially involved in their impact transmission. From this perspective, it is possible to identify a generic reform package based on the relative share and significance of the channels evaluated under the all-sample context. Such a package can, of course, be specialized by utilizing similar information obtained in the context of country groups defined in terms of their relative status in recent reform initiatives. While the inference on institutional priority is based on the relative size and significance of the impact transmission channels, the same on sequencing is based on the order and configuration of the variables in their underlying linkage chains.

From the perspective of institutional prioritization, the message of our comparative analysis of impact transmission channels is rather clear. The prioritization of the exogenous variables is rather straightforward as it is based on the intensity of their institutional linkages as reflected by the number of their impact transmission channels as well as relative magnitude and share of their performance impact. The results are unequivocal for giving top priority to the application of science & technology, building of a strong information base, creation of independent body for water pricing, broadening the functional specialization within water administration, and the formulation of an effective user participation policy. Although most of the channels transmitting the impact of the first three institutional aspects listed above are significant, there is also an issue of sequencing not only among these three aspects themselves but also between these and other institutional aspects. Particularly, science technology application is a critical first step for building an information base and the latter can enhance the effectiveness of water pricing. Similarly, an efficiently functioning network of WUAs at various levels is a precondition for an effective property rights arrangement and both of which taken together form the critical institutional condition for promoting many institutional aspects such as cost recovery, accountability, conflict resolution, and water transfers.

From the viewpoint of institutional packaging and sequencing, special attention should be given to balanced functional specialization and user participation policy as well as property rights format because most of their channels are insignificant. The focus here should be on the strengthening of the variables in the linkage chains underlying the channels transmitting the larger share of their impact. The variables underlying these channels as well as others with similar property should form part of the constellation of institutional aspects to be covered within the reform package. Since the insignificant channels are an indication of weak or dormant linkages among the variables in the linkage chains, they can be strengthened only adopting a package approach suitable for simultaneous reform in several related institutional and performance variables. Our comparative analysis of the channels in different contexts provides ample information for designing reform package necessary to strengthen some of the channels that are currently insignificant but have considerable potential for enhancing institutional and sectoral performance.

Having discussed the issue of priority and sequencing, it is important to recognize that the channels are categorized into law, policy, and administration-related channels essentially for analytical and presentational convenience. But, as we have seen, the impact being transmitted by these channels transcends this categorization in view of the strong institutional and performance linkages evident among legal, policy, and administration components of water institution. These linkages are clearly formalized by the variables in the linkage chains underlying the impact transmission channels. For instance, some of the law-related channels have policy and administration-related variables in their linkage chains. Similarly, the policy and administration-related channels have legal variables in their linkage chains. The administration-related channels are more important as they account for 61 percent of the total impact calculated from all coefficients and 52 percent of the same calculated with only significant coefficients. Their significance for the overall performance of water institution and water sector is due essentially to their importance not only for the performance of water administration but equally also for the performance of water policy and water law. However, the dominant share of administration-related channels does underline the fact that it is implementation-related institutional aspects rather than those related to legal prescription and policy statements that are critical for performance improvement. This also opens up the issue of a choice between poor law-policy regime implemented well and better law-policy regime with poor implementation.

Strengthening Impact Transmission Channels

We have argued for the need to strengthen the impact transmission channels as a means for both enhancing the performance contributions of significant channels as well as making insignificant channels into significant ones. But, how can this be done? We notice that in many cases, the channels that are significant also have the largest share whereas those with lower and marginal share are mostly insignificant. Such a direct association between the size and significance of the impact being transmitted by the channels has important implications. Since experts and policy-makers tend to attach a premium on the channels as well as their associated exogenous variables with a larger institutional and sectoral performance impact, these channels are likely to be significant and remain on the top of priority hierarchy. Thus, when institutional reform improves the performance contribution of one or more institutional/performance variables, their larger performance impact itself ensures that the significance of the channels in which they operate. By targeting the institutional and performance variables underlying both the significant channels with lower values as well as their insignificant counterparts with higher values, it is possible to alter their relative importance and significance.

While both the level and effectiveness of the impact being transmitted by some of the selected channels can be enhanced through institutional strengthening, the issue of how this can be done within an operational context of a reform program needs some elucidation. This can be illustrated using the results from our comparative analysis of impact transmission channels presented in this chapter as well as those on the relative role and significance of institutional variables reported and evaluated in Chapter 8. The comparative analysis of the channels in terms of the magnitude and significance of their impact transmission capabilities enables us to identify and prioritize the channels that need strengthening. The linkage chains underlying these prioritized channels provide information not only on the configuration but also on the sequencing of the institutional/performance variables that are to be targeted within such a strengthening exercise. Given the relative contribution of these variables as indicated by the size and significance of their coefficients in the relevant equations of model B reported in Chapter 8, the variables can also be prioritized for a more focussed reform attempt.

Before providing an illustration of why institutional strengthening is needed and how this can be done in practice, few words are in order to identify the channels and the variables that are to be prioritized. Our empirical results enable us to establish priority among channels only in terms of their relative share and significance of impact. But, there are also other considerations—especially related to the relative significance of their long-term impact on institutional strengthening and performance improvement—which are beyond our present model of institution-performance interaction. In view of the futuristic aspects and location-specificity of these considerations, they can be addressed only on a case-by-case basis giving due weight to factors such as local conditions, reform stage, and the expectation of reformers.[8] Since it is the channels with lengthy linkage chains that have the potential to strengthen institutional linkages, they need to receive higher priority. Similarly, the institutional and performance variables figuring in the linkage chains of more channels need priority over others for the main reason that any reform effort on them will strengthen all the channels in which they appear.

Most of the issues on the prioritization of channels and variables within an institutional strengthening program could be made more transparent with the following illustration. Consider, for instance, the policy-related channel PGPIUP-LCRMEE-

[8] For countries in the reform threshold, strategic considerations requires the priority for channels involving direct effects as they can yield relatively quicker performance returns needed for countering political resistance and consolidating performance gains. In contrast, in the case of countries in an advanced stage of reform, sustainability considerations requires priority for channels conveying indirect effects through lengthy linkage chains as they can deepen the process of institutional thickening so crucial for ensuring the resilience and sustainability of the reform process.

LOEFWL-WIPOEV-WSPOEV with a share of just 2.23 percent of the total impact being transmitted by all 63 channels. Although this channel is significant with a ninth largest share, the impact is low because the coefficients associated both with the exogenous variable PGPIUP as well as the two en route variables LCRMEE and LOEFWL are lower (see Table 8.1). In this condition, the impact being transmitted by the channel will improve if the performance of both the exogenous variable as well as the two en route variables is improved. Note, however, that the performance contributions of a marginal change in the institutional aspect of PGPIUP cannot be realized fully so long as the two en route variables continue to remain weak in the linkage chain. It is in this sense that institutional strengthening is a precondition even for undertaking reform in the exogenous variables. Also to note here is the fact that with institutional strengthening and improved performance (i.e., higher value for the coefficients) of the en route variables, there will be a change in total impact as well as in the relative share of the channels.

The impact transmission capabilities of the en route variables can be improved essentially by enhancing the value of their coefficient. How can we enhance the value of their coefficients? This question can be answered by referring to the results reported in Table 8.1. Notice that LCRMEE, the dependent variable in equation [1] but independent variable in equation [6], is significantly affected not only PGPIUP but also by three other institutional variables: ABALFS, AARINF, and AEXTST. Since all the three variables noted are also exogenous variables amenable for policy intervention, a change in one or more of them can positively affect LCRMEE in equation [1].[9] Within the simultaneous equation system, such positive impact is likely to improve the coefficient of LCRMEE in equation [6]. This, in turn, will have its repercussions also on LOEFWL, the dependent variable in equation [6] but independent variable in equation [9]. Notice that in a similar fashion, the coefficient of LOEFWL in equation [9] can also be improved by changing other significant legal aspects such as LINTRE and LOECEN. The system-wide impact of a change in one or more variables in different equations will also strengthen the linkage chains underlying all other channels involving the en route variables as well as those affecting or being affected by these en route variables. It is precisely for this reason that we argue that preference has to be given to institutional variables, which are involved in more number of channels.

Priority and Performance: Role of Recent Reforms

From an overall perspective, the comparison of the relative level and share of the impact of all channels across country groups reveals few notable facts. First, while the impact of the law-related channels is higher in the case of other countries, the impacts of policy and administration-related channels are higher in the case of reform countries. This means

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[9] Notably, given the fact that ABALFS has the largest magnitude of effect among all the four significant variables in the equation under consideration here, this variable deserves priority over others in reform efforts towards institutional strengthening.

that the consensus on the relative importance of the legal dimensions of institutional reform is stronger in other countries as compared to the reform countries. This also suggests further that the recent institutional changes observed in reform countries have a major thrust on the policy and administrative dimensions. Second, as we consider the share of the significant channels in total impact, the reform countries have a larger share than other countries both within and across the law, policy, and administration-related channels. This is a clear indication of the fact that the institutional linkages and their performance implications are relatively stronger in the reform countries.

Although the components and priorities of policy-related reforms are more or less the same across country groups, there are considerable differences in the thrust and scale as well as in the effectiveness of the initiated reforms. Since the reform countries have already undertaken significant reforms in various components of water institution, further institutional reforms involving both substantial and marginal changes are likely to be more effective and less costly in view of the upstream and downstream linkages created by the already undertaken reforms. As a result, the impact of the reforms on the institutional and sectoral performance is likely to be relatively faster and more effective in the reform countries than in other countries. From the perspective of institutional hierarchy, since information application mostly succeeds the application of science & technology, the dominant role of AARINF in reform countries suggests that these countries should have already made substantial progress in AEXTST. Although there is only a marginal variation in the number of significant channels among the country groups (14 for reform countries and 12 for other countries), the overall share of significant channels in total impact is far higher in reform countries (73 percent) than in other countries (56 percent). This result is suggestive of the following four important but interrelated aspects.

First, in reform countries, unlike other countries, most of the channels with a larger share of total impact are significant. This means that the reform program in the case of countries lacking recent reform should target variables in the linkage chains underlying the insignificant channels with a larger share. Second, the substantially higher share of significant channels in reform countries is essentially due to the stronger institutional linkages achieved through their recent institutional reforms. Third, although the insignificant channels are large in number, they only have a smaller share of the total impact even in reform countries. Since this means that most part of the total impact comes only from fewer channels, the extent of institutional linkages contributed by recent reforms appears to be low either due to a slower development of these linkages or due to a limited institutional coverage of the reforms. In order to enhance their institutional and sectoral performance, the reform countries have to concentrate more on intensifying the their reform by concentrating both on the already significant as well as on the currently insignificant channels. Fourth, it is more likely that in some of the reform countries with a mature water sector, additional performance benefits can be obtained only with substantial and higher level of reform effort. Fortunately, this is not the case with countries lacking recent reform as well as those in the early stage of institutional reform. The intuition here is that there is an increasing performance return in the initial stages of reform whereas the reverse is true in the later stages of reform.

The nature of the impact being generated by recent reform has clearly manifested in the fact that reform countries not only have a far higher level of total impact but also have a lager part of such impact to be significant. The fact that the number of both the significant channels as well as the significant variables is not much different among the two country groups suggests another important aspect. That is, the larger performance impact in reform countries is due more to the larger contributions of the exogenous variables through their direct impact transmission channels than to their indirect impact through the strengthening of institutional linkages. If the latter happens, then, we would have seen the number of significant channels in reform countries to be far higher than that observed in other countries. The implication of this fact for the nature and thrust of future institutional reform, especially in the context of reform countries, is that in order to ensure the sustainability of the performance impact of the recently undertaken reform, the reform in these countries have to move to its next stage. That is, the focus of future reform should be on strengthening the linkages among key institutional aspects. Although the reform efforts in the context of institutional linkages are likely to yield no or low immediate performance impact, they will certainly pave the way for more durable long-term benefits in terms of both on the institutional and sectoral performance.

Scale and Timing in Institutional Reform

In addition to the issues of priority and sequencing, our analysis also highlights the equally important aspects of the scale and dose of reform effort. The larger impact being conveyed by the significant channels also suggest the issue of scale in reform effort. That is, since the variables associated with these channels produce a larger impact, both institutional and sectoral performance can be enhanced with a larger dose of reform effort in the context of these variables. The scale of effort also has a time dimension as the additional reform effort can be undertaken either simultaneously or sequentially with appropriate time gap. But, the issue of when to take the additional reform effort depends on whether the performance impact associated with an exogenous variable is immediate or delayed. Since the speed of impact transmission depends on the nature and configuration of variables in the linkage chains, the final answer to the issue of scale and timing requires the evaluation of all channels specifically considering their immediate and long-term implications for institutional strengthening and performance improvement.

While our estimation is based on the assumption of linear effect of all variables, in reality, the effects of some of the institutional variables are subject to either increasing or decreasing return to scale. The information on the scale aspects has, therefore, to be derived outside of our model context. From our general knowledge of the reform process, the nature of the effects can be dependent on the level of reform already undertaken in a given institutional sphere, the extent of upstream and downstream linkages of the institutional aspect in question, and the level of supportive reforms in related spheres. All these aspects also depend on country-specific considerations. Usually, the nature of the effects associated with each of the key institutional aspect can be understood based on careful thinking and detailed observations in a given context. For instance, the performance impact of an additional unit of reform effort in user participation policy can be evaluated for a given region based on detailed review of its institutional linkages, the extent of reforms in related areas, and observations on current and past performance of this policy. The evaluation can be based both on observed data (e.g., extent of cost recovery, level of O&M expenditures) as well as anecdotal information (e.g., role of WUAs in decision-making and basin arrangements).

Although the linear specification of our model does not allow us to have any direct information on the issue of scale involved in the effects of exogenous variables, it does provide some idea as to the scale aspects involved in the transmission of their effects. The scale aspects involved in the impact transmission can be addressed in terms of the size of the coefficients associated with the en route variables. As we have noted already, when all the coefficients of the en route variables have a value of less than one, it obviously means that the effects of the exogenous variables will be transmitted only less than proportionately. But, in contrast, when all the en route variables have coefficients with values greater than one, the transmission of the effects of a variable will be more than proportionate. However, since the en route variables in many contexts are likely to have mixed values for their coefficients, i.e., some with fractional values and others with values greater than one, the ultimate scale of impact transmission will depend upon the size configuration of the coefficients of the en route variables. Based on the values of all channels—each with different number and configuration of en route variables—obtained in different estimation contexts, we can see that the scale of their impact transmission is characterized by diminishing trend mainly due to the lower values associated with their fractional coefficients. Since the issue of scale related to the impact transmission process is equally, if not more, important as the same related to the effects of the exogenous variables, there is a critical need to strengthen the impact transmission channels both for making the underlying coefficients larger and more significant.

Role of Time in Effecting Reform and Realizing Impact

From the perspective of designing institutional reform package, the relative performance impact of exogenous variables and their channels suggests that there is a clear choice among the exogenous variables with fewer channels but larger impact and those with larger channels and smaller impact. Unfortunately, the choice is not as easy as it seems because of the intervening role of institutional amenability, political feasibility, and the time dimension involved in effecting institutional strengthening and realizing their impact transmission potential. Although these issues cannot be addressed directly within our analytical framework where the time dimension is not explicitly incorporated, our results certainly provide some basis for deriving useful inferences and hypotheses on this count.

For instance, it is natural for the choice to tilt towards variables such as LINTRE and LOECEN in view of their stronger and more significant performance impact as well as their amenability for reform with lesser political resistance. Although the reforms needed for enhancing the internal consistency and privatization provisions within law may be politically easier and quicker, nevertheless, they take time to mature and yield performance impact.

In contrast, although there will be a considerable delay in undertaking property rights reform due to political difficulties, once such reforms are undertaken, their performance impact will be relatively faster. Besides, with the property rights reforms in place, institutional reforms in related spheres can become easier. Such a facilitative role for downstream reforms is very critical for reducing the total transaction cost of the overall reform program. More importantly, since property rights reforms have intricate linkages with use efficiency, accountability, conflict resolution, cost recovery, and water transfers, they are likely to contribute as much to the process of long-term institutional thickening as to immediate performance contributions. Such a process is indispensable for paving the foundation for institutional sustainability and long-term performance improvement. It is these considerations that tend to assign greater priority to variables with stronger institutional and performance linkages such as LPRSRF notwithstanding their lower immediate performance contributions. However, the choice among institutional aspects with a scope for quicker reform but delayed impact and those with difficult reforms but faster impact is still a difficult one. The difficulty can be resolved through a trade of between immediate performance benefits and long-term institutional and performance gains. The institutional reform program should be designed in such a way as to account for these tradeoffs with appropriate institutional prioritization, sequencing, and packaging of institutional aspects.

Chapter 10

IMPLICATIONS FOR THEORY AND POLICY

The main thrust of institutional change within water sector is to enhance the capabilities and increase the readiness to successfully face both current and future water challenges. Given this thrust, the major goals of institutional initiatives in the water sector are transparent. These goals are to: treat water as an economic good, strengthen allocation capabilities, increase the reliance on market forces, revive the payment culture, ensure financial self-sufficiency, promote decentralized decision structure, and encourage the adoption of modern technology and information inputs. Institutional reform of the magnitude required to achieve these goals is obviously a daunting challenge in most countries with outdated and poorly functioning water institutions. While the economic and resource-related rationale for both the thrust and objectives of institutional change are well understood, there is a lamentable dearth of understanding on how to effect water institutional change within the political economy constraints and opportunities.

The identification of a strategy for water institutional reform with minimum transaction cost and maximum political acceptability requires much sharper understanding of both the analytical and operational linkages among various components of water institutions as well as the ultimate impact of such institutional inter-linkages on the overall water sector performance. A better appreciation of the mechanics of institution-performance interaction within water sector also requires a broader and more integrated conception of water institutions including the institutional environment of such interaction as well as a recognition of the influence of prior, concurrent, and subsequent reforms elsewhere in the economy. While current knowledge does enable one to trace this causative chain of changes including their nature and direction, current methodologies and available information do not permit a rigorous evaluation of the performance implications of institutional linkages inherent in the process of institution-performance interaction. This is a serious gap both in institutional theory and in water sector policy that provides both the urge and justification for the present study. In its venture into this uncharted course of policy research, the study has succeeded in breaking new grounds both in terms of its analytical and methodological innovations and theoretical and policy contributions.

ANALYTICAL AND METHODOLOGICAL CONTRIBUTIONS

By providing an entirely new perspective on the inner dynamics of the process of institution-performance interaction, this study makes some important and unique contributions in terms of its analytical approach, evaluation methodology, empirical findings, and policy insights. The importance of these contributions to institutional economics in general and water institutional economics in particular is discussed below.

Analytical Framework

The analytical framework of this study is unique as it is developed based on a detailed, yet manageable decomposition of water institution and water sector performance and the characterization of the analytical and operational linkages among various components within a 'pattern model'. This study, for the first time, makes a detailed analytical decomposition of a broadly conceived concept of water institution that covers all the major legal, policy, and administrative aspects both within and outside the confines of conventionally defined water sector. Water institution is decomposed into three broad components, i.e., water law, water policy, and water administration. Each of these institutional components is again decomposed to identify their constituent institutional aspects. These institutional aspects cover not only those within the strict confines of the water sector but also those which capture the legal, policy, and administrative influences emanating especially from the agricultural, environment, and fiscal sectors. In a similar vein, the performance of water sector—considered to cover all the water sub-sectors—is also decomposed in terms of its physical, financial, economic, and equity dimensions. Notably, the institutional structure is distinguished from the institutional environment as defined by the social, political, economic, and resource-related exogenous factors so as to highlight the influence of these factors on the institutional and sectoral performance.

Although a still finer decomposition is possible, from analytical and operational convenience, the decomposition exercise concentrates mainly on the policy-wise most important institutional aspects. The institutional decomposition attempted here is similar to the one developed by Saleth and Dinar (1999b) and also consistent with the rule-based decomposition of institutions attempted E. Ostrom and her co-workers (E. Ostrom, 1986 and 1999; Ostrom, Gardner, and Walker, 1990 and 1994). Yet, our decomposition attempt is still unique, as it is less abstract and more amenable both for analytical exposition and empirical translation. By focusing on the internal structure and dynamics of institutions, it demonstrates not only the intricate linkages evident both within and across the institutional components but also their implications for institutional and sectoral performance. While the interest on the structure of and linkages within institutions are as old as institutional economics itself, empirical studies on this important aspect are rather rare. It is here that our study makes its mark. Taking institutional decomposition into the empirical realm, it sheds lights on the inner dynamics within the process of institution-performance interaction by demonstrating the performance implications of institutional linkages and the strategic roles of the general institutional environment as defined by socio-economic, political, legal, and resource-related factors.

Stage-based Perspective of Institutional Change

Despite the growth of theoretical and empirical literature in institutional economics, there are still dark and gray areas remaining as the frontier area for research in institutional economics. One area relates to the overestimation of the role of information and the concurrent underestimation of the role of the software that people use for interpreting information. Information alone cannot reduce uncertainties in human interaction as individuals differ in their interpretation of the same information. Since the differences originate from the differences in subjective perception or in the mental models of individuals, there is an inevitable need for a 'mental model approach' to reconstruct the software that people use for processing information. Another area relates to the need for evaluating the central role that the 'agents of change' play in the process of institutional change. Although the critical role of the 'agents of change' is repeatedly underlined in institutional economics, there is hardly any attempt to systematically investigate their role, especially within an empirical context. Since the role of the agents of change can be evaluated fully only with the incorporation of their subjective perception into the formal model, these two gray areas in institutional economics are interrelated.

This study, for first time, addresses these two interrelated gaps not only by incorporating them into the formal model but also by making them as the two pillars of its evaluation methodology and empirical framework. The analytical vehicle being used for formally incorporating them into the evaluation framework is a unique stage-based perception of institutional change. The central role of the subjective perception of the agents of change can be demonstrated by identifying four distinct stages in the process of institution-performance interaction. They are: perception change, political translation and articulation of such perception change, institutional changes of procedural nature followed then by institutional changes of substantive nature, and performance impact. Perception change among key actors is very crucial as it focuses on the agents of change, reflects the effects of the tension between existing institutions and sources of change, and provides clues as to the nature and direction of institutional change.

Perception change, though subjective in nature, is not independent of objective phenomena such as the impending water scarcity, prevalent fiscal crisis, emerging success stories, and even, natural disasters. While factors such as ideologies does influence the mental model of individuals, economic factors, especially the expected benefit and its share, also play equally a powerful role in the mental construct of desirable institutions. Clearly, transaction costs—both economic and political—remain a key force both in the cognitive and observed phases of the process of institutional change. Our stage-based conception of institutional change, therefore, integrates the roles of agents of change, their subjective perception, and transaction cost approach within a unified framework. In contrast to present literature that has completely ignored the insightful first stage, the present study highlights and elaborates on the centrality of the mind change of key players not just in the first stage but equally also in the remaining stages of the process of institution-performance interaction. A careful evaluation of the first stage of institutional change can provide insights on the perception of casual linkages within the process of institution-performance interaction, the extent of consensus on preferred institutional configurations, and the nature and direction of institutional change. Perceptional evaluation is also inevitable even in the remaining stages in view of the vast time gap between stages and the difficulty of observing actual institutional changes and measuring their performance impacts. While the stage-based perspective as such may not be unique, the four stages that we have identified, the key role assigned to the agents of change, and the way the transaction cost approach is integrated with the subjective perception of key players are definitely singular with no precedence.

Innovative Empirical Context

The stage-based perspective of institutional change is used both as the analytical framework to integrate a number of important but least addressed issues in institutional economics and as the empirical context for the evaluation of institution-performance interaction. It is the central roles that agents of change and their subjective perception play within the stage-based perspective of institutional change that, in fact, rationalize and justify our empirical context. Although the present study extends and refines the empirical tradition of using perception-based data for institutional analysis, its justifies the legitimacy of the empirical approach not in terms of the non-availability of objective data but in terms of its consistency with institutional theories. The inherently subjective nature of institutions and the centrality of subjective perception in institutional change, in fact, warrants subjective rather than observed data.

Apart from the strong theoretical and analytical justifications, there are also equally important practical justifications for our reliance on judgmental evaluation and its validity as an empirical basis for evaluating institutional change. The inevitability of subjective information is also underlined by few equally powerful facts. Subjective information, unlike observed data capturing past and static situation, can tap accumulated wisdom of key players, capture their expectations and futuristic considerations, and synthesize different types of information (i.e., objective data, subjective observation, and expected trend). In addition to its ability to internalize some of the difficult-to-measure concepts such as performance, efficiency, and equity, subjective evaluation can also capture the effects of both the objective factors such as water scarcity and economic development as well as individual-specific subjective factors such as disciplinary orientation and ideological predilections.

Relying on this empirical approach, the information on all relevant institutional and performance variables derived from our decomposition exercise is obtained by administering a structured questionnaire to a sample of key players in the water sector of several countries. The sample consists of 127 water sector experts with diverse background and experience from 43 countries/regions representing different continents, development stage, and resource conditions. While underlining the theoretical consistency and practical advantages of our empirical approach, we do recognize that the quality of information is sensitive to asset specificity, bounded rationality, and information impactedness condition. The survey approach indeed helps to capture the special knowledge of water sector experts as derived from their practical experience, understanding, and proximity to various layers of decision-making apparatus. The carefully designed survey instrument minimizes the cognitive and communication limitations imposed by bounded rationality and information impactedness so as to facilitate a more efficient and less biased information transfer. In an important sense, our approach of eliciting perceptional information through the survey instrument is similar in spirit to the contingent valuation approach used for eliciting values in missing market situations (e.g., Contingent Valuation Methods). The theoretical and practical consistency of our approach, carefully designed survey-instrument, and large and diverse sample could ensure that the obtained information is more representative and reliable. This has indeed been testified by the intuitively consistent empirical results.

Pluralistic Methodology

Since institutions are entities operating in the interface between law, policy, and administration, their evaluation requires multi-disciplinary approach involving multiple methodologies. Since our attempt aims at evaluating water institutional structures and their performance impacts from a macro level and a disaggregated perspective, our approach is based on a judicious combination of the relevant elements from various traditions of institutional theory and analysis. Although the methodological framework adopted in our study is similar in spirit to the Institutional Analysis and Development framework of E. Ostrom and her co-workers, it has it its own uniqueness. For, it combines a multi-pronged empirical analysis based on a descriptive cross-country analysis of recent institutional changes, anecdotal and theoretical support for institutional linkages and their performance implications, and a rigorous quantitative analysis of institution-performance interaction based on econometric techniques and perception-based information. While the cross-country analysis is inherently descriptive, it relies on institutional transaction cost approach and political economy perspective for explaining the nature and direction of ongoing institutional changes in global water sector.

While anecdotal evidences for institutional linkages and their performance implications are derived mainly from our cross-country review of global water sector, some theoretical reasoning and intuitive explanations are also given to support the existence and significance of institutional linkages and their performance contributions. The quantitative analysis is based on a unique model of institution-performance interaction that takes a systemic perspective of the interaction process and mimics, in fact, the way this process is perceived in the minds of key players in water sector. While the cross-country analysis highlights the role that factors, both internal and external to water sector, play in motivating water institutional changes, the relative influence of some the exogenous factors are also quantitatively evaluated using both perceptional and observed data. Since this exercise relates perception-based performance variables with observation-based secondary data on some exogenous variables, it also provides useful insights on the influence of exogenous factors on subjective perception of institutional and sectoral performance. Despite the pluralistic nature of our methodology, the central approach underlying the multi-pronged empirical analysis is invariant. Since we evaluate the performance implications of the internal structural features of water institution mainly from a macro perspective, our approach is positive rather than normative.

Modeling Institution-Performance Interaction

The review of existing literature on institutional evaluation shows how different is our attempt in terms of its detailed modeling of the institution-performance interaction within water sector. As noted already, it translates and mimics the mental process of evaluation. Utilizing the decomposition exercise, defining a set of variables to capture the status, nature, or performance of key institutional and performance aspects, and focusing on few critical layers of institutional and performance linkages, we have modeled the process of institution-performance interaction under alternative perspectives. The conventional conception of institution-performance interaction is represented in a single equation that postulates water sector performance as a simple and direct function of various law, policy, and administration-related institutional aspects. In contrast, the more realistic conception of the interaction process is modeled by a system of 10 inter-linked equations to clearly distinguish various layers evident in the process of institution-performance interaction and explicitly recognize the existence of sequential linkages among them. It is by contrasting the empirical performance of these two models that we have provided econometric evidences for the existence and performance significance of institutional linkages. Similarly, it is by evaluating the model with a systemic perspective under different disaggregated contexts that we have provided evidences for the robustness and sensitivity of the institutional aspects, their linkage, and their performance implications.

The methodological superiority and policy relevance of the system approach go far beyond its ability to provide evidence for the existence and performance significance of the institutional linkages. With the quantification of different layers of institutional and performance linkages, the simultaneous equation system provides a framework to systematically isolate and quantitatively trace out the multifarious routes through which the effects of a marginal change in an institutional variable get transmitted and reflected ultimately on water sector performance. These routes or impact transmission channels, in fact, characterize the micro-chains operating beneath the main layers of institution-performance linkages and can be defined by the number and configuration of en route variables that lie between the institutional variable being changed and the ultimate dependent variable in the system. These impact transmission channels associated with all the institutional variables that are amenable for deliberate policy intervention are identified and quantitatively evaluated in terms of their relative length, significance, and performance contributions. The insights from such an evaluation exercise are used both for understanding the inner dynamics of the process of institution-performance interaction as well as for addressing the practical issues of prioritization, sequencing, and packaging as well as scale and timing so critical for designing institutional reform programs.

Although the analytical mismatch between subjective information and objective data prevents us from directly incorporating exogenous effects from economic, social, political, and resource-related factors into our model of institution-performance interaction, the effects of these exogenous factors are still accounted for within our evaluation. While the inclusion of a constant term in all the equations of the system can help to capture the effects of exogenous factors, this technique helps neither in understanding their relative significance nor in distinguishing their influence from those of other excluded institutional variables. As a result, the individual and joint influence of the exogenous factors are evaluated in terms of a separate and independent model that explicitly postulates some key performance as a function of a selected set of exogenous variables. Since the performance variables are perception-based and the exogenous variables are derived from observed data on economic, demographic, institutional, and resource-related aspects, this exercise also helps us in evaluating the interface between the subjective perception of institution-performance interaction and the objective reality of the institutional environment.

IMPLICATIONS FOR THEORY AND POLICY

Since the theoretical significance and policy relevance of our study emerge mainly from the empirical results on institution-performance interaction, this section provides a summary of major results and highlights some of their key implications.

Existence and Performance Significance of Institutional Linkages

Besides the analytical exposition of institutional and performance linkages, our study also provides a strong econometric evidence both for the existence of institutional linkages and for their performance implications. Specifically, the evidence for the existence and performance significance of the institutional linkages are established by contrasting the empirical performance of different models of institution-performance interaction, each differing in term of its assumptions on institutional and performance linkages. As per our empirical results, the system model with the explicit recognition of these linkages has evinced a far better statistical and econometric performance in various estimation contexts. Since such a superior performance means that the model is consistent with the data and remains robust, the institutional and performance linkages incorporated in the model have to be consistent with reality. This is an important result as it opens up an entirely new way of looking at the process of institution-performance interaction and calls for a different approach to initiate and sustain institutional reform both in general and in water sector contexts.

Relative Role and Significance of Institutional Aspects

The empirical results provide us with considerable insights into the relative role and significance of institutional aspects in determining the performance of water institution and water sector. Considering first the institutional aspects that influence the performance of the institutional components, the overall performance of water law depends on the direct effects of three legal aspects: effectiveness of conflict resolution provisions, legal integration, and centralization tendency within water law. It also depends on the indirect effects of one policy aspect (effectiveness of user participation policy) and two administrative aspects (balanced functional specialization and information adequacy). Notably, all these seven aspects have a positive effect on legal performance. The overall performance of water policy depends on the direct effects of four policy aspects: the cost recovery status, effectiveness of water transfer policy, strength of law-policy linkage, and the effectiveness of privatization policy. The positive effect of the first three policy aspects noted above suggests the intuitively consistent result that better cost recovery, effective water transfer policies, and stronger law-policy linkages improve the overall performance of water policy. Water policy performance also depends on the indirect effects of one legal aspect (water rights format), and one policy aspect (effectiveness of user participation policy) and four administrative aspects (technology application, information adequacy, existence of independent water pricing body, and balanced functional specialization). Considering the direction and magnitude of the effects of the four administrative aspects listed above, it is clear that the ultimate performance of water policy depends critically on the effectiveness of the administrative arrangements necessary to translate and implement it in practice.

Notably, the overall performance of water administration depends only on the direct effects of three institutional aspects: balanced functional specialization, technology application, and information adequacy. The positive effects of these three administrative aspects suggest that staffing pattern with a more broad-based functional specialization, application of science & technology in critical areas of planning and management, and stronger water information base can jointly enhance the performance of water administration. This result is very much in conformity with current priority on the technical agenda of many national governments and international funding agencies. It also provides a clear justification for additional investment in these key technical areas indispensable for strengthening the planning and implementation capabilities of water administration. The insignificance of the administrative aspects such as the spatial organization of water administration and effectiveness of administrative provisions for accountability suggests that with a better technology, information, and functional specialization, probably, these administrative aspects may become relatively less important.

From an overall perspective, since the performance of water institution depends essentially on the performance of its administrative and legal components, it depends indirectly on all the institutional aspects that determined the performance of these two institutional components. In particular, the most important and significant institutional aspects determining water institution performance are: effective conflict resolution provisions, legal integration, a healthy dose of centralization trend within water law, user participation policy, balanced functional specialization, adequate information, and technology application. Since the performance of water institution is the main factor affecting the ultimate performance of water sector, all the institutional aspects affecting the former—mentioned above—also determine the latter indirectly. Besides these institutional aspects with indirect effects via water institution performance, water sector performance is also affected by the direct effects of two institutional aspects serving as proxies, i.e., cost recovery status and seriousness of budget constraint. There are also three other aspects that affect water sector performance indirectly through the direct effects of the proxy variables. They are water rights format, effectiveness of user participation policy, and existence of independent water pricing body. Thus, the overall performance of water sector depends on the multifarious effects of four legal aspects, two policy aspects, and five administrative aspects. The institutional aspects identified to have the dominant effect on institutional and sectoral performance are consistent with the attention that they receive in the currently ongoing debate on water sector reform both at the national and global levels.

Robustness and Sensitivity

The behavioral robustness and sensitivity of the institutional aspects are evaluated in terms of the consistency of the sign, size, and significance of their coefficients across three sample sizes, two expert groups (engineers and social scientists), and two country groups (reform countries and others). Of the 25 institutional and performance variables included in our model, only 12 variables are robust. Among the robust variables, four are linkage or endogenous variables and eight are independent or exogenous variables. These linkage variables are: cost recovery status, effectiveness of inter-sectoral water transfers, overall performance of water administration, and overall performance of water institution. The independent variables are: water rights format, legal provisions for privatization, law-policy linkages, user participation policy, existence of independent water pricing body, balanced functional specialization, information adequacy, and technology application. Since the robustness properties of some of these variables are also layer-specific in the sense that they are robust in one equation but not so in other equation(s), the robustness of individual institutional aspects, though necessary, are not sufficient for ensuring the robustness of the institutional and performance linkages.

While the behavioral sensitivity of institutional aspects to sample size variations is certainly not an unexpected result, the comparison does yield few distinct patterns with considerable implications for the relative significance of the institutional linkages and for the overall reliability of our model. Although the absolute size of the coefficients associated with most institutional aspects varies across sample contexts, there is a remarkable consistency in their relative importance and direction of the impact in the case of most equations. This consistency taken along with the robustness properties of institutional aspects indicates that the relative importance of institutional variables in various layers of institutional and performance linkages is largely free from sample size variations. As to the robustness of various layers of institutional and performance linkages, our results show that with the exceptions of three layers of linkages, all the remaining seven layers of linkages are robust with consistent behavior across estimation contexts. The inconsistent behavior of institutional aspects and layers of linkages also provides equally valuable information necessary for tailoring the institutional reform package to address location-specific issues. From perspective of reform design, the robust institutional aspects will form the nucleus around which other context-specific aspects can be built to enhance the effectiveness and flexibility of the reform package.

The distinct pattern in the configuration and performance significance of institutional aspects observed among the two sample size contexts—each covering countries with differential water scarcity and sectoral concerns—sheds light on the effects that the general institutional environment has on the process of institution-performance interaction. For instance, the coefficients associated with most of the institutional aspects are much larger and more significant for the sub-sample covering mainly countries facing severer water scarcity as compared to those for the sub-sample covering other countries where water quality and floods rather than water scarcity are the major problems. Understandably, since this result implies that a stronger perception of institution-performance linkages among experts in countries facing water scarcity as compared to those among other countries, it provide an evidence for the effect of water scarcity on the subjective perception of institutional performance. Still more interesting is the spatial pattern in the relative strength of inter and intra-institutional linkages. For instance, the inter-institutional linkages are relatively stronger than the intra-institutional counterparts in countries facing water scarcity whereas the reverse is true for other countries. But, as we compare these two linkage categories across the two country groups, we find that the inter-institutional linkages (intra-institutional linkages) are stronger (weaker) in water scarce countries as compared to others. The spatial patterns of institutional linkages and performance impact imply that linkages across institutional components are more important for performance than the linkages within institutional component.

Perceptional Convergence

From an overall perspective, the results obtained in the context of the two expert groups (engineers and social scientists) suggest a general consistency in the configuration of institutional aspects identified by both groups. But, the group-specific differences in the ordering of even the commonly agreed institutional aspects suggest that the expert groups differ in terms of their institutional ranking and priority. This means that perceptional convergence on the role of institutional aspects, though necessary, is not sufficient for the same on their relative significance. In general, social scientists place a considerable importance on legal aspects, especially those related to water rights, internally consistent water law, and a legally consistent water policy. But, engineers attach a greater significance on a relatively centralized water law, private sector participation, organizational aspects, and administrative accountability. But, considering the degree of consistency on the role and significance of many key institutional aspects, we can conclude that the disciplinary bias is restricted more to micro details than to macro thrust and focus.

The presence of macro convergence in the face of micro divergence is illustrated still more clearly by the group-specific pattern as to the relative importance of various layers of institution-performance interaction. For instance, while the expert groups agree on the importance of an effective user participation policy, other sectoral policies affecting water policy, and seriousness of budget constraint, they differ just in terms of their perception as to the layers through which their effects are transmitted. Thus, the group-specific differences in the relative importance of transmission channels and in the composition of transmitted effects need not be interpreted as an outcome of disciplinary bias among experts groups but as an outcome of genuine differences in their technical understanding. Notably, these group-specific differences confine mostly to the lower echelons of the layers of institution-performance interaction, as there is an increasing degree of convergence among expert groups as they evaluate higher layers of institution-performance interaction.

Role of Reform Environment

The influence of reform environment on the strength and performance impact of institutional linkages is evaluated by comparing the results obtained in the context of two country groups defined in terms of their recent reform status. As per our stage-based perspective of institutional change, it is an increasing convergence in the perception of the need for institutional change among key players that initiates the process of change. But, the effectiveness and sustainability of the initiated change depends on whether the perceptional convergence is powerful enough to create a pro-reform climate and political realignment, exploit scale economics, and circumvent path dependency constraints. In view of the critical role of other factors, it is clear that perceptional convergence, though necessary, is not be sufficient for initiating institutional change of substantial magnitude. Since it is the presence of the necessary and sufficient conditions that explains the reform initiatives, it is logical to expect the layers of institution-performance linkages observed in reform countries to be stronger than those in other countries. This expectation is indeed supported rather strongly by our empirical results. Not only are the institutional linkages stronger but also their performance impacts are more pronounced in reform countries as compared to other countries.

Despite the differential strength of institution-performance linkages across country groups, there is considerable convergence in the behavior of some institutional aspects. The institutional variables showing consistent behavior across country groups are: effective provisions for conflict resolution and privatization, cost recovery status, effective policies for inter-sectoral water transfer, user participation and private sector involvement, influence of other sectoral policies affecting water policy, existence of independent water pricing body, organizational basis of water administration, balanced functional specialization, seriousness of budget constraint, adequate information, and technology application. While countries lacking recent reforms also underline the same set of institutional aspects, the implied consensus could not result in actual reforms essentially due to the countervailing influence of resource and political economy-related factors. Most of the countries lacking recent reforms are resource-wise well-placed (e.g., those in South East Asia). Others (e.g., France, Germany, and United Kingdom), though do not have quantity-related scarcity issues, have undertaken significant reforms in the past to address water quality and inter-sectoral allocation issues. But, there are still others (e.g., those in North and East Africa) where the absence of reforms is related more to political economy constraints than to the lack of consensus for change. The message is clear that the general consensus as to the need, nature, and thrust of institutional change, though necessary, cannot be effective enough to initiate and sustain reforms without strong socio-economic and political pressures.

Interestingly, the convergence as to the role of institutional aspects also coexists with notable divergence as to their relative significance. For instance, in the context of reform countries, there is a greater emphasis on cost recovery, conflict resolution, organizational structures, administrative accountability, user involvement, and private sector participation. Although the reform process in most of these countries tends towards decentralization and market orientation, there is an overall thrust on a centralized system of water law as decentralization cannot succeed without a dose of centralization. In contrast, in the case of countries lacking recent reforms, the emphasis is more on the integrated approach to water resources, legal aspects of accountability, aligning water policy closely with water law, and policy aspects related to inter-sectoral and regional water transfers. This difference in the configurations of institutional aspects observed in the two country groups is, in a sense, indicative of them being in different stage of the reform process. A closer look at the institutional aspects getting attention in the two country groups shows that the reform countries are dealing with higher level institutional aspects having more immediate performance implications whereas other countries are still focusing on preliminary institutional issues with no or less direct performance significance. It is this fact that explains why institution-performance linkages are stronger in reform countries than in other countries.

As expected, the spatial differences in the nature and strength of institution-performance linkages are the direct outcome of country group-specific variations in the configurations of institutional aspects that define various layers of institution-performance. From an overall perspective, however, these distinct patterns are relatively more pronounced in the context inter-institutional linkages than in the context of intra-institutional linkages. This fact reinforces our earlier observation that the expert and country group-specific differences confine mostly to the lower echelons of institution-performance linkages and tend to diminish as we move up to higher levels of linkages. The region-specific differences in institutional configurations and their implications for institution-performance linkages also suggest some interesting aspects related to both the motivation and thrust of perceived institutional change. As per a more generic interpretation of our results, the financial deterioration within water sector caused by poor cost recovery and represented by the seriousness of budget constraint has been a major factor motivating institutional change in many reform countries. Since the financial performance of water sector is also affected by other sectoral policies, especially the macro economic policies and those related to agriculture, the critical role of the effects of these policies cannot be underestimated as well.

Exogenous Influence on Perceptional Evaluation

The significant positive effect that the constant term has in most contexts suggests clearly the synergy that the institution-performance interaction can derive from the general socio-economic, political, legal, and resource-related environment. In view of this synergy emanating from the general institutional environment, a given level of reform effort or institutional change is likely to lead to a faster and more than proportionate change in water sector performance. Although this is an encouraging sign, for exploiting such synergy in actual reform context, it is necessary to understand the relative role of individual components of the institutional environment. For this purpose, we have estimated few key performance variables derived from perceptional information as a function of some of the exogenous variables derived from observed data on economic, demographic, institutional, and resource-related aspects. Despite its simplicity and crude nature, this estimation exercise did allow us to understand the relative significance and configurations of exogenous factors affecting the performance of water institution, water sector, and their components. Interestingly, since the performance variables are perceptional and the exogenous variables are observed, this exercise also allowed us to derive some useful insights into the nature and pattern of exogenous influence on the subjective evaluation of institution-performance interaction.

Generally, factors associated with economic development, regulatory institutions, and education have a positive influence as they generate some autonomous changes in the institutional sphere to which water institution is not an exception. In view of the phenomenon of institutional creation and thickening usually associated with process of economic development, institutional linkages tend to be strengthened contributing, thereby, to improved institutional performance. This indeed supports the well-known fact that institutional performance benefits from autonomous changes in the overall institutional environment as induced by various factors associated with economic development. Demographic changes, resource scarcity, and increasing socio-economic inequity also tend to have a similar effect as they enhance the economic value of effective institutional arrangements in all sectors including water sector. From this perspective, therefore, the evaluation of institution-performance interaction—both in general and in water sector contexts—cannot be free from the overall socio-economic, demographic, institutional, and resource-related environment. In fact, as implied in our evaluation of the relative impact of the exogenous factors, the subjective process of institution-performance evaluation should have captured most part of the exogenous influence from the general environment.

Convergence and Stability of Results

Although the process of institution-performance interaction is evaluated only indirectly in terms of the subjective perception of such interaction, the analysis of our results across sample contexts does allow us to infer the convergence and stability properties of the results. First, in comparison to results obtained in various sub-sample contexts, the all-sample results show the same or more institutional variables to be significant in the case of almost all equations. This means that the institutional and performance linkages tend to become stronger with the enlargement of sample size, expertise mix, and country coverage. Second, the all-sample results tend to balance the differences or extremities in the behavior of institutional aspects observed in sub-sample contexts. While sub-sample results are indeed valuable to identify useful caveats and understand, thereby, the role of context-specific factors, the all-sample context with its normalizing property help to identify generic features both in institutional configuration and institution-performance linkages.

Although the influence of disciplinary bias and ideological aspects is strong at the individual layers of institutional and performance linkages, it tends to become weak from an overall or macro perspective of the process of institution-performance interaction. The effects of the group and area-specific bias at the micro levels as well as its remaining vestiges at the macro level are reduced considerably as we increase the number of experts and countries and the evaluation is performed from a general rather than from a group-specific perspective. This clearly implies that the results from the all-sample context are, to a greater extent, free from bias and provide a more reliable picture on the nature and strength of institution-performance linkages. The all-sample results have removed the extremities observed in group-specific results and provided a more balanced and generalizable evaluation of institution-performance interaction. It is rather clear that with an enlarged and diverse sample; the scope for convergence and consensus as to perception of institution-performance linkages will increase as does the overall reliability and credibility of the results.

IMPLICATIONS FOR INSTITUTIONAL DESIGN

As we compare the independent institutional variables and their impact transmission channels in terms of their relative importance and significance in different estimation contexts, we gain considerable insight into institutional design issues, especially for institutional prioritization, sequencing, and packaging. In order to appreciate well the implications of this comparative analysis, it is useful to recognize the fact that underpins our evaluation method and empirical approach. That is, the relative size and significance of the coefficients associated with various variables and hence, the relative share and significance of different channels, are viewed as a quantitative representation of the overall consensus among the opinion-makers in global water sector. Since such consensus is not only on the perception of reality at present but also on the expectation of future change, the results can be interpreted as a representation of both what has happened as well as what would happen in the realm of institution-performance interaction. Thus, the relative shares of the channels and exogenous variables in total impact can be viewed as a consensual estimation of both their actual as well as expected contributions. With this perspective, we can now identify some of the most important implications of our results for institutional prioritization, sequencing, and packaging as well as timing and scale aspects in reform programs.

Linkage Length and Impact Transmission

The negative but insignificant correlation observed between linkage length evaluated in term of the number of en route variables and the magnitude of impact being transmitted by various channels suggests that although channels with more en route variables have a lower value, this need not necessarily be true always. However, in absolute terms, since reform regions have a relatively larger correlation coefficient than other regions, the impact transmission by longer chains is lower than that by smaller chains. As the lower impact transmission by longer chains means weaker linkages among the en route variables, this results suggests that that the reform process, by and large, is notable more for its direct effect than for its indirect effect through institutional linkages. If this is the case, then, the performance gains realized in the reform countries cannot be sustained unless the reform is taken to the next stage where the focus shifts more towards institutional strengthening by concentrating on longer chains essential for institutional thickening and inter-linkages.

Larger chains, though good for institutional strengthening and institutional thickening, may not lead to any immediate impact on water sector performance in view of two factors. First, in the case of channels involving longer institutional chain, the initial effect of a change in institutional aspects may be moderated or even distorted by the weakness or inefficiency of the en route variables. Second, there is also an implicit role of time as some or all of the en route variables may need differential time frames for capturing and transmitting the effects of an initial institutional change. This suggests the critical role of the time-related dynamics of both institutional change and its performance impact. Since it is not enough to make changes just in one institutional aspects but also in others with critical institutional and performance linkages, it is necessary to prioritize the institutional chains and the underlying institutional aspects in terms of the magnitude, significance, and gestation period of their impact. Since the channels involving lower and slower performance impact are also essential for sustaining the operational capacity of water institutions, there has to be a proper packaging of institutional variables covering those with a larger and most immediate performance impact as well as those with lower and slower performance impact. While the former has the tactical role of keeping the economic and political pressure by bringing immediate performance returns, the latter is critical for ensuring the long-term sustainability of institutional reform through a gradual but concerted effort in strengthening institutional linkages.

Institutional Prioritization, Sequencing, and Packaging

The number, sequence, and configuration of variables in the linkage chains underlying the channels with larger and significant impact provide very valuable information for designing the reform package complete with institutional priority, sequencing, and packaging. While the inference on institutional priority is based on the relative size and significance of the impact transmission channels, the same on sequencing is based on the order and configuration of the variables in their underlying linkage chains. The prioritization of institutional variables is rather straightforward as it is based on the intensity of institutional linkages as reflected by the number of their impact transmission channels as well as on the relative magnitude and share of their performance impact. Our results are unequivocal for giving top priority to administrative aspects as they account for 61 percent of the total impact calculated from all coefficients and 52 percent of the same calculated with only significant coefficients. Their key role in overall institutional and sectoral performance is understandable in view of their importance not just for the performance of water administration but equally also for the performance of both water law and policy. Since performance improvement is predicated more on implementation-related institutional aspects rather than on mere legal prescription or policy statements, there is a dichotomy of a poor law-policy regime with better implementation and a better law-policy regime with poor implementation.

Specifically, the priority should be given to the application of science & technology, building of a strong information base, creation of independent body for water pricing, broadening the functional specialization within water administration, and the formulation of an effective user participation policy. There is also an issue of sequencing not only among these aspects themselves but also between these and other institutional aspects. Particularly, science technology application is a critical first step for building an information base and the latter can enhance the effectiveness of water pricing. Similarly, an efficiently functioning network of WUAs at various levels is a precondition for an effective property rights arrangement and both of which taken together set the necessary institutional framework for promoting many institutional aspects such as cost recovery, accountability, conflict resolution, and water transfers. Notably, institutional aspects such as balanced functional specialization, user participation policy, and property rights format need also priority as some of their channels, though not significant, have a larger performance impact. Since the insignificant channels are an indication of weak or dormant linkages among the variables in the linkage chains, they can be strengthened only by adopting a package approach suitable for simultaneous reform in several related institutional and performance variables.

Strengthening Impact Transmission Channels

Efforts to strengthen the impact transmission channels are crucial for both enhancing the performance contributions of significant channels as well as making some of the insignificant channels into significant ones. Our empirical results enable us to establish priority among channels only in terms of their relative share and significance of impact. But, there are also other considerations—especially related to the relative significance of their long-term impact on institutional strengthening and performance improvement—which are beyond our present model of institution-performance interaction. Nevertheless, they can be addressed on a case-by-case basis giving due weight to factors such as local conditions, reform stage, and the expectation of reformers. For countries in reform threshold, strategic considerations require priority for channels involving direct effects as they can yield relatively quicker performance returns needed for countering political resistance and consolidating performance gains. In contrast, for countries in an advanced stage of reform, sustainability considerations require priority for channels conveying indirect effects through lengthy linkage chains as they can deepen the process of institutional thickening so crucial for ensuring the resilience and sustainability of the reform process. Similarly, the institutional and performance variables figuring in the linkage chains of more channels need priority over others for the reason that any reform effort involving them will strengthen all the channels in which they appear.

We also notice that in many cases, the channels that are significant also have the largest share whereas those with lower and marginal share are mostly insignificant. Such a direct association between the size and significance of the impact being transmitted by the channels has important implications. Since experts and policy-makers tend to attach a premium to the channels as well as their associated institutional variables with a larger institutional and sectoral performance impact, these channels are likely to be significant and remain on the top of priority hierarchy. Thus, when institutional reform improves the performance contribution of one or more institutional/performance variables, their larger performance impact itself ensures the significance of the channels in which they operate. By targeting the institutional and performance variables underlying both the significant channels with lower values as well as their insignificant counterparts with higher values, it is possible to alter their relative importance and significance. This fact also suggests, though in an implicit manner, how institutional reform can alter both performance and perception.

Thrust and Scale in Institutional Reform

Although the components and priorities of reforms are more or less the same across country groups, there are considerable differences in the thrust and scale as well as in the effectiveness of the initiated reforms. Since the reform countries have already undertaken significant reforms in various components of water institution, further institutional reforms involving both substantial and marginal changes are likely to be more effective and less costly in view of the upstream and downstream linkages created by the already undertaken reforms. As a result, the impact of the reforms on the institutional and sectoral performance is likely to be relatively faster and more effective in the reform countries than in other countries. From the perspective of institutional hierarchy, since information application mostly succeeds the application of science & technology, the dominant role of information adequacy in reform countries suggests that these countries should have already made substantial progress in technology application within their water administration. Despite a marginal variation in the number of significant channels among the country groups, the overall share of significant channels in total impact is far higher in reform countries (73 percent) than in other countries (56 percent). This result implies the following four important but interrelated aspects.

First, the larger performance impact in reform countries is due more to the larger contributions of institutional variables through their direct impact transmission channels than their indirect impact through institutional strengthening. Second, in reform countries, unlike others, most of the channels with a larger share of total impact are significant. Such a higher share of significant channels in total impact suggests that the institutional linkages are stronger in the reform countries. But, as we have noted already, the strength is more visible in the case of intra-institutional linkages than in the case of inter-institutional linkages. Third, although the insignificant channels are large in number, they only have a smaller share of the total impact even in reform countries. Since this means that most part of the total impact comes only from fewer channels, the extent of institutional linkages contributed by recent reforms appears to be low either due to a slower development of these linkages or due to a limited institutional coverage of the reforms. In order to enhance and sustain their institutional and sectoral performance, the future reform programs in reform countries have to concentrate both on the already significant as well as on the currently insignificant channels. And, finally, it is more likely that in some of the reform countries with a mature water sector, additional performance benefits can be obtained only with substantial and higher dose of reform effort. Fortunately, this is not the case with countries lacking recent reforms and those in the reform threshold. The intuition here is that there is an increasing performance return in the initial stages of reform whereas the reverse is true in the later stages of reform.

The larger impact being conveyed by the significant channels also suggests the issue of scale and dose in reform effort. That is, since the variables associated with these channels produce a larger impact, both institutional and sectoral performance can be enhanced by a larger dose of reform effort in the context of these variables. The scale of effort also has a time dimension as the additional reform effort can be undertaken either simultaneously or sequentially with appropriate time gap. But, the issue of when to take the additional reform effort depends on whether the performance impact associated with an exogenous variable is immediate or delayed. Since the speed of impact transmission depends on the nature and configuration of variables in the linkage chains, the final answer to the issue of scale and timing requires the evaluation of all channels specifically considering their immediate and long-term implications for institutional strengthening and performance improvement.

Since our model assumes linear effect for all variables, the information on the scale aspects has to be derived only outside of our model context. Usually, the nature of the effects associated with each of the key institutional aspect can be understood based on careful thinking and detailed observations in a given context. For instance, the performance impact of an additional unit of reform effort in user participation policy can be evaluated for a given region based on detailed review of its institutional linkages, the extent of reforms in related areas, and observations on current and past performance of this policy. Although the linear specification of our model does not allow us to have any direct information on scale aspects, it does provide some idea on scale aspects involved in impact transmission. The scale in impact transmission can be addressed in terms of the size of the coefficients associated with the en route variables. Thus, when all the coefficients of the en route variables have a value of less (more) than one, it obviously means that the effects of the exogenous variables will be transmitted less (more) than proportionately. However, the en route variables in many contexts are likely to have mixed values for their coefficients, i.e., some with fractional values and others with values greater than one. The ultimate scale of impact transmission will, therefore, depend upon the size configuration of the coefficients of the en route variables. Since the issue of scale in the impact transmission process is as important, if not more, as the same in institutional change, it is indispensable to strengthen the impact transmission channels both for making the underlying coefficients larger and more significant.

Time Dimension in Institutional Reform

Although the issue of timing cannot be explicitly addressed within the framework of our model where the time dimension is not explicitly incorporated, our results certainly provide some basis for deriving useful inferences and hypotheses on this count. From a design perspective of institutional reform, the relative performance impact of institutional variables and their channels suggests that there is a clear choice among variables with fewer channels but larger impact and those with larger channels and smaller impact. Unfortunately, the choice is not as easy as it seems because of the intervening role of institutional amenability, political feasibility, and the time gap between institutional strengthening and impact transmission. It is natural for the choice to tilt towards variables such as internal consistency and centralization tendency within water law in view of their stronger and more significant performance impact as well as their amenability for reform with lesser political resistance. Although the legal reforms needed for promoting internal consistency and privatization may be politically easier and quicker, nevertheless, they take time to mature and yield performance impact of perceptible magnitude.

In contrast, although there will be a considerable delay in undertaking property rights reform due to political difficulties, once such reforms are undertaken, their performance impact will be relatively faster. Besides, with the property rights reforms in place, institutional reforms in related spheres can become easier. Such a facilitative role for downstream reforms is very critical for reducing the total transaction cost of the overall reform program. More importantly, since property rights reforms have intricate linkages with use efficiency, accountability, conflict resolution, cost recovery, and water transfers, they are likely to contribute as much to the process of long-term institutional thickening as to immediate performance improvement. Such a process is indispensable for paving the foundation for institutional sustainability and long-term performance improvement. It is these considerations that tend to assign greater priority to variables with stronger institutional and performance linkages such as water rights notwithstanding their lower immediate performance contributions. But, the choice among institutional aspects with quicker reform prospect but delayed impact and those with difficult reforms but faster impact is still a difficult one. While there are tradeoffs between immediate performance benefits and long-term institutional and performance gains, they can be resolved through appropriate institutional prioritization, sequencing, and packaging.

IMPLICATIONS FOR REFORM PROSPECT

In addition to the implications noted for theory, policy, and institutional design, there are also some significant observations that emerge both from our theoretical review and empirical analysis. These observations relate to some of the positive aspects that enhance the prospect for institutional reform both at the national and global levels.

Global Consensus on Reform Thrust

The cross-country review of water sector and water institution goes far beyond simple documentation and comparative analysis. Although both the nature and direction of the institutional changes observed among countries vary by country-specific economic, political, and resource realities, there are clearly identifiable common trends and patterns. These include the increasing importance attached to market-based allocation, decentralization and privatization, integrated water resource management, and economic viability and physical sustainability. As the physical, financial, and ecological constraints tend to limit the relevance of supply-side solutions, countries are now trying their best, within their political economy constraints, to set right the institutional foundation necessary for promoting demand-side solutions. These commonalities vouch to the fact that despite differences as to detail and format, there exists a considerable global consensus as to the major thrust and focus of institutional reform within water sector. Our empirical results as to the relative priority, packaging, and sequencing provide, in fact, some quantitative dimensions to the international consensus on reform thrust and focus. Although location-specific adjustments are also essential, it is possible to have a common agenda for institutional reform applicable to most contexts.

Role of Institutional Transaction Cost

Our cross-country review also suggests that the conditions are ripe for water institutional reform in many countries. The mere occurrence of institutional changes in most countries can be taken, in fact, as an observational evidence for the fact that the opportunity costs of institutional change are increasing to surpass the corresponding transaction costs. But, the fact that institutional changes are uniform neither across institutional components nor across water sub-sectors suggests that both the opportunity and transaction costs vary considerably by context. The review suggests that institutional changes within water sector occur due to the role of both endogenous factors (e.g., water scarcity, performance deterioration, and financial non-viability) as well as exogenous factors (e.g., macro economic crisis, political reform, natural calamities, and technological progress). These factors act together to raise the opportunity costs of institutional change, reduce the corresponding transaction costs, and create a pro-reform climate. From a policy perspective, the synergy among these factors can be exploited well with a proper timing and sequencing where water sub-sectors and institutional components are prioritized in terms of their relative performance impact, fiscal significance, facilitative roles for downstream reforms, and political acceptability.

Institutional Pluralism

In the past, institutional change was often marred by ideological attachment to some institutional forms. Today, there is a considerable consensus as to the need for pluralistic institutional arrangements. In agreement with such consensus and consistent with the dominant view in institutional economics literature, our study also favors institutional pluralism as the foundation of any institutional policy or reform program. Since the society needs a variety of inter-linked institutions to govern different spheres of human interaction, markets alone cannot be considered as the ideal or universal institutional arrangement. Neither the markets can perform without them being embedded in a nexus of rules, obligations, and public interventions nor the state can be effective without the reliance on market and delegation of some of its functions to private groups. We agree that the pervasive and unrealistic dichotomy between state and market has to be discarded and a broader array of institutional arrangements that mix them in varying degrees is to be considered.

While it is certainly desirable that institutional change strengthens the process of voluntary exchanges and interactions, it is not necessary for the market process itself to shape the direction of institutional change. For, institutional selection through market mechanism can be myopic and inefficient and lead to deadlocks. Although there are institutions that are amenable for market selection or transaction cost criterion, there are many others that can be explained mainly by social and political factors. While institutions evolve naturally through time and responds to economic, social, and political forces, purposive changes are also necessary not only to expedite the process and shape the direction of institutional change but also create imaginative collective forms of coordination mechanisms. The significance of institutional pluralism as a guiding principle of institutional reform program is also consistent with our positive approach to institution and institutional change.

Political Economy Opportunities

While political economy constraints are often overestimated, there is a general underestimation of equally powerful political economy opportunities. There is an exaggeration of the negative roles of interest groups and a corresponding underestimation of the power of normalizing aspects such as the constitution and collective efforts to avert the socially harmful economic decline. Apart from factors such as altruism and ideology, there are also mechanisms such as the constitution, congress or parliament, multi-party system, and bureaucracy that broaden the time horizon of policy-makers and reduce the negative effects of power and self-interest in institutional change. It is true that the natural process of institutional evolution is often obstructed by the role of factors such as rent-seeking, path dependency, ideology, and political risk, there are also a number of factors that tend to enhance reform prospect in a variety of situations.

From the particular perspective of water sector, with increasing water scarcity and emerging financial and performance crises, the rent derived from subsidized water supply is being threatened. The widespread and dominant trend towards political liberalization and democratization and the emergence of middle class as an outcome of economic development and education have also reduced the political dominance of few groups and improved the political balance necessary for group-neutral reforms. There is also a positive influence from progress in water and information technologies as well as the pressures from donor agencies and international commitments of countries. With the emergence and political influence of pro-reform constituencies, there is now a political urge for institutional reform. Our cross-country review of recent institutional reforms has clearly demonstrated the presence of significant political economy opportunities and many countries have indeed utilized them to their advantage either through proactive policies or by compulsions. For instance, macro economic reforms (e.g., China, India, and Mexico) and water-related natural disasters such as droughts (e.g., California), floods (e.g., China), and soil salinity (e.g., Australia and Pakistan) have magnified the fiscal and social implications of the opportunity costs of institutional change. In contrast, the socio-political reform attempts (e.g., in Chile during the 1970s, Spain during the 1980s, China since the 1980s, and South Africa since the 1990s) reduce transaction costs directly as the institutional changes in water sector form only part of a system-wide reform.

Supply Side of Institutional Change

The supply side of institutional change that used to be one of the most ignored dimensions of institutional economics is getting increasing attention in view of its role in minimizing the transaction cost of institutional reforms. From the demand-supply perspective of institutional change, the state can play a central role both as the supplier of institutional change and as a promoter of other supply sources such as research and information systems. Equally crucial is also the role of international donor and technical agencies. In fact, scale economic considerations make both the state and these agencies to be relatively more efficient in lowering the overall transaction costs of institutional services. Although path dependence limits the choice only to the already known institutions, the transaction costs can still be minimized to a substantial degree by the way the institutional options are designed, structured, timed, sequenced, and packaged. Similarly, timing can better exploit the pro-reform climate fostered by a crisis situation. Thus, design issues such as prioritization, sequencing, and packaging are all part of the supply-side of institutional change. Institutional design aspects minimize transaction costs both directly as well as indirectly in view of its role in the formation of pro-reform political coalitions. Since the supply of institutional innovation also depends, *inter alia*, on advances in the knowledge of the process of institutional change itself, policy research of the present type can also reduce transaction cost and augment institutional supply. With an increasing integration of world economic system under the ongoing process of globalization, documentation and dissemination of cross-country experience in the realm of water sector reforms can also minimize the costs and risks involved in experimenting with new institutions.

Sequential Reform Strategy

While the positive aspects noted so far are mostly exogenous to the policy apparatus, the sequential reform strategy outlined in this study is essentially endogenous as the policymakers can use it to enhance reform prospect from within. Although institutional reforms within water sector are urgent, they need not be undertaken at one go. They can be spaced within a well-planned time frame. The cost of transacting institutional reform in a given political economy context can be minimized and the usual inertia associated with the stupendous nature of the reform task can be overcome through a gradual but sequential reform strategy. Since such a strategy continuously builds on the synergy generated by the already undertaken reforms in key areas, subsequent reforms become easier to transact both politically and institutionally. This means that there is an intricate and functional linkage between the transaction costs of subsequent reforms and the opportunity costs of earlier reforms. Although these linkages appear to be highly abstract and theoretical, their practical influence within the political economy of reform process can neither be ignored nor be underestimated.

Since the institutional synergy reduces the transaction costs of subsequent reforms and the immediate performance impacts of initial reforms ensure a steady flow of economic benefits, the sequential strategy enhances the prospects for institutional change by gradually weakening political resistance even while precipitating an endogenous pressure for further reforms. Apart from its virtues from a political economy perspective, the sequential strategy is also more suitable for international lending agencies committed to promote institutional change within water sector. Since this strategy provides a natural framework for temporally and operationally linked long-term lending programs in the institutional sphere of water sector, it is mutually advantageous for both the borrowing countries and the lending agencies. While the countries have an inherent incentive to adhere to the reform schedule in view of the performance-based and sequentially linked funding commitments, the lending agencies can ensure more effective monitoring of the reform progress as well as better planning of their long-term investment portfolio.

LIMITATIONS AND CAVEATS

Despite its important theoretical and policy contributions, our study is not free from limitations and caveats. The macro and formal perspective of both water institution and water sector taken in this study obviously involves a sacrifice of micro details including informal institutions that play an important role in grassroots level decisions water use and management. But, the focus on macro and formal institutions is not only an analytical necessity for a focussed analysis but also a practical requirement as micro and informal institutions lack international comparability and remain largely outside the ambit of purposive policy changes. While a still finer decomposition of institutional and performance aspects is certainly possible and desirable, the focus has been mainly on some of the major and policy-wise important institutional and performance aspects. Likewise, the model of institution-performance interaction does not exhaust all the intricate linkages that exist among institutional aspects, but concentrate only on some of the key layers of institutional and performance linkages evident in the process of institution-performance interaction.

Although the model equations can be estimated with a variety of functional forms involving quadratic and logarithmic transformation, we rely only on simple linear form for estimating all equations for to make the analysis simple and transparent. Similarly, our inability to explicitly incorporate the effects of exogenous factors such as historical forces, political arrangements, demographic condition, resource endowment, and economic development within the model of institution-performance interaction is also understandable in view of data limitations including the analytical mismatch between subjective information and objective data. Although our analysis provides some indirect inferences as to the role few time-related aspects, analytical issues and data limitations have made it difficult to explicitly incorporate time in all its dimensions. While it is possible to specify a generic institutional reform program—complete with prioritization, packaging, and sequencing—from our empirical analysis, we have deliberately refrained from such an attempt as we consider this study more as a framework for a solution rather than the solution itself. This is partly to avoid cliché and stereotype approach and partly to recognize location-specific aspects in reform design and implementation.

Despite its limitations and constraints, the study has succeeded in addressing its two-fold objectives. The cross-country comparative review of water institutional changes attempted within an institutional transaction cost framework indicates how factors—both endogenous and exogenous to water sector—guide countries through various stages of the process of institutional changes. The empirical evaluation not only demonstrates the inner dynamics of the process of institution-performance but also shows how insights of such process can be used for determining institutional prioritization, sequencing, and packaging within an institutional reform program. More importantly, it has also opened up an entirely new way of looking at institutional change that can facilitate a better understanding of the constraints and opportunities that are internal to institutional structure itself. Extension of the present study is also possible in many directions. With estimated model, it is possible to experiment with alternative institutional combinations (packages) and their institutional and performance impact. The large amount of perception-based data on many of the country-specific institutional aspects also opens up another interesting avenue to develop an international index for capturing the relative health of water institutions across countries.

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REFERENCES

Abdulrazzak, M. J., 1995, "Water Supplies Versus Demand in Countries of Arabian Peninsula", *Journal of Water Resources Planning and Management*, 121(3): 227-234.

Acheson, James M., 1994a, *Anthropology and Institutional Economics*, Monographs in Economic Anthropology, No.12, New York: University Press of America.

Acheson, James M., 1994b, "Welcome to Nobel Country: A Review of Institutional Economics" in *Anthropology and Institutional Economics,* New York: University Press of America, pp. 3-42.

Adam, Ahmed M., 1997, "Sudan" in Dinar, Ariel and Ashok Subramanian, ed.

Adelman, Irma, and T.F. Head, 1983, *Promising Developments for Conceptualizing and Modeling Institutional Change*, Working paper No: 259, Gianni Foundation, University of Berkeley, Berkeley.

Adelman, Irma, and Cynthia Taft Morris, 1967, *Society, Politics, and Economic Development: A Quantitative Approach*, Baltimore: Johns Hopkins Press.

Adelman, Irma, and Cynthia Taft Morris, 1974, "Growth, Income Distribution, and Equity- Oriented Development Strategies", *World Development*, 4(1): 67-76.

Adelman, Irma, and Jan-Berndt Lohmoller, 1994, "Institutions and Development in The Nineteenth Century: A Latent Variable Regression Model", *Structural Change and Economic Dynamics*, 5(2): 329-359.

Adelman, Irma, Cynthia Taft Morris, Habib Fetini and Elise Golan-Hardy, 1992, "Institutional Change, Economic Development, and the Environment", *Ambio,* 21(1): 106-110.

Aekaraj, Sukontha and Saravuth Chevapraset, 1999, "Protection and Rehabilitation of the Chao Phraya River in Thailand: National Policy and Strategies" in United Nations, 1999b, pp. 99-105.

Agence Loire-Bretange, 1998, "Financial Assistance and Charges: 30 Years of Experience of the Loire-Brittany River Basin Bodies" Fax sent by Agence Loire-Bretange.

Alam, A. F. M. Nural, 1997, "Sustainable Development of Water Resources in Bangladesh" in United Nations.

Alchian, Armen A., 1950, "Uncertainty, Evolution, and Economic Theory", *Journal of Political Economy,* 58(2): 211-221.

Alesina, Alberto, 1994, "Political Models of Macroeconomic Policy and Fiscal Reforms" in Stephan Haggard and Steven B. Webb, eds., pp. 37-57.

Alston, Lee J. and Joseph P. Ferrie, 1996, " The Economics and Politics of Institutional Change: Paternalism in Agricultural Labor Contracts in the U.S. South: Implications for the Growth of the Welfare State", in *Empirical Studies in Institutional Change,* Lee J. Alston, Thrainn Eggertsson, Douglass C. North, eds., pp.307-341.

Alston, Lee J., 1996, "Empirical Work in Institutional Economics: An Overview" in *Empirical Studies in Institutional Change*, Lee J. Alston, Thrainn Eggertsson, Douglass C. North, eds., pp. 25-30.

Alston, Lee J., Thrainn Eggertsson, Douglass C. North, 1996b, "Introduction" in *Empirical Studies in Institutional Change*, Lee J. Alston, Thrainn Eggertsson, Douglass C. North, eds., pp.1-5.

Alston, Lee J., Thrainn Eggertsson, Douglass C. North, eds., 1996a, *Empirical Studies in Institutional Change,* Cambridge: Cambridge University Press.

Alzira Santos, Maria and Rui Rodrigues, 1998, "Water Resources Information Policy" in Corrreia, Francisco Nunes, ed., 1998b, pp. 39-72.

Amer, Mohamed Hassan, 2000, "Country Position Paper: Egypt" in ICID, 2000a, pp. 96-111.

Archibald, Sandra O, and Mary E. Renwick, 1998, "Expected Transaction Costs and Incentives for Water Market Development" in K. William Easter, Ariel Dinar, and Mark Rosegrant.

Arlosoroff, Saul, 1997a, "Israel: A Case Study of Water Resources Management", *EAWAG News*, 43E, December.

Arlosoroff, Saul, 1997b, "The Public Commission on the Water Sector Reform (The General Ideas Underlying Its Recommendations)", *International Water and Irrigation Review*, 1-9.

Armitage, R. M., 1999, "An Economic Analysis of Surface Irrigation Water Rights Transfers in Selected Areas of South Africa", WRC Report No. 870/1/99, Pretoria: Water Research Commission.

Armitage, R. M., W. L. Nieuwoudt, and GB Backeberg, 1999, "Establishing Tradable Water Rights: Case Studies of Two Irrigation Districts in South Africa", Water SA, 25(3):301-310.

Arriens, Wouter Linklaen, Jeremy Bird, Jeremey Berfoff, and Paul Moseley, eds., 1996, *Towards Effective Water Policy in the Asian and Pacific Region,* Vol. 2, Country Papers, Asian Development Bank, Manila

Artana, Daniel, Fernando Navajas, and Santiago Orbiztondo, 1999, "Governance and Regulation: A Tale of Two Concessions in Argentina" in William Savedoff and Pablo Spiller, eds., pp. 197-248.

Asian Development Bank and USAID, 1994, *Comprehensive Water Resources Management in Sri Lanka*, Vol. 2 (Annexes), Technical Assistance Project TA1918-SRI, Asian Development Bank, Manila.

Axelrod, R., 1984, "*The Evolution of Cooperation*, New York: Basic Books.

Azevedo, Luiz Gabriel, and Larry D. Simpson, 1995, *Brazil: Management of Water Resources*, Economic Notes No. 4, Country Department I: Latin American Region, the World Bank, Washington, DC.

Azevedo, Luiz Gabriel, and Musa Asad, 2000, "The Political Process Behind the Implmentation of Bulk Water Pricing in Brazil" in Ariel Dinar ed.

Baltazar, Menlchor, O., 1999, "Protection and Rehabilitation of the Pasig River in the Philippines" in United Nations, 1999b, pp. 73-92.

Bangladesh National Committee of Irrigation and Drainage, (BNCID), 2000, "Country Position Paper: Bangladesh", in ICID, 2000a, 9-19.

Bangladesh Water Development Board, 2000, *Gorai River Restoration Project*, Draft Feasibility Report, Vol. I (Main Report), Bangladesh Water Development Board, Ministry of Water Resources, Government of Bangladesh, Dhaka.

Barraque, Bernard, 1998, "Water Rights and Administration in Europe" in Francisco Nunes Corrreia, ed., 1998b, pp. 353-386.

Barraque, Bernard, Jean-Marc Berland, and Edith Floret-Miguet, 1998b, "Selected emerging Issues In Water Quality Control Policies" in Francisco Nunes Corrreia, ed., 1998b, pp. 73-102.

Barraque, Bernard, Jean-Marc Berland, and Sophi Cambon, 1998a, "France" in Francisco Nunes Corrreia, ed., 1998a, pp. 85-182.

Barrett, Scott, and Kathryn Graddy, 2000, "Freedom, Growth, and the Environment", *Environment and Development Economics*, 5: 433-456.

Barzel, Y. 1989, *Economic Analysis of Property Rights*, Oxford: Cambridge University Press.

Bates, R.H., 1989 Beyond the Miracle of the Market: *The Political Economy of Agrarian Development in Kenya*, Oxford: Cambridge University Press.

Bates, Robert H., 1996, "*Institutions as Investments*", Development Discussion Paper No. 527, Harvard University, Massachusetts.

Bates, Robert H., and Anne O. Krueger, eds., 1993, *Political and Economic Interactions in Economic Policy Reform,* Oxford: Blackwell.

Beaumont, Peter, 1994, "The Myth of Water Wars and the Future of Irrigated Agriculture in the Middle East", *International Journal of Water Resources Development*, 10(1): 9-21.

Berbeka, Krzysztof, 2000, *Liberalisation of the Water Economy in Poland,* Draft Report, Cracow Academy of Economics, Cracow.

Berkoff, D.J.W., 1997, *Water Policy: Functional Analysis*, Institutional Strengthening for Comprehensive Water Resources Management, WRC/WRS, Colombo.

Betlem, Ilja, 1998a, "Relationship between Water Policy and Environmental Policy" in Francisco Nunes Corrreia, ed., 1998b, pp. 143-180.

Betlem, Ilja, 1998b, "River Basin Planning and Management" in Francisco Nunes Corrreia, ed., 1998b, pp. 73-102.

Bhaskar, Roy, 1979, The Possibility of Naturalism: *A Philosophical Critique of the Contemporary Human Sciences,* Brighton: Harvester.

Blanco, Alejandro Vergara, 1997, "La Libre Transferibiblidad de los Derechos de Aguas: A Caso Chileno", *Revista Chilena de Derecho*, 24(2): 369-395.

Bos, M.G., 1997, "Performance Indicators for Irrigation and Drainage", *Irrigation and Drainage Systems*, 11(2): 119-137.

Boun, Souk, 1999, "Nan Ngum River Water Quality Protection and Rehabilitation in the Lao People's Democratic Republic" In United Nations, 1999b, pp. 36.

Boyer Robert and J. Rogers Hollingswoth, 1997, "The Variety and Unequal Performance of Really Existing Markets: Farewell to Doctor Pangloss?" in J. Rogers Hollingsworth and Robert Boyer, eds., pp. 49-54.

Boyer, Robert and J. Rogers Hollingsworth, 1997, "From National Embeddedness to Spatial and Institutional Nestedness" in J. Rogers Hollingsworth and Robert Boyer, eds., pp. 433-477.

Boyer, Robert, 1987, "Regulation", in *The New Palgrave*, London, Macmillan.

Boyer, Robert, 1988b, "Formalizing Growth Regimes" in Dosi et al., eds.

Brehm, Monica Rios, and Jorge Quiroz, 1995, *The Market for Water Rights in Chile: Major issues*, Technical Paper No: 285, The World Bank, Washington, DC.

Brewer, J.D., R. Sakthivadivel, and K.V. Raju, 1997, *Water Distribution Rules and Water Distribution Performance: A Case Study in the Tambraparani Irrigation System*, Research Report No: 12, International Irrigation Management Institute (IIMI), Colombo.

Brinkerhoff, D.W., 1994, "Institutional Development in World Bank Projects: Analytical Approaches and Intervention Designs", *Public Administration and Development*, 14(1): 135-151.

Bromley, D.W., 1985, "Resources and Economic Development", *Journal of Economic Issues*, 19(September): 779-96.

Bromley, D.W., 1989a, *Economic Interests and Institutions: The Conceptual Foundations of Public Policy*, New York: Basil Blackwell.

Bromley, D.W., 1989b, "Institutional Change and Economic Efficiency," *Journal of Economic Issues*, 23(3): 735-759.

Bromley, Daniel, 1989, *Economic Interests and Institutions: The Conceptual Foundations of Public Policy*, Basil Blackwell, New York.

Buchanan, J.M., and Tullock, G., 1962, *The Calculus of Consent*, Ann Arbor, The University of Michigan Press.

Buckland, Jonathan, and Thomas Zabel, 1998, "Economic and Financial Aspects of Water Management Policies" in Francisco Nunes Corrreia, ed., 1998b, pp. 261-318.

Burt, C. M. and S. Styles, 1997, *Irrigation Modernization Study (Appendix on Irrigation Indicators*, World Bank-IPTRID-IIMI, Washington, D.C.

Bush, P.D., 1987, The Theory of Institutional Change, *Journal of Economic Issues*, 21(3): 1075-1116.

Caldwell, B.J., 1982, *Beyond Positivism: Economic Methodology in the Twentieth Century*, London: Allen and Unwin.

Carruthers, I.D. and J.A. Morrison, 1996, "Institutions in Water Resource Management: Insights From New Institutional Economics" in P. Howsam and R.C. Carter, eds., *Water Policy: Allocation and Management in Practice*, E and FN Spon.

Challen, Ray, 2000, *Institutions, Transaction Costs, , and Environmental Policy: Institutional Reform for Water Resources*, Cheltenham, UK: Edward Elgar.

Chang, Ha-Joon, 1994, "State, Institutions, and Structural Change", *Structural Change and Economic Dynamics*, 5(2): 293-313.

Chen, Zhikai, 1992, "Water Resource Development in China", in Guy Le Moigne, et al., ed., *Country Experiences with Water Resources Management: Economic, Institutional, Technological, and Environmental Issues*, Technical Paper No: 175, The World Bank, Washington, DC.

Cheung, S.N.S., 1968, Private Property Rights and Sharecropping, *Journal of Political Economy,* 76: 1107-1122.

Chong, Alberto, and Cesar Calderon, 2000, "Institutional Quality and Income Distribution", *Economic Development and Cultural Change*, 49: 761-786.

Ciriacy-Wantrup, S.V., 1956, "Concepts Used as Economic Criteria for a System of Water Rights", *Land Economics*, 32(4): 295-312.

Clague, Christopher, 1994, "Bureaucracy and Economic Development", *Structural Change and Economic Dynamics*, 5(2): 273-91.

Clague, Christopher, 1997a, "Introduction" in *Institutions and Economic Development: Growth and Governance in Less-Developed and Post-Socialist Countries*", in Christopher Clague ed., pp.1-12.

Clague, Christopher, 1997b, "The New Institutional Economics and Economic Development" in Christopher Clague ed., pp. 13-36.

Clague, Christopher, ed., 1997, *Institutions and Economic Development: Growth and Governance in Less-Developed and Post-Socialist Countries*", Baltimore and London: The Johns Hopkins University Press.

CNCID, 2000, "Country Position Paper: Canada", in ICID, 2000a, pp. 41-48.

Coase, Ronald, H., 1937, "The Nature of the Firm", *Economica*, 4(2): 386-405.

Coase, Ronald, H., 1960, "The Problem of Social Cost", *Journal of Law and Economics*, 3(1): 1-44.

Colby, Bonnie, 1990, "Transaction Costs and Efficiency in Western Waters", *American Journal of Agricultural Economics*, 72(5): 1184-1192.

Coleman, J.S., 1987, "Norms as Social Capital" in G. Radnitzky and P. Bernholz, eds., *Economic Imperialism: The Economic Approach Applied Outside the Field of Economics*, Paragon House, New York, pp. 133-155.

Coleman, James, 1990, *Foundations of Social Theory*, Cambridge, MA: The Belknap Press of Harvard University Press.

Coleman, James, 1990, *Foundations of Social Theory*, Cambridge: Harvard University Press.

Commission Nacional del Agua (CAN), 1990, *Water Policies and Strategies*, Mexico City.

Commons, J.R., 1934, *Institutional Economics*, Macmillan, New York.

Commons, J.R., 1968, *Legal Foundations of Capitalism*, Madison: University of Wisconsin Press.

Cook, Karen Schweers and Margaret Levi, eds., 1990, *The Limits of Rationality*, Chicago: The University of Chicago Press.

Cooter R.D., and T. Ullen, 1988, *Law and Economics*, Harper Collins, New York.

Coriat, Benjamin and Giovanni Dosi, 1998, "The Institutional Embeddedness of Economic Change: An Appraisal of the 'Evolutionary' and 'Regulationist' Research Programmes" in *Institutions and Economic Change,* eds., Klaus Nielsen and Bjorn Johnson, MA: Edward Elgar, pp. 3-32.

Corrreia, Francisco Nunes, ed., 1998a, *Institutions for Water Resources Management in Europe*, Rotterdam, The Netherlands: A.A. Balkema Publishers.

Corrreia, Francisco Nunes ed., 1998b, *Selected Issues in Water Resources Management in Europe*, Rotterdam, The Netherlands: A.A. Balkema Publishers.

Corrreia, Francisco Nunes, Eduardo Beja Neves, Maria Alzira Santos, and Joaquim Evaristo Da Silva, 1998, "Portugal" in Francisco Nunes Corrreia, ed., 1998a, pp. 449-536.

Cukierman, Alex, Steven B. Webb and Bilin Neyapti, 1998, "Measuring the Independence of Central Banks and its Effects on Policy Outcomes", *The World Bank Economic Review*, 6(3): 353-398.

Dahlman, Carl J., 1979, "The Problem of Externality", *Journal of Legal Studies*, 22(1): 141-162.

Dales, J.H., 1968, "Land, Water, and Ownership", *Canadian Journal of Economics*, 1(4): 791-804.

Davis, L.E., and D.C. North, 1970, "Institutional Change and American Economic Growth: A First Step Towards a Theory of Institutional Innovation", *Journal of Economic History*, 30(March): 131-49.

Department of Water Affairs and Forestry, 1999, "National Water Act (Act No. 36 of 1998) for South Africa", Pretoria: National Gazette 20615, November 12.

Department of Water Affairs, 1999, *Water Management in Namibia – Achievements and Future Prospects*, Report of the Parliament Standing Committee on Agriculture and Environment of the Swedish Parliament, Windhoek.

DETR (Department of Environment, Transport and the Regions), 1998a, "Water Charges in England and Wales – A New Approach, Consultation Paper", London: Department of Environment, Transport and the Regions, March.

DETR, 1998b, "Water Charges in England and Wales, Government Decisions Following Consultation", London: Department of Environment, Transport and the Regions, November.

DETR, 1999, "Taking Water Responsibility, Government Decisions Following Consultation on Changes to the Water Abstraction Licensing System in England and Wales", London: Department of Environment, Transport and the Regions, March.

DGOH, 1996, *Institutional Framework and The Water Use in Spain*, Ministerio de Obras Publicas, Transportes, y Medio Ambiente, Madrid.

DiMaggio, P., and W. Powell, 1983, "The Iron Cage Revisited", *American Sociological Review*, 48: 147-170.

Dinar, Ariel, ed., 2000, *The Political Economy of Water Pricing Reforms*, New York: Oxford University Press.

Dinar, Ariel and Ashok Subramanian, eds., 1997, *Water Pricing Experience: An International Perspective*, Technical Paper No: 386, The World Bank, Washington, DC.

Dinar, Ariel and J. Latey, 1991, "Agricultural Water Marketing: Allocative Efficiency and Drainage Reduction", *Journal of Environmental Economics and Management*, 20: 210-223.

Dinar, Ariel and Edna Lohman, eds., 1995, *Water Quantity/Quality Disputes and Their Resolutions*, Praeger, New York.

DLWC, 1997a, *Water Reforms: Information for Users*, Government of New South Wales, Sydney.

DLWC, 1997b, *Report to the Minister on NSW Water Reforms*, Water Management Task Force, Government of New South Wales, Sydney.

DLWC, 1998, *Submission to IPART on Rural Bulk Water Pricing*, Government of New South Wales, Sydney.

Dollery, Brian, 1995, " Institutional Change, Property Rights and Economic Performance in Post-Apartheid in South Africa", *Development Southern Africa*, 12(6): 851-862.

Donahue, John M., and Barbara Rose Johnston, 1998, *Water, Culture, and Power: Local Struggles in a Global Context*, Washington, DC: Island Press.

Donoso, Guillermo, 1996, *El Mercado de Derechos de Aprovenchameinto como Mecanismo Asignador del Recurso Hidrico*, Departmento de Economia Agraria, Pontifica Universidad Catolica de Chile, Santiago (*mimeo*).

Dosi, G., C. Freeman, R.R. Nelson, G. Silverberg and L. Soete (eds), 1988, *Technical Change and Economic Theory*, Columbia University Press, New York.

Douglas, Mary, 1986, *How Institutions Think?* New York: Syracuse University Press.

DWAF, 1986, *Management of the Water Resources of the Republic of South Africa*, Pretoria.

DWAF, 1997, *White Paper on a National Water Policy for South Africa*, Pretoria.

Easter, K. William, 2000, "Asia's Irrigation Management in Transition: A Paradigm Shift Faces High Transaction Costs", *Review of Agricultural Economics*, 22(2): 370-388.

Easter, K. William, Ariel Dinar, and Mark Rosegrant, eds., 1998, *Markets for Water: Potential and Performance*, Boston: Kluwer Academic Press.

Easter, K. William, Mark W. Rosegrant and Ariel Dinar, 1999, "Formal and Informal Markets for Water: Institutions, Performance and Constraints", *The World Bank Research Observer*, 14(1): 99-116.

Easter, K. William and Gershon Feder, 1996, *Water Institutions and Economic Incentives to Ameliorate Market and Government Failures,* Staff Paper Series, Department of Applied Economics, University of Minnesota, P96-14.

Eggertsson, Thrainn, 1990, *Economic Behavior and Institutions*, Cambridge, UK: Cambridge University Press.

Eggertsson, Thrainn, 1996, "A Note on the Economics of Institutions" in *Empirical Studies in Institutional Change*, Lee J. Alston, Thrainn Eggertsson, and Douglass C. North, eds., pp. 6-21.

Eggertsson, Thrainn, 1996, "The Economics of Control and the Cost of Property Rights", in Susan Hanna, Carl Folke, and Karl-Goran Maler, eds., *Rights to Nature: Ecological, Economic, Cultural, and Political Principles of Institutions for the Environment*, eds., Washington, DC: Island Press, pp.157-178.

ESCAP, 1997, "Current Status and Future Trends of Water and Sustainable Development in Nepal" in United Nations, 1997, pp. 94-104.

Esty, C. Daniel, and Michael E. Porter, 2000, "Measuring National Environmental Performance and Its Determinants" in The World Economic Forum, *The Global Competitiveness Report 2000,* Geneva, Switzerland.

Falkenmark, Malin, 1999, "Forward to the Future: A Conceptual Framework for Water Dependence", *Ambio*, 28(4): 356-361.

Falkenmark, Malin and Gunnar Lindh, 1993, "Water and Economic Development" in Peter H. Gleick, ed.,

Farley, Peter, J. and Benjamin M. Simon, 1996, "Privatizing Government Irrigation Projects in New Zealand", *Water Resources Bulletin*, 32(3): 585-594, June.

Feeny, David, 1993, "The Demand for and Supply of Institutional Arrangements", in *Rethinking Institutional Analysis and Development*, ed., Ostrom, Feeny, and Picht.

Food and Agriculture Organization (FAO), 1996, *Food Production: The Critical Role of Water*, Technical Background Document for the World Food Submit: 7, Rome.

Fox, Irving K., 1976, "Institutions for Water Management in a Changing World", *Natural Resources Journal*, 16(4): 743-758.

Frederiksen, Harald D., 1992, *Water Resources Institutions: Some Principles and Practices*, World Bank Technical Paper No: 191, The World Bank, Washington, DC.

Frederiksen, Harald D., 1996, "Water Crisis in Developing World: Misconceptions and Solutions", *Journal of Water Resources Planning and Management*, 122(2): 79-87.

Frederikson, Harald D., 1992, *Water Resources Institutions: Some Principles and Practices*, Technical Paper No: 191, The World Bank, Washington, DC.

Frederiksen, Harald D., 1998, "International Community Response to Critical World Water Problems: A Perspective for Policy Makers", *Water Policy*, 1: 139-158.

Garrido, Alberto, 1997, "A Mathematical Programming Model Applied to the Study of Water Markets within the Agricultural Sector", Paper presented in the 8th European Agricultural Economists Association Congress, Edinburgh, United Kingdom, September.

Gazmuri, Renado and Mark Rosegrant, 1994, "Chilean Water Policy: The Role of Water Rights, Institutions, and Markets", Paper prepared for the *Irrigation Support Project for Asia and the Near East (ISPAN)*, International Food Policy Research Institute, Washington, DC.

Gleick, Peter H., 1993, "Water in the 21st Century" in Peter H. Gleick, ed., *Water in Crisis: A Guide to the World's Fresh Water Resources*, New York: Oxford University Press.

Gleick, Peter H., 1998, *The World's Water: The Biennial Report on Fresh Water Resources*, Washington, DC: Island Press.

GOI, 1992, *Report of the Committee on Pricing Irrigation Water*, Planning Commission, New Delhi.

GOI, 1995, *Report of the High Level Committee on Private Sector Participation in Irrigation and Multi-purpose Projects*, Ministry of Water Resources, New Delhi.

Gorriz, Cesilia M., Ashok Subramanian, and Jose Simas, 1995, *Irrigation Management Transfer in Mexico: Process and Progress*, Technical Paper No: 292, The World Bank, Washington, DC.

Government of Sudan, 2001, National Water Policy of Sudan, Khartoum.

Granovetter, Mark, 1985, "Economic Action and Social Structure: The Problem of Embeddedness", *American Journal of Sociology*, 91: 481-510.

Gray, Cheryl W., and Daniel Kaufmann, 1998, "Corruption and Development", *Finance & Development*, 35(1): 7-10.

Grief, A., 1989, Reputations and Coalitions in Medieval Trade: Evidence on the Maghribi Traders, Journal of Economic History, 49: 857-882.

Griffin, Ronald C., 1991, "The Welfare Analytics of Transaction Costs, Externalities, and Institutional Choice", *American Agricultural Economics Association*, 73 (August), 601-614.

Groenewegen, John, 1996, *Transaction Cost Economics and Beyond*, Dordrecht: Kluwer Academic Publishers.

Groenewegen, John, Frans Kerstholt, and Ad Nagelkerke, 1995, "On Integrating New and Old Institutionalism: Douglass North Building Bridges", *Journal of Economic Issues*, 29(2): 467-474.

Guggenheim, Scott, 1992, "Institutional Arrangements For Water Resources Development" in Le Moigne, et al.

Guoliang, Tan, 1993, ed., *Water Resources Development in China*, China Water and Power Press, Beijing.

Hage, Jerald, and Catherine Alter, 1997, "A Typology of Interorganisational Relationships and Networks", in J. Rogers Hollingsworth and Robert Boyer, eds., *Contemporary Capitalism: The Embeddedness of Institutions*, Cambridge, UK: Cambridge University Press, pp. 94-127.

Haggard, Stephan and Steven B. Webb, eds., 1994a, *Voting for Reform: Democracy, Political Liberalization, and Economic Adjustment,* The World Bank: Washington, D.C.

Haggard, Stephan and Steven B. Webb, 1994b, " Introduction" in Haggard and Webb, ed., pp. 1-36.

Haggard, Stephan, 1997, " Democratic Institutions, Economic Policy, and Development", in Clague ed., pp. 121-152

Haggard, Stephan, Robert Kaufman, and Steven B. Webb, 1992, "Democracy, Dictatorship, and Inflation in Middle-Income Countries", Harvard University, Rutgers University, and World Bank, Washington, D.C. Processed.

Hall, Peter, 1986, *Governing the Economy, The Politics of State Intervention in Britain and France*, Cambridge: Polity Press.

Ham, gee Bong, 1997, "Water and Sustainable Development in the Republic of Korea",

Hanna, Susan, Carl Folke, and Karl-Goran Maler, eds.,1996, "Property Rights and Natural Environment" in Susan Hanna, Carl Folke, and Karl-Goran Maler, eds., *Rights to Nature, Ecological, Economic, Cultural and Political Principles of Institutions for the Environment*, Washington, DC: Island Press, pp. 1-10.

Hartman, L.M., and D. Seastone, 1970, *Water Transfers: Economic Efficiency and Alternative Institutions*, Baltimore: John Hopkins Press.

Hearne, Robert, and K. William Easter, 1995, *Water Allocation and Water Markets: An Analysis of Gains-from-Trade in Chile*, Technical Paper No: 315, The World Bank, Washington, DC.

Hearne, Robert, and K. William Easter, 1997, "The Economic and Financial Gains from Water Markets in Chile", *Agricultural Economics*, 15: 187-199.

Hee, Lee Chan, 1998, "Water Quality Management in the Republic of Korea" in United Nations, pp. 133-140.

Heyns, Pieter, 1997, "Namibia" in Dinar, Ariel and Ashok Subramanian, ed.,

Heyns, Pieter, 1999, "Water Management in Namibia: Achievement and Future prospects", Paper prepared for the visit of the parliament standing committee on agriculture and environment of the Swedish Parliament, Department of Water Affairs, Windhoek.

Hodgson, Geoffrey M., 1993, *Economics and Evolution: Bringing Life Back into Economics*, Cambridge: Polity Press, & Ann Arbor: University of Michigan Press.

Hodgson, Geoffrey M., 1998, "The Approach of Institutional Economics", *Journal of Economic Literature*, 56(1): 166-192.

Hollingsworth, J. Rogers and Robert Boyer, eds., 1997, *Contemporary Capitalism: The Embeddedness of Institutions*, Cambridge, UK: Cambridge University Press.

Howe, C.W., D.R. Schurmeier and W.D. Shaw, 1986, "Innovative Approaches to Water Allocation: The Potential for Water Markets", *Water Resources Research*, 22(4), 439-445.

Howitt, Richard E., 1994, " Effects of Water Marketing on the Farm Economy" in Harold O. Carter, et al., ed., *Sharing Scarcity: Gainers and Losers in Water Marketing*, University of California, Agricultural Issues Center, Berkeley.

Howitt, Richard, 1998, "Spot Prices, Option Prices, and Water Markets in California" in K. William Easter, Ariel Dinar, Mark Rosegrant, eds.

Howitt, Richard, 1998, "Spot Prices, Option Prices, and Water Markets in California" in K. William Easter, Ariel Dinar, Mark Rosegrant.

Huntington, Samuel, 1991, *The Third Wave: Democratization in the Late Twentieth Century*, University of Oklahoma Press, Norman.

Indonesian Delegation, 1996, "Country Paper for Indonesia" in Arriens, et al., eds.

International Commission on Irrigation and Drainage (ICID), 2000a, *Draft ICID Strategy for Implementing Sector Vision,* Water for Food and Rural Development and Country Position Papers, New Delhi.

ICID, 2000b, "Country Profile: Canada", *ICID Newsletter*, 2000(3): 12-13.

Isham, Jonathan, and Satu Kahkonen, 1999, "Institutional Determinants of the Impact of Community-Based Water Services: Evidence from Sri Lanka and India", IRIS working Paper, University of Mary Land, College Park.

Ismaji, Tri Harjun, 1998, "A Study of Water Pollution Problems in the Brantas River Basin, Indonesia" in United Nations, 1998.

Israel, Arturo, 1987, *Institutional Development Incentives to Performance*, Baltimore: The John Hopkins University Press.

Italian National Committee on Irrigation and Drainage (INCID), 2000, "Country Position Paper: Italy" in ICID, 2000a, pp. 213-224.

IWACO, 2000, "Egypt: Review of Institutional Options and Water Quality Management" Water Sector Note, Project 57291 Prepared for World Bank's Middle East Department.

Jahn, Detlef, 1998, "Environmental Performance and Policy Regimes: Explaining Variations in 18 OECD-Countries", *Policy Studies*, 31: 107-131.

Japanese National Committee on Irrigation and Drainage (JNCID), 2000, "Country Position Paper: Japan" in ICID, 2000b, pp. 225-240.

Jarayabhand, Srisuda, Supa Sokultanjaroenchai, and Chanin Tongdhamachart, 1998, " Sources and Nature of Pollution in the Rivers of Thailand" in United Nations, 1998, pp. 141-143.

Johnson, Bjorn, and Klaus Nielsen, 1998, "Introduction" in *Institutions and Economic Change*, eds., Klaus Nielsen and Bjorn Johnson, MA: Edward Elgar, pp. xiii-xxviii.

Johnson, Sam H., 1996, "Irrigation Management Transfer in Mexico: Moving Toward Sustainability", Paper presented at the 6th Annual Conference of the International Association for the Study of Common Property, June 5-6, University of California, Berkeley.

Johnson, Sam H., 1997, "Irrigation Management Transfer: Decentralizing Public Irrigation in Mexico", *Water International*, 22(3): 159-167.

Johnston, John, 1984, *Econometric Methods* (Third Edition), New York: The McGraw-Hill Book Company.

Ke Lidan, 1997, "Water Law and Water Management" in Qian Zhengying, ed., *Water Resources Development in China*, China Water and Power Press/Central Board of Irrigation and Power, Beijing/New Delhi.

Kemper, Karin, and Douglas Olson, 2000, "The Dynamics of Institutional Change in Mexico and Ceara, Brazil" in Dinar, Ariel (Ed.), *The Political Economy of Water Pricing Reforms*, NY: Oxford University Press.

Kennedy, Peter, 1987, *A Guide to Econometrics* (Second Edition), Cambridge, MA: The MIT Press.

Keohane, Robert O., 1988, "International Institutions: Two Approaches", *International Studies Quarterly*, 32, No.4: 379-96.

Kinnersley, David, 1992, "Privatization And The Water Environment In England", in Le Moigne, et al.

Kiser, Larry, and Elinor Ostrom, 1982, "The Three Worlds of Action: A Metatheoretical Synthesis of Institutional Approaches" in Elinor Ostrom, ed., *Strategies of Political Inquiry*, Beverly Hills: Sage Publications, pp. 179-222.

Kislev, Yoav, 1993, *The Water Economy of Israel: Principles and Their Application*, Policy Studies No: 14, Institute of Advanced Strategic and Political Studies, Jerusalem.

Knight, Jack, 1995, "Models, Interpretations, and Theories: Constructing Explanations of Institutional Emergence and Change", in Explaining Social Institutions, eds., Jack Knight and Itai Sened, pp. 95-120.

Kraemer, R. Andreas, 1998, "Public and Private Water Management in Europe" in Francisco Nunes Correia, ed., 1998b, pp. 319-352.

Kraemer, R. Andreas, and Frank Jager, 1998, "Germany" in Francisco Nunes Correia, ed., 1998a, pp. 183-325.

Kunte, Arundhati, Kirk Hamilton, John Dixon, and Michael Clemens, 1998, *Estimating National Wealth: Methodology and Results*, Environment Department Papers, No. 57, The World Bank, Washington, D.C.

Kwun, Soon-kuk, 2000, "Country Position Paper: Korea" in ICID, 2000a, pp. 241-255.

Landa, J.T., 1994, *Trust, Ethnicity, and Identity: Beyond the New Institutional Economics of Ethnic Trading Networks, Contract Law, and Gift Exchange*, Ann Arbor: University of Michigan Press.

Landry, Rejean, 1996, *A Framework for the Study of Incomplete Institutions*, Colloquium Presentation at the Workshop in Political Economy, Indiana University, Bloomington.

Le Moigne, Guy, Ashok Subramanian, Mei Zie, and Sandra Giltner, 1994, *A Guide to the Formulation of Water Resources Strategy*, Technical Paper No: 263, The World Bank, Washington, DC.

Le Moigne, Guy, Shawki Barghouti, Gershon Feder, Lisa Garbus, and Mei Xie, eds., 1992, *Country Experiences with Water Resources Management: Economic, Institutional, Technological, and Environmental Issues*, World Bank Technical Paper No: 175, The World Bank, Washington, DC.

Levi, Margaret, 1990, "A Logic of Institutional Change" in Karen Schweers Cook and Margaret Levi, eds., *The Limits of Rationality*, Chicago: The University of Chicago Press.

Li Quan, 1999, "Institutional Design and the Performance of Trade Blocs", paper prepared for International Studies Association Annual Meeting, Washington, D.C., February.

Libecap, G.D., 1978, "Economic Variables and the Development of the Law: The Case of Western Mineral Rights", *The Journal of Economic History*, 38(June): 338-62.

Livingston, Marie Leigh, 1987, "Evaluating the Performance of Environmental Policy: Contribution of Neoclassical, Public Choice, and Institutional Models", *Journal of Economic Issues*, 21(1): 281-93.

Livingston, Marie Leigh, 1993, *Designing Water Institutions*, Policy Research Working Paper, The World Bank, Washington.

Lo, Carlos, Wing-Hung, and Shui-Yan Tang, 1994, "Institutional Contexts of Environmental Management: Water Pollution Control on Guangzhou, China, *Public Administration and Development*, 14(1): 53-64.

Lorek, Maciej, 2000. "Poland- Country Description" in Berbeka, Krzysztof, *Water pricing in selected Accession Countries to the European Union, current policies and trends,* Part II Country descriptions. Contract number B4-3040/99/130877/MAR/B2 Cracow, December.

Maass, A., and R.L. Anderson, 1986, *... and the Desert Shall Rejoice: Conflict Growth and Justice in Arid Environments,* Malabar, Fa: R.E. Krieger.

Maia, Rodrigo, 2000, "Sharing the Waters of the Iberian Peninsula", Paper presented at the 10th World Water Congress, Melbourne, Australia, March.

March J.G., and J.P. Olsen, 1989, *Rediscovering Institutions: The Organizational Basis of Policies*, New York: Free Press.

Marglin, Stephen, A., 1991, "Understanding Capitalism: Control Versus Efficiency", In Bo Gustafasson, ed. *Power and Economic Institutions*, Cheltenham : Edward Elgar, pp. 225-252.

Marino, Manuel and Karin Kemper, 1999, "Institutional Frameworks in Successful Water Markets: Brazil, Spain, and Colorado, USA", Technical Paper No 427, Washington, DC: World Bank, February.

Marshall, Alfred, 1948, *Principles of Economics*, Eighth ed., Macmillan, New York.

Massarutto, Antonio, ed., 2001, "Irrigation Water Demand in Italy, Water Pricing, The Common Agricultural Policy and Irrigation Water Use", European Commission, DG Environment.

Massarutto, Antonio, 1999a, *Water Institutions and Management in Italy*, Dipartimento di Scienze Economiche, Universita di Udine and Iefe, Italy.

Massarutto, Antonio, 1999b, *Comparing Water Policies in the EU: A Positive Analysis*, Universita di Udine e lefe, Universita Bocconi, Italy.

McDonald, A. and D. Kay, 1988, *Water Resources: Issues and Strategies*, Longman Scientific and Technical Publishers Ltd., London.

McGlynn, Tony, 1997, *Making Sense of Water Licenses and Transfers*, Sydney (*mimeo*).

MEA, 1997, *Progress Report-1997*, Ministry of Mahaweli Development, Colombo.

Merrey, Douglas J., 1996, *Institutional Design Principles for Accountability in Large Irrigation Systems*, Research Report, International Irrigation Management Institute, Colombo, Sri Lanka.

Milliman, J.W., 1959, "Water Law and Private Decision-Making: A Critique", *Journal of Law and Economics*, 2(1): 41-63.

Mohtadullah, Khalid, 1997, "Pakistan" in Areil Dinar and Ashok Subramanian, eds.

Molle, Francois, 2001, "Water Pricing in Thailand: Theory and Practice", DORAS-DELTA Research Report n7, Kasetsart University, Institut de Recherche pour le Developpment, DORAS Center Bangkok, Thailand.

MOPT, 1993, *Plan Hidrologico Nacional Memoria*, Madrid.

Morris, Cynthia Taft, and Adelman, I., 1988, "Comparative Patterns of Economic Development, Baltimore: Johns Hopkins University Press, pp. 1850-1914.

MOWREP, 1987, *Water Resources and Hydropower Development in China*, Beijing.

Muhammad, Dil, 1998, *Legal Framework for Irrigation Management in Punjab and Sindh Provinces, Pakistan*, Report No. C-11, Lahore: Pakistan National Program, International Irrigation Management Institute, September.

Musgrave, Warren F., "Australia", in Ariel Dinar and Ashok Subramanian, eds.

Musgrave, Warren, 2000, "The Political Economy of Water Price Reform in Australia" in Dinar, Ariel, ed.

Myint, Ohn, 1997, "Sustainable Development of Water Resources in Myanmar" in United Nations, pp. 86-93.

Myint, U Myo, U Aung Kyaw, and U Myint Thwin, 1996, "Country Paper of Myanmar in Arriens, et al., eds., pp. 103-112.

Nam, Le Duc, 1997, "Current Status and Future Trends of Water and Sustainable Development in Vietnam" in United Nations, pp. 141-143.

Nanni, Marcella, 1996, *Preliminary Report on National Water Resource Laws and Institutions in Sri Lanka*, Water Policy and Law Advisory Programme, CGP/INT/620/NET, Food and Agriculture Organization, Colombo.

Nash, Linda, 1993, "Water Quality and Health" in Peter H. Gleick, ed.

Nelson, Douglas and Eugene Silberberg, 1987, "Ideology and Legislator Shirking", *Economic Enquiry*, 25: 15-25.

Nelson, Joan, ed., 1990, *Economic Crisis and Policy Choice: The Politics of Adjustment in the Third World*, Princeton: Princeton University Press.

Nepalese Delegation, 1996, "Country Paper on Nepal" in Arriens, et al. 1996, *Towards Effective Water Policy in the Asian and Pacific Region…*, Volume two, Country Papers, Manila: Asian Development Bank, pp. 113-117.

New Zealand Ministry for the Environment, 1999, "Making Every Drop Count-Water 2010, The National Agenda for Sustainable Water Management", Ministry of the Environment, Draft Report, July.

Nguyen, Thai Lai, 1999, "Protection and Rehabilitation of the Red River in Vietnam" in United Nations, 1999b, pp. 106-113.

Nishat, A and I. M. Faisal, 2000. "An Assessment of the Institutional Mechanisms for Water Negotiations in the Ganges-Brahmaputra-Meghna Basin." *International Negotiation*, 5(?); ??-??.

North, Douglas C., 1990c, "A Transaction Cost Theory of Politics", *Journal of Theoretical, Politics,* 2(4): 355-67.

North, Douglas C., and R.P. Thomas, 1970, "An Economic Theory of the Growth of the Western World", *The Economic History Review* 23(March): 1-17a.

North, Douglas C., and R.P. Thomas, 1973, "*The Rise of the Western World: A New Economic History,* Cambridge, MA: Cambridge University Press.

North, Douglass C. and Barry R. Weingast, 1996, "The Evolution of Modern Institutions of Growth: Constitutions and Commitment: The Evolution of Institutions Governing Public Choice in Seventeenth-Century England", in Empirical Studies in Institutional Change, Lee J. Alston, Thrainn Eggertsson, Doglasss C. North, eds., pp.129-133.

North, Douglass C., 1981, *Structure and Change in Economic History*, New York, Norton.

North, Douglass C., 1986, "The New Institutional Economics", *Journal of Institutional and Theoretical Economics,* 142: 230-237.

North, Douglass C., 1988, *Institutions and a Transaction Cost Theory of Exchange*, Political Economy Working paper No. 144, Washington University, St. Lois, MO.

North, Douglass C., 1990a, *Institutions, Institutional Change, and Economic Performance*, Cambridge, Mass: Cambridge University Press.

North, Douglass C., 1990b, "Institutions and Their Consequences for Economic Performance" in Karen Schweers Cook and Margaret Levi, eds.

North, Douglass C., 1994, "Economic Performance Through Time", *American Economic Review*, 8(2): 359-368.

North, Douglass C., 1997, *The Contribution of the New Institutional Economics to an Understanding of the Transition Problem*, Wider Annual Lectures 1, World Institute for Development Economics Research, Helsinki, Finland.

North, Douglass C., ed., 1995, "Five Propositions about Institutional Change" in Knight and Sened, eds.

Office of Water Services (OFWAT), 1999a, *1999-2000 Report on Tariff Structure and Charges*, Birmingham.

OFWAT, 1999b, *Future Water and Sewerage Charges 2000-05*, Birmingham.

Olson, Mancur, 1965 (1971), *The Logic of Collective Action*, Cambridge: Harvard University Press.

Olson, M., 1982, *The Rise and Decline of Nations: Economic Growth, Stagflation, and Social Rigidities*, Hew Haven, CT: Yale University Press.

Omachi, Toshikatsu, 1997, "Drought Conciliation and Water Rights: Japanese Experence", Water Series No. 1, Infrastructure Development Institute, Tokyo.

Orloci, J., K. Szesztay and L. Varkonyi, 1985, *National Infrastructure in the Field of Water Resources*, UNESCO, Paris.

Ortega, Consuelo Varela, et al., 1997, *Water Pricing Policies, Public Decision Making and Farmers Response: Implications for Water Policy*, Departmento de Economia Agraria, Universidad Politechnica de Madrid, Madrid (*mimeo*).

Ostrom, Elinor, 1990, *Governing the Commons: The Evolution of Institutions for Collective Action*, Cambridge, UK: Cambridge University Press.

Ostrom, Elinor, 1999, *Institutional Rational Choice: An Assessment of the Institutional Analysis and Development Framework*, Working Paper, Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington.

Ostrom, Elinor, and J. Walker, 1990, "Communication in a Commons: Cooperation without External Enforcement" in T. R. Palfrey, ed., *Contemporary Laboratory Research in Political Economy*, Ann Arbor: University of Michigan Press.

Ostrom, Elinor, Roger B. Parks, and Gordon P. Whitaker, 1978, *Patterns of Metropolitan Policing*, Cambridge, MA: Ballinger.

Ostrom, Vincent and Elinor Ostrom, 1972, "Legal and Political Conditions of Water Resource Development", *Land Economics*, 48(1): 1-14.

Palacios, Enrique V., 1997, *Benefits and Second Generation Problems in Irrigation Management Transfer in Mexico*, EDI Participatory Irrigation Management Case Studies, The World Bank, Washington, DC.

Pattanee, Surapol, 2000, "Country Position Paper: Thailand" in ICID, 2000a, pp. 427-435.

Peoples Republic of China, 1988, *Water Law of the People's Republic of China*, Ministry of Water Resources, Beijing.

Peoples Republic of China, 1997, *China Water Resources News* (December 4), Ministry of Water Resources, Beijing.

Perdok, Peter, J., 1998, "Netherlands", in Corrreia, Francisco Nunes, ed., 1998a, pp. 327-447.

Pereira, Nelson, 1997, "Irrigation Policies and Irrigation Management Transfer Programs in Chile", CNR, Santiago (*mimeo*).

Philippines Delegation, 1996, "Country Paper of the Philippines" in Arriens, et al., eds, pp. 127-136.

Piccotto, Robert, 1995, *Putting Institutional Economics to Work: From Participation to Governance*, Discussion Paper: 304, The World Bank, Washington, DC.

Pigram, John J., 1986, *Issues in the Management of Australia's Water Resources*, Longman Cheshire Pvt. Ltd., Melbourne.

Poças Martins, Joaquim, 1998, "Serviços Públicos de Abstecimento de Água e de Saneamento" Villa Nova del Gaia: Associaçáo das Empresas Portuguesas para o Sector do Ambiente, September.

Poland National Committee on Irrigation and Drainage (PNCID), 2000, "Country Position Paper: Poland" in ICID, 2000a, pp. 363-369.

Polanyi, Karl, 1957, *The Great Transformation: The Political and Economic Origins of Our Time*, Boston: Beacon Press,(originally published in 1944).

Polanyi, Michael, 1962, *Personal Knowledge: Towards a Post-Critical Philosophy*, Harper & Row, New York.

Porat, M., and M. Rubin, 1977, *The Information Economy* (Nine Volumes), Office of Communications, Special Publication: 77-12, US Department of Commerce, Government Printing Office, Washington, D.C.

Posner, Richard A., 1986, *Economic Analysis of Law,* Boston: Little Brown.

Posner, Richard A., 1997, Equality, Wealth, and Political Stability, *The Journal of Law, Economics and Organization,* 13(2): 344-365.

Postal, S. L., 1999, *Pillar of Sand: Can the Irrigation Miracle Last?*, W.W. Norton, New York.

Postal, S. L., G. C. Daily and P. R. Ehrlich, 1996, "Human Appropriation of Renewable Fresh Water", *Science*, 271: 785-788.

PRC, 1988, *Water Law of the People's Republic of China*, Ministry of Water Resources, Beijing.

PRC, 1997, *China Water Resources News* (December 4), Ministry of Water Resources, Beijing.

Qishun, Zhang and Zhang Xiao, 1995, "Water Issues and Sustainable Social Development in China", *Water International*, 20(3): 122-128.

Raadschelders, Jos C.N., 1991, *Nine Centuries of Water Boards in the Netherlands: From Autonomy to Interdependence*, Working Paper, Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington.

Rahman, Shafi-ur, 1998, "Status of Water Quality and Water Quality Managemnet in the Rivers of Bangladesh" in United Nations.

Randall, Alan, 1974, "Coasian Externality Theory in a Policy Context", *Natural Resources Journal*, 14(January): 34-54.

Rasphone, Sitahng, 1996, "Country Paper of the Lao People's Democratic Republic" in Arriens, et al, eds.

Ratnayake, Ranjit, 1997, "Water Resources and Environment: Institutional Aspects", Discussion Draft, Colombo (*mimeo*).

Rausser, Gordon C., and Pinhas Zusman, 1991, "Organizational Failure and the Political Economy of Water Resources Management" in Ariel Dinar and David Zilberman, eds.

Rausser, Gordon, C., and Leo Simon, 1992, "The Political Economy of Transition in Eastern Europe" in Christopher Clauge and Gordon C. Rausser, eds., *The*

Emergence of Market Economies in Eastern Europe, Cambridge, MA: Basil Blackwell, pp. 245-70.

Rees, Yvonne and Thomas Zabel, 1998a, "United Kingdom" in Francisco Nunes Corrreia ed., 1998a, pp. 537-670.

Rees, Yvonne, and Thomas Zabel, 1998b, "Regulations and Enforcement of Discharges to Water" in Francisco Nunes Corrreia, 1998b, ed., pp. 181-222.

Rees, Yvonne, Thomas Zable, and Jonathan Buckland, 1998, "Overview of Water Resources Management Issues" in Francisco Nunes Corrreia, ed., 1998b, pp. 7-38.

Regmi, Dev Raj, Laxman Sharma, and Y. L. Yaidya, 1998, "Sources and Nature of Pollution in the Rivers of Nepal" in United Nations, pp. 115-117.

Remmer, Karen L., 1998, "Does Democracy Promote Interstate Cooperation? Lessons from the Mercosur Region", *International Study Quarterly*, 42(1): 25-52.

Renault, Daniel, 1998, *On Reliability in Irrigation Service: Conceptual Approach and Definitions*, International Irrigation Management Institute, Colombo, Sri Lanka.

Riker, William H., 1995, "The Experience of Creating Institutions: The Framing of the United States Constitution", in Explaining Social Institutions, eds., Jack Knight and Itai Sened, pp. 121-144.

Rivera, Marcelino, M. and Luis M. Sosa, 1998, "Sources and Nature of Pollution in the Rivers of the Philippines" in United Nations, pp. 131-133.

Rosegrant, M. W., and H. Binswanger, 1994, "Markets in Tradable Water Rights: Potential for Efficiency Gains in Developing Country Water Resource Allocation", *World Development*, 22(1): 1613-1625.

Rosegrant, M.W., and C. Ringler, 1999, *Impact on Food Security and Rural Development of Reallocating Water from Agriculture*, EPTD Discussion Paper No: 47, International Food Policy Research Institute, Washington, DC.

Rosen, Sherwin, 1996, "Institutional Transformation: Supply or Demand?", *Journal of Institutional and Theoretical Economics*, 152(1): 275-94.

Royal Government of Cambodia, 1996, "Country Paper of Cambodia" in Arriens, et al., eds., pp. 7-22.

Royds Consulting Ltd., et al., 2000, "Nepal Irrigation Sector Project, Irrigation Subsidy Study" (IDA CR. 3009-NEP), Department of Irrigation Katmandu, Ministry of Water Resources, His Majesty's Government of Nepal, Katmandu.

Rutherford, Malcolm, 1995, "The Old and the New Institutionalism: Can Bridges Be Built?, *Journal of Economic Issues,* 29(2): 443-450.

Ruttan, Vernon W., 1978, "Induced Institutional Change", in H.P. Binswanger and Vernon W. Ruttan, eds., *Induced Innovation*, Baltimore: Johns Hopkins University Press.

Ruttan, Vernon W., 1999, *Induced Institutional Innovation,* Paper presented in the Conference on "Induced Technology Change and the Environment", Luxembourg, Austria.

Ruttan, Vernon W., and Y. Hayami, 1984, "Toward a Theory of Induced Institutional Innovation", *Journal of Development Studies*, 20(July): 203-23.

Saghir, Jamal, Manuel Schiffler and Mathewos Woldu, 2000. "Urban Water and Sanitation in the Middle East and North Africa The Way Forward", Washington, DC: World Bank.

Saleth, R. M., 1996, *Water Institutions in India: Economics, law, and Policy*, New Delhi: Commonwealth Publishers.

Saleth, R. M., 1999, "Irrigation Privatization in India: Options, Framework, and Experience", *Economic and Political Weekly*, 34(26), A86-A92.

Saleth, R. M., and John B. Braden, 1995, "Minimizing the Potential Distortions in a Spot Water Market: A Multilateral Bargaining Approach" *in* Ariel Dinar and Edna Lohman, eds.

Saleth, R. M., John B. Braden, and J. Wayland Eheart, 1991, "Bargaining Rules for Thin Spot Water Market", *Land Economics*, 67(3): 326-339.

Saleth, R. M., and Ariel Dinar, 1999a, *Water Challenge and Institutional Response: A Cross-Country Perspective*, World Bank Policy Research Working Paper No: 2045, World Bank, Washington, DC.

Saleth, R. M., and Ariel Dinar, 1999b, *Evaluating Water Institutions and Water Sector Performance*, World Bank Technical Paper No: 447, World Bank, Washington, DC.

Saleth, R. M., and Ariel Dinar, 2000, "Institutional Changes in Global Water Sector: Trends, Patterns, and Implications", *Water Policy*, 2(3): 175-199.

Saleth, R.M., 1996, *Water Institutions in India: Economics, law, and Policy*, Commonwealth Publishers, New Delhi.

Saleth, R.M., and Ariel Dinar, 1998, "Water Institutions and Water Sector Performance: Evaluating Their Linkages with Cross-Country Data", Rural Development Department, The World Bank, Washington, DC (*mimeo*).

Sampath, R. K., 1990, "Measures of Inequity for Distribution of Large Public Surface Irrigation Systems: A Welfare-Theorectic Approach" in R.K. Sampath and R. A. Young, eds., pp. ???-???

Savedoff, William, and Pablo Spiller, eds., *Spilled Water*, Washington, DC: Inter-American Development Bank.

Schmid, A. A., 1972, "Analytical Institutional Economics: Changing Problems in the Economics of Resources for a New Environment", *American Journal of Agricultural Economics*, 54(5): 893-901.

Schmitter, C. Philippe, 1997, "Levels of Spatial Coordination and the Embeddedness of Institutions", in J. Rogers Hollingsworth and Robert Boyer, eds., *Contemporary Capitalism: The Embeddedness of Institutions*, Cambridge, UK: Cambridge University Press, pp. 311-319.

Schotter, A., 1981, "The Economic Theory of Social Institutions", Cambridge: Cambridge University Press.

Scrimgeour, Frank, 1997, "New Zealand" in Ariel Dinar and Ashok Subramanian, eds.

Seckler, David, Upali Amarasinghe, David Molden, Radhika de Silva, and Randolph Barker, 1998, *World Water Demand and Supply, 1990 to 2025: Scenarios and Issues,* Research Report, International Water Management Institute, Colombo, Sri Lanka.

Sharma, Kem Raj, 2000, "Country Position Paper: Nepal" in ICID, 2000a, pp. 299-316.

Shepsle, K. A. and Weingast, B. R., 1981, Structure Induced Equilibrium and Legislative Choice, *Public Choice*, 37: 503-520.

Shepsle, K.A., 1979, "Institutional Arrangements and Equilibrium in Multidimentional Voting Models", *American Journal of Political Science*, 23: 27-60.

Shiklomanov, Igor A., 1993, "World Fresh Water Resources" in Peter H. Gleick, ed.

Shim, Soon-Bo, 1996, "Korean Experience and Challenges in Water Resources Planning and Management" in Arriens, et al., eds, pp. 236-249.

Simas, Jose, 1997, *Mexico: Policy Options for Managing Aquifer Over-exploitation,* World Bank Mission, Mexico City (*mimeo*).

Simon, Herbert A., 1957, *Models of Man*, John Wiley & Sons, New York.

Simon, Herbert A., 1961, *Administrative Behavior*, 2d ed., New York: Macmillan (Original Publication in 1947).

Sina, Chea, 1998, "Sources and Nature of Pollution in Rivers of Cambodia" in United Nations, pp. 98-100.

Sina, Chea, 1999, "Protection and Rehabilitation of the Tonle Sap River in Cambodia" in United Nations, 1999b, pp. 4-7.

Sisovann, Ouk, 1997, "Water and Sustainable Development in Cambodia" in United Nations, 1997, pp. 23-29.

Sjostrand, Sven-Erik, 1995, "Toward a Theory of Institutional Change" in John Groenewegen, Christos Pietelis, and Sven-Erik Sjostrand, eds., *On Economic Institutions: Theory and Applications*, Brookfield, Vermont: Edward Elgar, pp.19-44.

Sosa, Luis M., 1997, "Current Status and Future Trends on Water Sustainable Development in the Philippines" in United Nations, pp. 118-127.

Sosongko, Djoko, 1999, "Protectioon and Regabilitation of the Cisadane River in Indonesia" in United Nations, 1999b.

Souk, Boun, 1998, "Status of Water Quality Management and Pollution Control in the Lao Peopl'e Democratic Republic" in United Nations, pp. 110-112.

Souvannabouth, Phouang Phanh, 1997, "Water Resources Development in Lao People's Democratic Republic" in United Nations, pp. 74-79.

Stein, Johan, 1997, "How Institutions Learn: A Socio-Cognitive Perspective", *Journal of Economic Issues*, 31(3): 729-39.

Su, Pham Xuan, 1996, "Country Paper of Vietnam" in Arriens, et al., eds, pp. 165-171.

Su, Pham Xuan, 1998, "Water Resources Potential and Water Quality in the Rivers of Vietnam" in United Nations, pp. 145-154.

Summerton, Neil, 1998, "The British Way in Water", *Water Policy*, 1(1): 45-65,

Sutardi, 1997, "Water and Sustainalbe Development: Current Status and Future Trends in Indonesia". In: United Nations.

Talec, J.F., 1994, *The French Experience in River Basin Management*, Loire-Bretagne River Basin Agency, Orleans, France.

Thai Delegation, 1996, "Country Paper of Thailand" in Arriens, et al., eds., pp. 155-160.

The Economist Intelligence Unit, 2000a, "Myanmar (Burma)", Country Profile 2000, London.

The Economist Intelligence Unit, 2000b, "Namibia, Swaziland", Country Profile 2000, London.

The Economist Intelligence Unit, 2000c, "Sudan", Country Profile 2000, London.

Thompson, Paul M. and Parvin Sultana, 1996, "Operation and Maintenance Performance and Conflicts in Flood-control Projects in Bangladesh", *International Journal of Water Resources Development,* 12(3): 311-328.

Tool, M. R., 1977, "A Social Value Theory in Neoinstitutional Economics", *Journal of Economic Issues*, 11(December): 823-849.

Tu, Dao Trong, 2000, "Country Position Paper: Vietnam" in ICID, 2000a, pp. 445-450.

Ul-Haq, Asrar, 1998, *A Case Study of the Panjub Irrigation Department*, Report No. C-12, Pakistan National Program, International Irrigation Management Institute, Lahore.

United Nations, 1991, *The Administration of Water Resources in Latin America and the Caribbean*, Economic Commission for Latin America, Santiago.

United Nations, 1997, *Sustainable Development of Water Resources in Asia and the Pacific: An Overview*, Economic and Social Commission for Asia and the Pacific, New York, pp. 128-130.

United Nations, 1998, *Sources and Nature of Water Quality Problems in Asia and the Pacific*, Economic and Social Commission for Asia and the Pacific, New York.

United Nations, 1999a, *Assessment of Water Resources and Water Demand by User Sectors in the Philippines*, Economic and Social Commission for Asia and the Pacific, New York.

United Nations, 1999b, *Water Quality of Selected Rivers in Asia: Protection and Rehabilitation*, Economic and Social Commission for Asia and the Pacific, New York.

United Nations, 2000, *Economic Survey of Europe*, No. 2/3, Economic Commission for Europe, United Nations Publications, Geneva.

Upadhyay, Lakshman Prasad and Dev Raj Regmi, 1999, "River Water Quality Management in Nepal: Problems and Solutions" in United Nations, 1999b, pp. 37-40.

Upadhyay, S. N., 1996, *A Critical Analysis of the Legal Regime on Water Resources in Sri Lanka*, Irrigation Management Support Activity, Colombo.

Varis, Olli, 1999, "Water Resources Development: Vicious and Virtuous Circles", *Ambio*, 28(7): 599-603.

Vaux, Henry, and Richard Howitt, 1984, "Managing Water Scarcity: An Evaluation of Inter-regional Transfers, *Water Resources Research*, 20: 785-792.

Veblen, Thorstein B., 1899, *The Theory of the Leisure Class: An Economic Study in the Evolution of Institutions*, Macmillan, New York.

Veblen, Thorstein B., 1914, *The Instinct of Workmanship and the State of the Industrial Arts,* Augustus Kelley, New York.

Veblen, Thorstein B., 1919, *The Place of Science in Modern Civilization and other Essays*, Huebsch, New York.

Vermillion, Douglas L., 1997, "Impact of Irrigation Management Transfer: A Review of Evidence", IIMI, Colombo.

von der Fehr, Nils-Henrik M., and Lise Sandsbraten, 1997, "Water on Fire: Gains from Electricity Trade", *Scandinavian Journal of Economics*, 99(2): 281-297.

Wade, Robert, 1982, *Employment, Water Control, and Water Supply Institutions: South India and South Korea*, Discussion Paper: 182, Institute of Development Studies, Sussex.

Wai, Oo Tun, and U Win Thein, 1998, "Sources and Nature of Pollution in the Rivers of Myanmar" in United Nations, 1998, pp. 113-115.

Wallis, J., and D. North, 1986, "Measuring the Transaction Sector in the American Economy, 1870-1970" in S. Engerman and R. Gallman, eds., *Long-Term Factors in American Economic Growth*, NBER Studies in Income and Wealth, Vol. 51, pp. 95-148, Chicago: The University of Chicago Press.

Wambia, Josepph, Makwata, 2000, "The Political Economy of Water Resources Institutional Reform in Pakistan" in Dinar, Ariel, ed., *The Political Economy of Water Pricing Reforms*, NY: Oxford University Press.

Water Research Commission, 1996, *Policy Proposal for Irrigated Agriculture in South Africa*, WRC Report No: KV96/96, Pretoria.

Weignberg, M., 1997, "Federal Water Policy Reform: Implications for Irrigated Farms in California", *Contemporary Economic Policies*, 15(2): 63-73.

Weingast, Barry, 1993, "Constitutions as Governance Structures", *Journal of Institutional and Theoretical Economics*, 149(March): 286-311.

Weissing, F., and E. Ostrom, 1990, "Irrigation Institutions and the Games Irrigators Play" in R. Selten, ed., *Game Equilibrium Models*, Vol. II: Methods, Morals, and Markets, ed., Berlin: Springer-Verlag.

White, Louise G., 1990, *Implementing Policy Reforms in LDCs: A Strategy for Designing and Effecting Change*, Boulder & London: Lynne Rienner Publishers.

Wijayaratna, C. M, and Douglas L. Vermillion, 1994, *Irrigation Management Turnover in the Philippines: Strategy of the National Irrigation Administration*, Short Report Series on Locally Managed Irrigation, No. 4, Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington.

Wijkman, J. and L. Timberlake, 1984, *National Disasters: Acts of God or Acts of Man*, London: Earthscan Publishers Ltd.

Wilber, C.K., and R.S. Harrison, 1978, "The Methodological Basis of Institutional Economics; Pattern Model, Stodry-Telling, and Holism", *Journal of Economic Issues*, 12(1): 61-89.

Wilks S., and M. Wright, eds., 1987, *Comparative Government-Industry Relations: Western Europe, the United States and Japan*, Oxford: Clarendon Press.

Williamson, Oliver E., 1975, *Markets and Hierarchies, Analysis and Antitrust Implications: A Study in the Economics of Internal Organization*, New York: Free Press.

Williamson, Oliver E., 1985, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, New York: Free Press.

Williamson, Oliver E., 1990, "The Firm as a Nexus of Treaties", in M. Aoki, B. Gustafsson, and O. E. Williamson, eds., *The Firm as Nexus of Treaties*, Newbury Park, CA: Sage Publications, pp. 1-25.

Williamson, Oliver E., 1991, "The Logic of Economic Organization", in O. Williamson and S. Winter, eds., *The Nature of the Firm: Origins, Evolution and Development*, Oxford: Oxford University Press.

Williamson, Oliver E., 1993, "Transaction Cost Economics and Organizations Theory", *Industrial and Corporate Change*, 2(2): 107-156.

Williamson, Oliver E., 1994, *Institutions and Economic Organization: The Governance Perspective*, Annual Bank Conference on Development Economics, The World Bank, Washington, D.C.

Williamson, Oliver E., 1999, "Public and Private Bureaucracies: A Transaction Cost Economics Perspective", *Journal of Law, Economics, and Organization*, 5: 306-347.

Wittfogel, Karl A., 1957, *Oriental Despotism: A Comparative Study of Total Power*, New Haven, CT: Yale University Press.

World Bank, 1992, *Asia Water Resources Study: Stage 1*, Vol. 2, Annexes, Agricultural Division, Asia Technical Department, Washington, DC.

World Bank, 1992, *Asia Water Resources Study: Stage 1*, Vol. 2, Annexes, Agricultural Division, Asia Technical Department, Washington, DC.

World Bank, 1993, "Second large-scale Irrigation Improvement Project Kingdom of Morocco", Staff Appraisal Report No. 10732-MOR, Washington DC.

World Bank, 1993a, *Water Resources Management: A World Bank Policy Paper*, Washington, D.C.

World Bank, 1993b, *Kingdom of Morocco: Irrigated Areas Agricultural Services Project*, Staff Appraisal Report (No. 11947-MOR), Washington, DC.

World Bank, 1993c, *Republic of Tunisia: Agricultural Sector Investment Loan*, Staff Appraisal Report No. 12229-TUN, Washington, DC.

World Bank, 1994, *Irrigation Improvement Project Arab Republic of Egypt*, Staff Appraisal Report No. 13454-EGT, Washington, DC.

World Bank, 1994, *Second National Drainage Project Arab Republic of Egypt*, Project Appraisal Document No. 20443-EGT, Washington, DC.

World Bank, 1994."Water Resources Management Project: Kingdom of Morocco", Project Appraisal Report No. 15760-MOR, Washington DC.

World Bank, 1995, *Kingdom of Morocco: Water Sector Review*, Report No. 14750-MOR, Washington, DC.

World Bank, 1995, *Socialist Republic of Vietnam Irrigation Rehabilitation Project*, Staff Appraisal Report No. 13702-VN, April 7, Washington, DC.

World Bank, 1996, *Philippines-Water Resources Development Project*, Staff Appraisal Report No 15297-PH, Washington, DC.

World Bank, 1997, *Nepal Project Appraisal Document Nepal Irrigation Sector Project*, Report No. 17104-NEP, Washington, DC.

World Bank, 1997, *World Development Report 1997*, Washington, DC.

World Bank, 1998, *India Water Resources Management Sector Review: Initiating and Sustaining Water Sector Reforms*, Report No 18356-IN, Washington, DC.

World Bank, 1998, *Kingdom of Morocco: Water Resources Management Project*, Report No. 15760-MOR, Washington, DC.

World Bank, 1999, *Socialist Republic of Vietnam: Mekong Delta Water Resources Project*, Project Appraisal Document, Washington DC.

World Bank, 1999, *Republic of Indonesia: Water Resources Sector Adjustment Loan*, Report No P 7304-IND, Washington DC.

World Bank, 2000, *Republic of Tunisia: Water Sector Investment Project*, Project Appraisal Document, Report No. 20422-TUN, Washington, DC.

World Bank, 2000, *Sudan: Options for the Sustainable Development of the Gezira Scheme*, Report No. 20398-SU, Washington, DC.

World Bank, 2000, *Argentina: Water Resources Management: Policy Elements for Sustainable Development in the 21st Century*," Report No. 20729-AR, Washington DC.

World Bank, Asian Development Bank, FAO, UNDP, and Water Resources Group, in Cooperation with the Institute of Water Resources Planning, Vietnam, 1996, *Vietnam Water Resources Sector Review*, Main Report, Washington DC.

World Economic Forum, 1997, *The World Competitiveness Report*, Geneva, Switzerland.

WRS, 1997, *Approach for Comprehensive Water Resources Management in Sri Lanka*, Colombo.

WRS, 1997, *Approach for Comprehensive Water Resources Management in Sri Lanka*, Colombo.

Yaffey, Michael, 1998, " Moral Standards and Transaction Costs: Long Term Effects" in Klaus Nielsen and Bjorn Johnson, eds., *Institutions and Economic Change*, Northampton, MA: Edward Elgar, pp. 258-290.

Yang, Youngseok, 1997, "Crafting Institutions and the Determination of Their Hierarchy in Environmental Policy-making: The Platte River as a Case Study", *Journal of Economic Issues*, 31(3): 834-40.

Yaron, Daniel, 1997, "Israel" in Ariel Dinar and Ashok Subramanian, eds.

Zekri, Slim, 1997, "Tunisia" in Ariel Dinar and Ashok Subramanian, eds..

Zilberman, David, et al., 1998, *Private and Institutional Adaptation to Water Scarcity During the California Drought, 1987-1991*, Staff Paper of the Economic Research Service, US Department of Agriculture, Washington, DC.

Appendix-A

QUESTIONNAIRE

COMPARATIVE STUDY OF WATER INSTITUTIONS AND THEIR IMPACT ON WATER SECTOR PERFORMANCE IN SELECT COUNTRIES

(A World Bank-funded Research Project)

REQUEST to RESPONDENTS

Knowing fully well the value of your time and information, it is our intention to use them as efficiently as we can and, of course, with full acknowledgement of your specific views and contributions (unless stated specifically to the contrary). Thanks, in advance, for your co-operation and active support to this pioneering study.

(A) Definitions

1. Water Institution = An entity defined interactively by water law, water policy, and water administration both at the formal and informal as well as macro and micro levels

2. Water Sector = Covers all consumptive uses of water like irrigation, domestic consumption, and industrial processing from both surface and sub-surface sources as well as reclaimed or recycled sources. Non-consumptive uses like hydel power generation, navigation, and in-stream ecological needs are considered only to the extent of their effect on consumptive uses directly or indirectly.

3. Water Sector Performance = Covers physical performance (Demand vs. Supply), operational performance (allocational ease and its efficiency), and financial performance (cost recovery and pricing efficiency)

(B) Notes

1. This questionnaire is intended essentially to highlight major issues as a starting point to initiate discussion and **elicit gut-feeling response** of country experts, specialists, and policy-makers. Since it does not exhaust all issues (especially the country-specific ones), **additional issues are most welcome to be brought to our attention**. Your valuable comments/suggestions on and modifications/ refinements of specific issues are of utmost value as we plan to further fine-tune this questionnaire and mail/email/fax it to many experts worldwide subsequent to this initial and personalized survey.

2. Given the nature of the subject under study, questions with straightforward quantitative answers are inter-related with questions that allow only qualitative or **judgmental response**. The latter set of questions can be quantified by carefully **choosing a value on a 1 to 10 scale** ***(1 = the least and 10 = the best)*** along with the reason(s) justifying the choice of the assigned value.

3. Inter-connectivity among issues makes the questions not only inter-related but also repetitive. The repetition of the same questions in different contexts is deliberately intended to crosscheck the response as well as to capture the multifarious effects of the same aspect in different institutional and performance contexts.

4. **Kindly try to answer all the questions in all the three section** of this questionnaire. Since we aim at evaluating the inter-linkages among the three components of water institution (water law, water policy, and water administration), a **completely responded questionnaire is critical.**

5. Besides the structural questionnaire and open-ended discussion, we also seek your help/direction in obtaining published/unpublished materials and data on water institution and water sector performance. For this purpose, a **checklist of quantitative data needed** for the study is given at the end of the questionnaire.

(C) Background Information

1. Respondent's Name (Optional) ....

2. Specialization — Economist/Engineer/Legal expert/ Others (specify)...

3. Affiliation ....

4. Address ....
....
....
....
Email:..
Phone:...
Fax:..

5. Any Other Relevant Information: ....
....

1. WATER LAW

1.1. Legal Treatment of Different Water Sources *(Tick one/more)*

(a) Surface and groundwater are treated alike ....
(b) They are treated differently ....
(c) Laws discriminate water development/use by public and private parties ....
(d) Law distinguishes water development/use across sectors like irrigation, domestic, and industrial uses ....
(e) Differential priority and treatment of consumptive and non-consumptive uses. ....

1.2. Legal Linkages between Water and Water-related Resources

1.2.1. In your perception, how strong are the legal linkages *(On a 1 to 10 scale)*

(a) Between land and groundwater ....
(b) Between land and surface water ....
(c) Between forest/environment and water ....

1.3. Property Rights Status (*Local Level*)

1.3.1. Whether water law allows private water rights Yes/No

1.3.2. If yes, is it is in the form of *(Tick one or more)*:

(a) Individual rights ....
(b) Group/collective rights ....
(c) Other forms (specify)
....
....

1.4.3. If no, what are the constraints *(Tick one or more)*?

(a) Public control is needed for equity ....
(b) Administering private rights is socially difficult ....
(c) Gaps in water control institutions/technologies ....
(d) Others (specify)
....
....

1.5. Property Rights Status (*General*)

1.5.1. Basis for general rights in surface water *(Tick one or more)*

(a)	None or not clear	....
(b)	Common/state property	....
(c)	Riparian system	....
(d)	Appropriative system	....
(e)	Correlative system (Equal/proportional sharing)	....
(f)	Any other, please specify	
	....	....

1.5.2. Basis for general rights in groundwater *(Tick one or more)*

(a)	Open access	....
(b)	Common/state property	....
(c)	Appropriative system	....
(d)	Correlative system (Equal/proportional sharing)	....
(e)	Any other, please specify	
	....	....

1.5.3. Is there legalized inter-sectoral prioritization? Yes/No

1.5.3.1. If yes, specify the priority order *(by placing rank number)*

(a)	Domestic use	....
(b)	Irrigation	....
(c)	Industrial/commercial uses	....
(d)	Power generation	....
(e)	Navigation	....
(f)	Environmental purpose (e.g., in-stream needs)	....

1.5.3.2. What is the main basis of such prioritization?
(Tick one or more. If more than one, indicate relative importance on a 1 to 10 scale)

(a)	Equity concerns	....
(b)	Resource conditions	....
(c)	Economic considerations	....
(d)	Any other, specify (e.g., historical reasons)	
	....	....
	....	....

1.6. Conflict Resolution/Co-ordination

1.6.1. Are the conflict resolution mechanisms explicitly specified in law? Yes/No/Not Clear

1.6.2. If yes, indicate the kind of conflict resolution mechanisms

		(Tick)	*(Tick)*
(a)	Administratively/bureaucratically rooted system (Water Resource Dept., Irrigation Dept., etc.)		--------
	(i) Local administration/govt.	....	
	(ii) National Water Council	....	
(b)	Relatively more decentralized system	--------	
	(i) River boards	....	
	(ii) Basin organization	....	
	(iii) Any others, specify (e.g., WUAs)		
	....	....	
	....	....	
	....	....	
(c)	Tribunals		--------
(d)	Judicial/legislative/constitutional		--------
(e)	Any others, specify		
	....	....	

1.6.3. What are the legally specified mechanisms for trans-boundary conflicts (inter-state and international)?

(a) River boards ....
(b) Basin organizations ....
(c) Tribunals ....
(d) Others specify
....

1.6.4. In your learned judgement, how effective are the legal provisions for conflict resolution/co-ordination mechanisms *(On a 1 to 10 scale)*?

(a) Local level (among users) ....
(b) National level (among regions/sectors) ....
(c) International level (among nations) ....

1.7. Accountability of Water Sector Officials and Water Users

1.7.1. Are there explicit legal provisions for ensuring the accountability of officials/water suppliers/users? Yes/No/Not Clear

1.7.2. If yes, specify the legal instruments for the accountability of *(Tick one or more in each case)*

(a)	Officials	(i)	Indemnity clause in water law	....
		(ii)	Penalty provisions in water law	....
		(iii)	Other administrative actions	....
(b)	Users	(i)	Sanctions/tortious liabilities	....
		(ii)	User-oriented/decentralized Mechanisms (e.g., WUAs)	....
		(iii)	Actions by local govt./ irrigation department/ water supply agency, etc.	....

1.7.3. In your learned judgement, how effective are the accountability provisions? *(On a 1 to 10 scale)*

(a) For the officials ....
(b) For the users ....

1.7.4. Do the accountability provisions vary by

(a) Water sources ....
(b) Use Categories ....
(c) User groups ....
(d) None ....

1.8. Intra-governmental Responsibility in Water Law

1.8.1. Please indicate *(by ticking)* current intra-governmental responsibility

Govt. Layer	*Surface Water*	*Ground Water*	*Recycled Water*	*Water Quality*	*Environ -ment*
National	....	....	....	....	....
State	....	....	....	....	....
Local	....	....	....	....	....

1.8.2. Does the existing division of legal responsibility favor an integrated treatment of water planning/development? Yes/No

1.8.3. If yes, how strong is such favorable effect *(On a 1 to 10 scale)*? ....

1.8.4. Is there a legally conceivable property rights in water quality (i.e., pollution permits)? Yes/No

1.8.5. Please specify the legal provisions for pollution control.

(a) Quality standards ....
(b) Pollution control legislation ....
(c) Any other, Specify
....

1.8.6. In your opinion, how effective are the overall legal provisions in protecting water quality *(On a 1 to 10 scale)*? ....

1.9. Overall Evaluation

1.9.1. Does the present law tend to contribute to centralization? Yes/No

1.9.2. In your opinion, how strong is the tendency towards centralization *(On a 1 to 10 scale)* ? ....

1.9.3. How favorable are the legal provisions for private sector/Non-Governmental Organization (NGO)/community participation in water development/management *(On a 1 to 10 scale)*?

Private sector ....
NGO ....
Community ....

1.9.4. In your opinion, how integrated are water laws with other laws related to land, forest, and environment *(On a 1 to 10 scale)*? ....

1.9.5. In your opinion, how relevant are the water and related laws for the current situation *(On a 1 to 10 scale)* ....

1.9.6. How strong is water law *(On a 1 to 10 scale)* in addressing new challenges in the sphere of

(a) Water sharing conflicts ....
(b) Environmental concerns ....
(c) New water technologies ....

2. WATER POLICY

2.1. Water Policy Implications in Other Policies and Law *(Tick one or more)*

(a) Water law ....
(b) Agricultural policy ....
(c) Fiscal policies ....
(d) Credit/investment policies ....
(e) Environmental policies ....

2.2. Priority of Uses

2.2.1. If inter-sectoral use priority is not explicit in water law, is it stated--explicitly or implicitly--in other policies? Yes/No

2.2.2. If yes, specify the order *(By placing a rank)*

(a) Domestic use ....
(b) Irrigation ....
(c) Industrial/commercial use ....
(d) Power generation ....
(e) Navigation ....
(f) Environmental purpose (in stream use, etc.) ....

2.2.3. Is such prioritization rooted more in *(Tick one or more)*

(a) Equity concerns ....
(b) Resource conditions ....
(c) Economic considerations ....
(d) Any other, specify (e.g., historical reasons)
....

2.3. Project Selection Criteria

2.3.1. Indicate *(by ticking)* the dominant criteria used in water project selection

	Criterion	*Irrigation Project*	*Urban Project*	*Multi-purpose Scheme*
(a)	Benefit-cost ratio	....	....	....
(b)	Internal rate of return	....	....	....
(c)	Equity factors	....	....	....
(d)	Ecological factors	....	....	....
(e)	Any other, specify			
	....	....	....	....

2.3.2. In case more than one criterion is used, please indicate your *Judgmental percentage (or proportion)* of projects using each criteria

	Criterion	*Irrigation Project*	*Urban Project*	*Multi-purpose Scheme*
(a)	Benefit-cost ratio	....	....	....
(b)	Internal rate of return	....	....	....
(c)	Equity factors	....	....	....
(d)	Ecological factors	....	....	....
(e)	Any other, specify			
	....	....	....	....

2.3.3. In case the project selection criteria vary by the type of projects, please indicate *(by ticking)*.

Criterion	*Local Fund*	*Foreign Fund/aid*	*New Constr -uction*	*Improv -ing old projects*	*Managerial Improvement/ Institutional Improvement*
(a) Benefit-cost ratio	....	....	....	....	....
(b) Internal rate of return	....	....	....	....	....
(c) Equity factors	....	....	....	....	....
(d) Ecological factors	....	....	....	....	....
(e) Other specify					
....	....	....	....	....	....

2.3.4. Do you feel that the recent trend in project selection criteria is towards economic orientation? Yes/No

2.4. Pricing and Cost Recovery

2.4.1. How often water prices/charges are revised *(Please tick)*?

	Irrigation	*Domestic Use* Urban	Rural	*Industrial*
(a) Often	....	....	....	....
(b) Infrequently	....	....	....	....
(c) Rarely	....	....	....	....
(d) Not revised	....	....	....	....

2.4.2. Water pricing based on *(Please tick)*

(a) Fullcost recovery	....	....	....	....
(b) Partial recovery	....	....	....	....
(c) Full subsidy	....	....	....	....

2.5. Inter-regional and inter-sectoral water transfers

2.5.1. Are there well-established policies or precedent for

(a) Inter-regional water transfers	Yes/No
(b) Inter-sectoral water transfers	Yes/No

2.5.2. If yes, what is the dominant basis for such transfers *(Tick one or more)*?

		Inter-regional	*Inter-sectoral*
(a)	Equity concerns	....	....
(b)	Resource conditions	....	....
(c)	Economic considerations	....	....
(d)	Any other, specify	....	....

2.5.3. What is the dominant means for such water transfers *(Tick one or more)*?

		Inter-regional	*Inter-sectoral*
(a)	Purely a political decision	....	....
(b)	Administrative dictates	....	....
(c)	Negotiation	....	....
(d)	Water Market (i) Macro	....	....
	(ii) Micro	....	....
(e)	Any other, specify	....	....

2.5.4. What is the organizational basis for water transfers *(Tick one or more)*?

		Inter-regional	Inter-sectoral
(a)	River Boards	....	....
(b)	Basin Level Organizations	....	....
(c)	Tribunals	....	....
(d)	Other Decentralized systems (Stakeholders, WUAs, etc.)	....	....

2.5.5. Efficiency and extensiveness of water transfers *(On a 1 to 10 scale)*

		Inter-regional Transfers	*Inter-sectoral Transfers*
(a)	How extensive are they?		
	(i) Macro level	....	....
	(ii) Micro level	....	....
(b)	How smooth are they?		
	(i) Macro level	....	....
	(ii) Micro level	....	....

2.6. Other Policies Affecting Water Development/Use

2.6.1 Other policies affecting water development/use.

		Tick	*(1 to 10)*
(a)	Agricultural policies	....	....
(b)	Energy/power policies	....	....
(c)	Soil conservation policies	....	....
(d)	Pollution control/environmental policies	....	....
(e)	Fiscal policies (structural adjustment)	....	....
(f)	Credit/investment policies	....	....
(g)	Foreign investment/aid policies	....	....
(h)	Others, specify (e.g., trade policies)	....	....

2.7 Privatization and Decentralization Tendencies

2.7.1 Do state policies favor water sector privatization? Yes/No

2.7.2 If yes, how favorable are those policies *(On a 1 to 10 scale)*?

(a)	Irrigation	....
(b)	Urban domestic use	....
(c)	Rural domestic use	....
(d)	Industrial/commercial use	....

2.7.3 How extensive is private sector participation *(On a 1 to 10 scale)?*

(a)	Irrigation	....
(b)	Urban domestic use	....
(c)	Rural domestic use	....
(d)	Industrial/commercial/use	....

2.7.4 In your opinion, how well are users disposed towards private sector involvement in water sector *(Tick one)*?

(a)	Favorable overall	....
(b)	Favorable in particular sector	....
(c)	Not favorable	....
(d)	Indifferent	....
(e)	Opposed	....

2.7.5 Do state policies favor user participation/decentralization? Yes/No

2.7.6 If yes, how favorable are these policies *(On a 1 to 10 scale)*?

		Planning	*Development*	*Management*
(a)	Irrigation	....	....	....
(b)	Urban domestic use	....	....	....
(c)	Rural domestic use	....	....	....
(d)	Industrial/commercial/use	....	....	....

2.7.7 How extensive is user participation *(On a 1 to 10 scale)*?

		Planning	*Development*	*Management*
(a)	Irrigation	....	....	....
(b)	Urban domestic use	....	....	....
(c)	Rural domestic use	....	....	....
(d)	Industrial/commercial use	....	....	....

2.7.8 How well are government officials disposed towards user participation and decentralization *(Tick one)*?

		User Participation	Decentralization
(a)	Favorable overall	....	....
(b)	Favorable in selective contexts	....	....
(c)	Not favorable	....	....
(d)	Indifferent	....	....
(e)	Opposed	....	....

2.7.9 How effective are NGO's (users, private sector, and foreign funding and technical agencies) participation in water sector *(On a 1 to 10 scale)*?

	Resource Development Planning	*Resource Development* Finance	*Resource Development* Execution	*Distribution*	*Management*
I. Irrigation					
(a) User groups	....	....	....	....	....
(b) Private sector	....	....	....	....	....
(c) Foreign aid/ Funding agencies	....	....	....	....	....
(d) Foreign private technical firms	....	....	....	....	....
II Domestic Use					
(a) User groups	....	....	....	....	....
(b) Private sector	....	....	....	....	....
(c) Foreign aid/ Funding agencies	....	....	....	....	....
(d) Foreign private technical firms	....	....	....	....	....

2.8. Policies towards Water Technologies/Extension/Recycling

2.8.1. How effective are these policies *(On a 1 to 10 scale)*?

(a) Water technology policies

(i)	Measuring devices	....
(ii)	Recycling technologies	....
(iii)	Drip systems	....
(iv)	Sprinkler systems	....
(v)	Any other, specify	....

(b) Water technology policies

(i)	Water saving methods	....

(ii) Climate/rain forecasts ....
(iii) Drought resistant crops and farming practices ....
(iv) Water quality/sanitation ....
(v) Any other, specify
....

(c) Water technology policies
(i) Regulatory policies ....
(ii) Incentives policies ....
(iii) Research/extension/education ....
(iv) Any other, specify
....

(d) Technological application policies
(i) Satellites/Remote sensing ....
(ii) Computers ....
(iii) Geographical information system ....
(iv) Management information system ....
(v) Any other, specify
....

2.9 Linkage between Water Law and Water Policy

2.9.1 How well water policy reflects water law *(on a 1 to scale)*? ....

3. WATER ADMINISTRATION

3.1 Government Branches and Departments Influencing Water Sector

3.1.1 Indicate your judgement on the relative role and influence of government branches on water sector *(On a 1 to 10 scale)*

	Irrigation	*Domestic use*	*Industrial Use*
(a) Central/Federal Govt.	....	....	....
(b) State/Regional Govt.	....	....	....
(c) Local Govt.	....	....	....
(d) Statutory Bodies/Authorities	....	....	....

3.1.2 Is there an exclusive department for water Yes/No

3.1.3 If not, indicate *(On a 1 to 10 scale)* the influence of departments on water sector.

(a) Water Resources/Irrigation Department ....
(b) Agricultural Department ....
(c) Environment and Forest Department ....
(d) Urban/Local Admin. Dept. ....
(e) Legal Department ....
(f) Others, specify
(e.g., Economic Affairs/finance) ....

3.1.4 To what extent administrative co-ordination is achieved?
(on 1 to 10 scale) ....

3.1.5 Is there a specialized agency for different sub-sectors? Yes/No

3.16 If yes, name the agency for each sub-sector:

Surface water ....
Groundwater ....
Water Quality ....
Recycling ....
Irrigation ....
Urban Use ....
Rural Use ....
Hydro Power ....

3.1.7 If there is no exclusive Department for water sector or specialized agencies for different sub-sector, indicate *(On a 1 to 10 scale)* the extent this lacuna deter better water administration ....

3.2. Organizational Basis and Structure of Water Administration

3.2.1. How the water administration is organized *(Tick)*

(a) On administrative division (mere geographical basis) ....
(b) On Hydro-geological regions ....
(c) River Basins ....
(d) Mixture of all ....

3.2.2 How strong is the functional capacity in following spheres *(On a 1 to 10 scale)*?

(a) Planning and design ....
(b) Implementation ....

(c) Financial Management ....
(d) Operation and maintenance ....
(e) Rehabilitation and resettlement ....
(f) Environmental monitoring ....
(g) Research, training, and extension ....
(h) Inter-agency/dept. relationships ....
(i) Others, specify (e.g., public relations/accountability) ....

3.2.3 Is functional specialization within water administration balanced? Yes/No

3.2.4 If no, what are the gaps in the existing administrative set-up (*Please list them with their priority ranking*)?

3.3 Financing and Staffing Pattern

3.3.1 Do you feel water administration budget to be adequate to meet the modernization and strengthening objectives? Yes/No

3.3.2 If yes, how serious is the budget constraint *(On a 1 to 10 scale)*? ....

3.3.3 Is the water administration overstaffed? Yes/No

3.3.4 If yes, how strong is the scope for staff reduction *(On a 1 to 10 scale)*? ....

3.3.5 Can privatization and community participation lead to redundancy in water administration? Yes/No

3.3.6 If yes, how strong is the staff reduction effect *(On a 1 to 10 scale)*

(a) Privatization ....
(b) User participation ....

3.3.7 If no, are privatization and user participation complements but not substitutes in staffing context? Yes/No

3.4. Water Pricing and Fee Collection Bodies

3.4.1. Is there an independent body for determining water price Yes/No

3.4.1.1. If yes, state the name of the body and its relationship with water administration

(a) Name ....

(b) Its Administrative Relationship ....

3.4.1.2. If no, what are the agencies involved in price determination?
(Please list them for various water uses like irrigation, water supply, etc.).

3.4.2. Are the price determination and fee collection functions performed by the same agency? Yes/No

3.4.3. If no, which agency performs fee collection?
(Please list them)

3.5. Regulatory and Accountability Mechanisms

3.5.1. What are the regulatory mechanisms and how effective are they at the implementation stage

	Mechanisms *(Tick)*	Effectiveness *(On a 1 to 10 scale)*
(a) Legal Regulations	....	....
(b) Administrative directions	....	....
(c) Pollution control agencies	....	....
(d) River Boards	....	....
(e) Basin Organizations	....	....
(f) Groundwater Regulations		
(i) Depth Restrictions	....	....
(ii) Spacing regulations	....	....
(g) Withdrawal restrictions (Water rights, quota)	....	....
(h) Limits on moving water across regions (surface water)	....	....
(i) Any other, specify	....	....

3.5.2. In what way, the legal provisions of accountability are administratively (or organizationally) translated and how effective are they in practice?

		(Tick)	*(On a 1 to 10 scale)*
(a)	**Within formal water administration**		
(i)	Administrative Supervision	....	....
(ii)	Financial Auditing (Public Accounts Committees)	....	....
(iii)	Work Auditing	....	....
(iv)	Grievance cells	....	....
(v)	Monitoring procedure for sectoral/regional water allocation	....	....
(vi)	Inter-ministerial committees	....	....
(vii)	Any other, specify	....	....
(b)	**Outside formal Water Administration**		
(i)	Local User Groups	....	....
(ii)	NGOs	....	....
(iii)	Local Administration (Govt.)	....	....
(iv)	Any other, specify (statutory Bodies)	....	....

3.6. Information Basis of Water Sector

3.6.1. Is there a separate wing within water administration for water data collection/updating/maintenance? Yes/No

3.6.1.1. If yes, please state the name of the agency.

3.6.1.2. If no, which other agency or agencies maintain water data? *(Please list them)*

3.6.2. Are water data published regularly? Yes/No

3.6.3. Are water data computerized? Yes/No

3.6.4. How adequate and reliable *(On a 1 to 10 scale)* are water data for planning purpose?

(a)	Adequacy	....
(b)	Reliability	....

3.6.5. How strong *(On a 1 to 10 scale)* is the information flow between irrigation/water department and water/land research institutes/experiment stations/universities?

(a) Research Institutes ....
(b) Experiment Stations ....
(c) Universities/experts ....

3.6.7. How strong *(On a 1 to 10 scale)* is the influence of water administration on the research agenda of the research institutes/experiment stations/universities/experts?

(a) Research Institutes ....
(b) Experiment Stations ....
(c) Universities/experts ....

3.6.8. Do you feel the ongoing research adequately address the emerging issues in water sector *(On a 1 to 10 scale)*? ....

3.7. Use of Science and Technology in Water Administration

3.7.1. Please indicate the extent *(On a 1 to 10 scale)* the following science/technology components are used within water administration.

(a) Computers ....
(b) Remote sensing and satellite ....
(c) Research/experimental information ....
(d) Modern accounting/auditing techniques ....
(e) Management information system ....
(f) Geographic information system ....
(g) Wireless communication ....
(h) Water measuring technology ....
(i) Computerized dynamic regulation of canal/water delivery networks ....
(j) Any other, specify ....

3.8. Overall Evaluation

3.8.1. How strong are the administrative and technical linkages between water administration and research system *(On a 1 to 10 scale)* ....

3.8.2. How adequate is the administrative setup to operationalise water policy and water law *(On a 1 to 10 scale)?* ....

4. WATER SECTOR & WATER INSTITUTION: OVERALL PERFORMANCE

4.1. **Physical Performance** *(On a 1 to 10 scale)*

(a) Ability to bridge overall demand-supply ....
(b) Physical Health of Water Development Projects ....
(b) Conflict resolution efficiency (low-cost and less time) ....
(c) Smoothness of water transfers across sectors/regions ....
(d) Smoothness of water transfers among users ....

4.2. **Financial Performance** *(On a 1 to 10 scale)*

(a) Actual investment vs. investment requirements ....
(b) Cost recovery vs. expenditure ....

4.3. **Economic Efficiency** *(On a 1-10 scale)*

(a) Extent water prices cover supply cost ....
(b) Extent water price cover scarcity value ....

4.4. **Equity Performance** *(On a 1 to 10 scale)*

(a) Equity between regions ....
(c) Equity between sectors ....
(d) Equity among social groups ....

4.5. **Progressives of Water Institution** *(On a 1 to 10 scale)* ....
(Key Considerations here include factors like technological applications, innovation, openness for change, etc.).

Appendix-B

LIST OF EXPERTS MET AND PROVIDED INPUT AND DATA

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Appendix-C

MATHEMATICAL ANALOGUE FOR IMPACT TRANSMISSION CHANNELS

The purpose of this appendix is to show the derivation of the mathematical analogue for the 64 impact transmission channels associated with the exogenous variables listed in Table 9.1. The mathematical analogue of the channels are represented in terms of the partial derivatives of the 10 equations in model B with respect to the exogenous variables as well as to some of the endogenous variables entering as independent variables in few equations. For representing the partial derivatives in a compact manner, it is necessary to denote the variables by compact notations rather than by their full names. Thus, the 16 exogenous variables are denoted by X_i (i = 1, 2, …, 16) and 10 exogenous variables in model are denoted as Y_j (j = 1, 2, …, 10). The names and notations used for these variables are tabulated below.

Variable Name	Notation Used
LPRSRF	X1
PGPIUP	X2
POWLWL	X3
POPAWE	X4
AIBDWP	X5
PGPIPP	X6
LOEPRV	X7
AACCME	X8
ABALFS	X9
AARINF	X10
LTRWSA	X11
LINTRE	X12
LOECEN	X13
PPSCRI	X14
AORGBA	X15
AEXTST	X16
LCRMEE	Y1
PIRSWE	Y2
PCOREC	Y3
ASBUDC	Y4
LACPRE	Y5
LOEFWL	Y6
POEFWP	Y7
AOEFWA	Y8
WIPOEV	Y9
WSOPEV	Y10

With the assigned notations for all the exogenous and endogenous variables, the ten equations of model B can be represented as:

$$Y_1 = F_1(X_1, X_2, X_4, X_9, X_{10}, X_{16})$$

$$Y_2 = F_2(X_1, Y_1, X_2, X_{16})$$

$$Y_3 = F_3(X_1, X_2, X_4, X_5)$$

$$Y_4 = F_4(X_2, X_5, Y_3, X_6)$$

$$Y_5 = F_5(X_1, X_3, Y_3, X_7, X_8)$$

$$Y_6 = F_6(X_1, X_5, Y_5, X_7, X_{11}, X_{12}, X_{13})$$

$$Y_7 = F_7(X_2, X_3, X_4, Y_3, X_6, X_{14}, Y_1)$$

$$Y_8 = F_8(X_5, X_8, X_9, X_{10}, X_{15}, Y_4, X_{16})$$

$$Y_9 = F_9(Y_6, Y_7, Y_8)$$

$$Y_{10} = F_{10}(Y_9, X_4, Y_3, X_{10}, Y_4, X_{16}).$$

Since the first nine equations are sequentially linked with the tenth equation, the 10 equations of model B can also be written as a single equation, i.e.,

$$\begin{aligned} Y_{10} = F_{10} \Big\| F_9 \Big\langle & F_6 \{X_1, F_1(X_1, X_2, X_4, X_9, X_{10}, X_{16}), F_5[X_1, X_3, F_3(X_1, X_2, X_4, X_5), \\ & X_7, X_8], X_7, X_{11}, X_{12}, X_{13}\}, \\ & F_7\{X_2, X_3, X_4, F_3(X_1, X_2, X_4, X_5), X_6, X_{14}, F_2[X_1, F_1(X_1, X_2, X_4, X_9, \\ & X_{10}, X_{16}), X_2, X_{16}]\}, \\ & F_8\{X_5, X_8, X_9, X_{10}, X_{15}, F_4[X_2, X_5, F_3(X_1, X_2, X_4, X_5), X_6], X_{16}\}\Big\rangle, \\ & X_4, F_3(X_1, X_2, X_4, X_5), X_{10}, F_4[X_2, X_5, F_3(X_1, X_2, X_4, X_5), X_6], X_{16}\Big\|. \end{aligned}$$

Notice that this equation is defined exclusively in terms of the 16 exogenous variables. By differentiating this equation with respect to each of the 16 exogenous variables, it is possible both to provide a mathematical description of all the impact transmission channels as well as to have a quantitative evaluation of their impact transmission in terms of the relevant value of the partial derivatives. As explained in Chapter 9, the partial derivative with respect to an exogenous variable is nothing but its coefficient in the relevant equation.

As we differentiate the single equation noted above with respect to X_1 (LPRSRF), we obtain the following differential chain:

$$\frac{\partial Y_{10}}{\partial X_1}=\frac{\partial F_{10}}{\partial X_9}\left\langle\frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial X_1}+\frac{\partial F_6}{\partial F_1}\frac{\partial F_1}{\partial X_1}+\frac{\partial F_6}{\partial F_5}\left[\frac{\partial F_5}{\partial X_1}+\frac{\partial F_5}{\partial F_3}\frac{\partial F_3}{\partial X_1}\right]\right\}\right.$$

$$+\frac{\partial F_9}{\partial F_7}\left\{\frac{\partial F_7}{\partial F_3}\frac{\partial F_3}{\partial X_1}+\frac{\partial F_7}{\partial F_2}\left[\frac{\partial F_2}{\partial X_1}+\frac{\partial F_2}{\partial F_1}\frac{\partial F_1}{\partial X_1}\right]\right\}$$

$$\left.+\frac{\partial F_9}{\partial F_8}\left\{\frac{\partial F_8}{\partial F_4}\frac{\partial F_4}{\partial F_3}\frac{\partial F_3}{\partial X_1}\right\}\right\rangle+\frac{\partial F_{10}}{\partial F_3}\left\{\frac{\partial F_3}{\partial X_1}+\frac{\partial F_4}{\partial F_3}\frac{\partial F_3}{\partial X_1}\right\}.$$

As we expand this differential chain, we find ten terms each of which—defined by a product of two or more partial derivatives—represents the impact being transmitted respectively by the 10 channels associated with LPRSRF. Thus, the differential chain captures the total impact of a marginal change in LPRSRF that is being transmitted in 10 different channels.

Similarly, when we differentiate the single equation with respect to X_2, the following differential chain captures the total impact of a marginal change in PGPIUP being transmitted through 11 channels.

$$\frac{\partial Y_{10}}{\partial X_2}=\frac{\partial F_{10}}{\partial F_9}\left\langle\frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial F_1}\frac{\partial F_1}{\partial X_2}+\frac{\partial F_6}{\partial F_5}\frac{\partial F_5}{\partial F_3}\frac{\partial F_3}{\partial X_2}\right\}\right.$$

$$+\frac{\partial F_9}{\partial F_7}\left\{\frac{\partial F_7}{\partial X_2}+\frac{\partial F_7}{\partial F_3}\frac{\partial F_3}{\partial X_2}+\frac{\partial F_7}{\partial F_2}\left[\frac{\partial F_2}{\partial F_1}\frac{\partial F_1}{\partial X_2}+\frac{\partial F_2}{\partial X_2}\right]\right\}$$

$$\left.+\frac{\partial F_9}{\partial F_8}\left\{\frac{\partial F_8}{\partial F_4}\left[\frac{\partial F_4}{\partial X_2}+\frac{\partial F_4}{\partial F_3}\frac{\partial F_3}{\partial X_2}\right]\right\}\right\rangle+\frac{\partial F_{10}}{\partial F_3}\left\{\frac{\partial F_3}{\partial X_2}\right\}+\frac{\partial F_{10}}{\partial F_4}\left\{\frac{\partial F_4}{\partial X_2}+\frac{\partial F_4}{\partial F_3}\frac{\partial F_3}{\partial X_2}\right\}.$$

We can verify that the differential chain has 11 products of partial derivatives and the sum of which defines the total impact of a marginal change in PGPIUP on the ultimate dependent variable of the system, i.e., WSPOEV representing the overall performance of water sector.

The differentiation of the single equation with respect to X_3 (POELWL) yields the following differential chain.

$$\frac{\partial Y_{10}}{\partial X_3}=\frac{\partial F_{10}}{\partial F_9}\left\langle\frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial F_5}\frac{\partial F_5}{\partial X_3}\right\}+\frac{\partial F_9}{\partial F_7}\frac{\partial F_7}{\partial X_3}\right\rangle.$$

As can be seen, this differential chain involves two product terms. These terms capture the impact of a marginal change in POELWL that is being transmitted through its two impact transmission channels. On the other hand, the differentiation of the single equation with respect to X_4 (POPAWE) yields the following differential chain.

$$\frac{\partial Y_{10}}{\partial X_4}=\frac{\partial F_{10}}{\partial F_9}\left\langle\frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial F_1}\frac{\partial F_1}{\partial X_4}+\frac{\partial F_6}{\partial F_5}\frac{\partial F_5}{\partial F_3}\frac{\partial F_3}{\partial X_4}\right\}\right.$$

$$+\frac{\partial F_9}{\partial F_7}\left\{\frac{\partial F_7}{\partial X_4}+\frac{\partial F_7}{\partial F_3}\frac{\partial F_3}{\partial X_4}+\frac{\partial F_7}{\partial F_2}\frac{\partial F_2}{\partial F_1}\frac{\partial F_1}{\partial X_4}\right\}$$

$$\left.+\frac{\partial F_9}{\partial F_8}\left\{\frac{\partial F_8}{\partial F_4}\frac{\partial F_4}{\partial F_3}\frac{\partial F_3}{\partial X_4}\right\}\right\rangle+\frac{\partial F_{10}}{\partial X_4}+\frac{\partial F_{10}}{\partial F_3}\frac{\partial F_3}{\partial X_4}+\frac{\partial F_{10}}{\partial F_4}\frac{\partial F_4}{\partial F_3}\frac{\partial F_3}{\partial X_4}.$$

This differential chain has nine terms. All term except one involve the products of two or more partial derivatives. While these terms capture the indirect effects of POPAWE, the one with a single partial derivative capture its direct effect. In any case, these nine terms capture respectively the value of impact being transmitted through the nine channels associated with POPAWE.

By differentiating the single equation with respect to X_5 (AIBDWP), we obtain the following differential chain consisting of eight terms each of which represents the impact being transmitted by the eight channels associated with AIBDWP.

$$\frac{\partial Y_{10}}{\partial X_5}=\frac{\partial F_{10}}{\partial F_9}\left\langle\frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial F_5}\frac{\partial F_5}{\partial F_3}\frac{\partial F_3}{\partial X_5}\right\}+\frac{\partial F_9}{\partial F_7}\left\{\frac{\partial F_7}{\partial F_3}\frac{\partial F_3}{\partial X_5}\right\}\right.$$

$$\left.+\frac{\partial F_9}{\partial F_8}\left\{\frac{\partial F_8}{\partial X_5}+\frac{\partial F_8}{\partial F_4}\left[\frac{\partial F_4}{\partial X_5}+\frac{\partial F_4}{\partial F_3}\frac{\partial F_3}{\partial X_5}\right]\right\}\right\rangle$$

$$+\frac{\partial F_{10}}{\partial F_3}\frac{\partial F_3}{\partial X_5}+\frac{\partial F_{10}}{\partial F_4}\left[\frac{\partial F_4}{\partial X_5}+\frac{\partial F_4}{\partial F_3}\frac{\partial F_3}{\partial X_5}\right].$$

The differentiation with respect to X_6 (PGPIPP) yields the following differential chain involving three terms corresponding to three impact transmission channels associated with the exogenous variable in question.

$$\frac{\partial Y_{10}}{\partial X_6}=\frac{\partial F_{10}}{\partial F_9}\left\langle\frac{\partial F_9}{\partial F_7}\left\{\frac{\partial F_7}{\partial X_6}\right\}+\frac{\partial F_9}{\partial F_8}\left\{\frac{\partial F_8}{\partial F_4}\frac{\partial F_4}{\partial X_6}\right\}\right\rangle+\frac{\partial F_{10}}{\partial F_4}\frac{\partial F_4}{\partial X_6}.$$

Similarly, the differentiation with respect to X_7 (LOEPRV) and X_8 (AACCME) yield the following differential chains involving two terms each that represent the magnitude of the impact being transmitted by the two channels associated with each of these exogenous variables.

$$\frac{\partial Y_{10}}{\partial X_7}=\frac{\partial F_{10}}{\partial F_9}\left\langle\frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial F_5}\frac{\partial F_5}{\partial X_7}\right\}+\frac{\partial F_6}{\partial X_7}\right\rangle \text{ and}$$

$$\frac{\partial Y_{10}}{\partial X_8} = \frac{\partial F_{10}}{\partial F_9}\left\langle \frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial F_5}\frac{\partial F_5}{\partial X_8}\right\} + \frac{\partial F_9}{\partial F_8}\left\{\frac{\partial F_8}{\partial X_8}\right\}\right\rangle.$$

As we differentiate the single equation with respect to X_9 (ABALFS), we obtain the following differential chain.

$$\frac{\partial Y_{10}}{\partial X_9} = \frac{\partial F_{10}}{\partial F_9}\left\langle \frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial F_1}\frac{\partial F_1}{\partial X_9}\right\} + \frac{\partial F_9}{\partial F_7}\left\{\frac{\partial F_7}{\partial F_2}\frac{\partial F_2}{\partial F_1}\frac{\partial F_1}{\partial X_9}\right\} + \frac{\partial F_9}{\partial F_8}\left\{\frac{\partial F_8}{\partial X_9}\right\}\right\rangle.$$

This differential chain involving three terms captures both the individual and joint impact of a marginal change in ABALFS as transmitted through three channels associated with this variable. Similarly, the differentiation with respect to X_{10} (AARINF) yields the differential chain involving four terms corresponding to the four channels associated with this exogenous variable.

$$\frac{\partial Y_{10}}{\partial X_{10}} = \frac{\partial F_{10}}{\partial F_9}\left\langle \frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial F_1}\frac{\partial F_1}{\partial X_{10}}\right\} + \frac{\partial F_9}{\partial F_7}\left\{\frac{\partial F_7}{\partial F_2}\frac{\partial F_2}{\partial F_1}\frac{\partial F_1}{\partial X_{10}}\right\} + \frac{\partial F_9}{\partial F_8}\left\{\frac{\partial F_8}{\partial X_{10}}\right\}\right\rangle + \frac{\partial F_{10}}{\partial X_{10}}.$$

As can be seen, the last term captures the direct effect whereas others capture the indirect effect transmitted through one or more en route variables.

When we differentiate the single equation with respect to X_{11} (LTRSWA), X_{12} (LINTRE), X_{13} (LOECEN), X_{14} (PPSCRI), and X_{15} (AORGBA), we obtain the following differential chains involving just single term representing the impact being transmitted by the single channel associated with each of these exogenous variables.

$$\frac{\partial Y_{10}}{\partial X_{11}} = \frac{\partial F_{10}}{\partial F_9}\left\langle \frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial X_{11}}\right\}\right\rangle,$$

$$\frac{\partial Y_{10}}{\partial X_{12}} = \frac{\partial F_{10}}{\partial F_9}\left\langle \frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial X_{12}}\right\}\right\rangle,$$

$$\frac{\partial Y_{10}}{\partial X_{13}} = \frac{\partial F_{10}}{\partial F_9}\left\langle \frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial X_{13}}\right\}\right\rangle,$$

$$\frac{\partial Y_{10}}{\partial X_{14}} = \frac{\partial F_{10}}{\partial F_9}\left\langle \frac{\partial F_9}{\partial F_7}\left\{\frac{\partial F_7}{\partial X_{14}}\right\}\right\rangle, \text{ and}$$

$$\frac{\partial Y_{10}}{\partial X_{15}} = \frac{\partial F_{10}}{\partial F_9}\left\langle \frac{\partial F_9}{\partial F_8}\left\{\frac{\partial F_8}{\partial X_{15}}\right\}\right\rangle.$$

On the other hand, the differentiation with respect to X_{16} (AEXTST) yields the following differential chain involving five terms representing respectively the value of impact being transmitted by the five channels associated with this variable.

$$\frac{\partial Y_{10}}{\partial X_{16}} = \frac{\partial F_{10}}{\partial F_9}\left\langle \frac{\partial F_9}{\partial F_6}\left\{\frac{\partial F_6}{\partial F_1}\frac{\partial F_1}{\partial X_{16}}\right\} + \frac{\partial F_9}{\partial F_7}\left\{\frac{\partial F_7}{\partial F_2}\frac{\partial F_2}{\partial F_1}\frac{\partial F_1}{\partial X_{16}} + \frac{\partial F_2}{\partial X_{16}}\right\}\right.$$

$$\left. + \frac{\partial F_9}{\partial F_8}\left\{\frac{\partial F_8}{\partial X_{16}}\right\}\right\rangle + \frac{\partial F_{10}}{\partial X_{16}}.$$

We also note that the last term with a single partial derivative captures the direct effect while others involving the product of two ore more partial derivatives capture the indirect effect associated with a marginal change in AEXTST.

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