

Chinatown: Transaction Costs in Water Rights Exchanges

The Owens Valley Transfer to Los Angeles

by

Gary D. Libecap
Karl Eller Center and Department of Economics
University of Arizona, Tucson
National Bureau of Economic Research

November 4, 2004

Support was provided by NSF Grant 03 17375, co PIs Alan Ker and Robert Glenion; the Julian Simon Fellowship at the Property and Environment Research Center (PERC), Bozeman, Montana; the Earhart Foundation; and the International Center for Economic Research (ICER), Turin, Italy. Helpful comments were provided by Zeynep Hansen, Alan Ker, Price Fishback, Dean Lueck, Michael Hanemann, Ann Carlos, Robert Glennon, Lee Alston, Ellen Hanak, Terry Anderson P.J. Hill, Dan Benjamin, Claude Menard, Robert Fleck, Randy Rucker, Rick Stroup, Greg Crawford, Stan Reynolds, and Nick Parker as well as by participants at workshops at Montana State University, the Western Economics Association Meetings, Vancouver, BC, June 29-July 3, 2004; the NBER, DAE, Summer Institute, July 2004, and the Economic History Association Meetings, San Jose, September 9-12, 2004. Able research assistance was provided by Jed Brewer and Travis Rust. Special thanks go to Paul Soifer for graciously making the Los Angeles Department of Water and Power Archives available and assisting in data location.

ABSTRACT

I explore the transaction costs that impede otherwise welfare-enhancing water rights transfers from low-value agriculture to high-value urban and environmental uses. Valuation disputes, bi-lateral monopoly conditions, and third-party effects are key factors. The study adds empirical content to basic transaction costs concepts. The focus is on the notorious Owens Valley water transfer to Los Angeles. Despite the fact that both groups of parties benefited from the transaction, the Owens Valley exchange serves today as a metaphor, cautioning any agricultural region against water sales to urban areas. Using new qualitative and quantitative evidence, especially for 1924-34, when most water-bearing land was purchased, I examine the bargaining between land and water rights owners and the Los Angeles Water Board to determine why it was so contentious and became so notorious. Implications for contemporary water rights negotiations are drawn.

"It seems to us that the importance of the Owens River Project to the City of Los Angeles cannot be overestimated." Los Angeles Board of Water Commissioners, *Report on Water Supply* (1906, 6).

"Do you have any idea what this land would be worth with a steady water supply—About 30 million more than they paid for it." J.I. Gittes (Jack Nicholson) referring to land in the San Fernando Valley, in the movie, *Chinatown*, 1974.

". . .farmers remain suspicious of the 'Owens valley syndrome'...The 'theft' of its water... in the early 20th century has become the most notorious water grab by any city anywhere... the whole experience has poisoned subsequent attempts to persuade farmers to trade their water to thirsty cities." *The Economist*, July 19, 2003, 15.

Introduction.

The most rapid population growth in the U.S. is in the urban areas of the semi-arid West. This growth is fueled by shifts from agriculture and extractive industries to service and technology industries. Most western cities, such as Los Angeles and Las Vegas, do not have sufficient local water sources to supply this growth in urban demand. Accordingly, there is effort to acquire water from agriculture, where approximately 70-75 percent of western water is allocated. But this process generally is slow and controversial, resulting in sharp differences in urban and agricultural water prices.¹

To better understand the problems that impede water rights transfers, I examine the notorious Owens Valley water transfer to Los Angeles. This exchange was the first large-scale market transfer of water rights in the American West. As described below, subsequent sizable, voluntary water trades from agriculture to urban areas have been rare.

Beginning in 1905, representatives of the Los Angeles Board of Water and Power Commissioners purchased land and appurtenant water rights from some 869 farmers and 825 town lot owners. By 1934, the agency had acquired 95 percent of the agricultural acreage and 88 percent of the town properties in the valley.² The water was transported 250 miles via the Los Angeles Aqueduct, which became one of the nation's largest public

works projects at the time, second only to the Panama Canal (Osborne, *Scientific American*, 364-71, 1913). By 1920 Owens Valley provided a flow of 283 cubic feet per second of water, whereas the entire Los Angeles basin supplied a flow of just 68 cubic feet per second. The new water supported the city's growth from 250,000 people in 1900 to 2,208,492 by 1930. Dramatic increases in land values also followed, particularly in the San Fernando Valley, and for a time, Los Angeles became the nation's largest agricultural county in terms of value of production. Associated power generation made the Los Angeles Department of Water and Power the largest municipal electric utility in the country.³

Despite all of this, the standard assessment of the Owens Valley transfer is decidedly negative, asserting theft of farm land and water and destruction of the local economy. (Wood, 1973, 8; Reisner, 1986, 60-107; Kahrl, 1982, 38; 387, Kahrl 2000, 255; Ewan, 2000, 42; Wheeler, 2002).⁴ Although difficult to test, the Owens Valley legacy appears to have been harmful for development of water markets. Ostrom (1971, 449) claimed it deterred efforts to re-allocate water from Northern California to urban centers in the south, and Haddad (2000, xv) argued that the "Ghost of Owens Valley" inhibited *all* proposed water transfers from rural areas to cities in the West. Hanak (2003, 5, 123) pointed to the Owens Valley experience in motivating county restrictions on water transfers in California. The 1974 movie, "Chinatown," staring Jack Nicholson and Faye Dunaway, dramatized conspiracies involving Owens Valley water and land speculation in Los Angeles, adding to its negative notoriety.⁵

Indeed, the negotiations between the city and land owners were often acrimonious, and in total, they took some 30 years to complete, although the key period

was from 1924 to 1934. During that time most land and water rights were purchased and most of the violence accompanying the negotiations took place. The aqueduct was periodically dynamited during bargaining impasses, investigative committees were sent by the Governor, Legislature, and Los Angeles Chamber of Commerce in attempts to resolve disputes between land owners and the Water Board, and the national press termed the conflict, "California's little Civil War." The task then is to explain why the negotiations over land and water rights took so long and why they were so rancorous, leaving a harmful legacy for later water transfers.

The analysis of Owens Valley negotiations makes use of detailed records—letters, reports, memorandums from 1905 to 1934 between the Los Angeles Water Board, its land agents, and land owners in the Owens Valley as deposited in the Los Angeles Department of Water and Power Archives. These documents describe the bargaining history between the Board and farmers as they negotiated over land and water rights. Bargaining positions, strategies, and key issues of contention are described in the data. Additionally, there is a compilation of 869 farm land purchases, including year of purchase, amount paid, location of property, name of owner, as well as other property characteristics. These data are used in the econometric analysis. Other data sets exist for sellers' pool membership and for town lot sales.

The information provides a rich basis for examining the bargaining conflicts that occurred in Owens Valley in a manner that has not been done previously. The added transaction costs of negotiating land and water rights sales in the early 20th century centered on three issues: disputes over valuation of property, bi-lateral monopoly, and third-party effects. Insights from the analysis not only explain why the Owens Valley

negotiations were so lengthy and contentious, but also why current transfer efforts are so difficult.⁶ The study of Owens Valley adds empirical content to basic transaction costs concepts.

II. An Overview of the Owens Valley Water Transfer.

Between 1880 and 1900, the population of Los Angeles grew five fold, from 50,393 people to 250,000, and given the city's climate, links via the intercontinental railroads, and position as a major West Coast port, prospects for continued growth seemed promising, except for the absence of sufficient water. The city averaged just 14.62 inches of precipitation, whereas Chicago, for example had mean rainfall of 34.12 inches.⁷ Los Angeles relied upon the meager Los Angeles river watershed for its water supply, but by the turn of the century, there was growing concern among city boosters that more water had to be found if the city were to achieve prominence on the west coast.⁸ Owens Valley on the eastern slopes of the Sierras, some 250 miles to the northeast (Figure 1), offered some 37 million acre feet (a.f.) of water from the Owens River flow and ground water, about the same as that held in Lake Mead today (Miller, 1977, 49-50).

Figure 1

The Owens Valley, approximately 120 miles long and 2 to 6 miles wide, was bisected by the Owens River that eventually dumped into an alkaline, desert sump, Owens Lake. In 1920 there were 7,031 people in the area on farms and in five towns—Bishop, Big Pine, Laws, Independence, and Lone Pine (1920 U.S. Census). There were 140,000 acres of farm land, 65,163 acres irrigated and of those 20,906 acres in crops, mostly alfalfa, some grains, and small orchards (apple and pear).⁹ Livestock was the principal product.

Between 1905 and 1921 the Water Board purchased land in the southern part of Owens Valley to acquire right of way for the aqueduct as well as to secure claims to water that had not been diverted for irrigation in the northern, most agricultural section of the valley. These land and water rights purchases did not interfere with irrigated farming in the north. Southern Owens Valley lands were mostly desert and average purchase prices ranged from \$1.25 to \$23.86 per acre. By contrast, mean purchase price for lands bought later in the north was \$198 per acre.¹⁰ The purchases were financed through water bond issues.¹¹ Through 1924, this water supply was thought sufficient to meet anticipated demand in Los Angeles and to justify the construction of the aqueduct.

The initial reallocation of water brought dramatic property value gains in Los Angeles (Nadeau, 1950, 29). When the aqueduct began flowing in 1913 it supplied 4 to 5 times domestic urban demand, but under the appropriative water rights doctrine, the

12

water had to be in beneficial use in order for Los Angeles to retain ownership. Accordingly, water was made available for farming in the San Fernando Valley, and irrigated acreage in Los Angeles County expanded by over 124,000 acres. Gradually, as urban water demand increased, agricultural use of Owens Valley water in Los Angeles declined.¹³

By 1924, drought and increased water demand in Los Angeles due to rapid population growth caused the Water Board to begin negotiations to purchase additional farm properties in the northern Owens Valley in order to acquire more water supplies. These negotiations, however, were much more difficult than were the earlier purchases, taking some 10 years to complete for the most valuable properties. Ultimately, the Board secured 145,867 acres of farmland and 1,300 town parcels in Owens Valley.¹⁴

The lands of primary interest to the Board were those that carried the most water, and generally they were part of formal irrigation ditch companies. The construction of ditches required cooperative investments so that farmers joined to incorporate mutual ditch companies and to place joint appropriative water claims. The amount of water held by each farmer was directly linked to the number of shares owned in the ditch company. Once the Water Board completed purchase of a farm located on a ditch, its water allocation, as well as any water held via riparian rights, could be released to flow down river to the aqueduct. As we will see, however, these ditch companies provided a ready organizational device for farmers in bargaining with the city.

III. Transaction costs: Valuation Disputes, Bi-lateral Monopoly, and Third-Party Effects.

The notion of transaction costs used here is a standard one, the costs of discovering, negotiating, and completing the exchange of an asset, in this case, water-bearing lands. Broadly speaking, exchange requires locating the relevant parties; communicating information about the asset to be traded and terms of trade (offer and ask prices); inspection, verification, and measurement of the asset; negotiation to reach a sale price over mutually-accepted asset attributes and property rights; and finally, contract drafting and enforcement. The transaction costs literature emphasizes that each of these activities can be complex, affecting the timing, extent, and nature of trade (Coase, 1937, 1960; Barzel, 1982; Dahlman 1979; Demsetz; 1964, 1968; and Williamson 1979, 1981).¹⁵ The record of the Owens Valley transfer underscores the potential complexity involved in transactions, especially with respect to search, measurement, and negotiation.¹⁶

Two key points are useful for understanding subsequent bargaining disputes. One is that Owens Valley farms generally were marginal. Since water values were based in large part on their contribution to agricultural production, this condition led to sharp differences in the estimation of the value of water in that region relative to Los Angeles. The valley's elevation (from 3,600 to 4,300 feet), short growing season (150 days), alkaline soil, narrow cultivatable area, and limited access to markets constrained its agricultural potential. Indeed, its production was more characteristic of Great Basin agriculture than of elsewhere in California. Comparing Inyo County (Owens Valley) farms with a baseline of farms in similar Great Basin counties—Lassen, California and Churchill, Douglas, Lyon, Nevada for 1920, however, reveals that they tended to be smaller on average (269 acres versus 713 acres) and the annual value of production per farm lower (\$4,759 versus \$10,332).¹⁷

Second, Owens Valley farms were heterogeneous with respect to productivity and water. Cultivation required irrigation, and water was directed through ditches to those parts of the valley with the most fertile soil, lowest elevation, and most level terrain to facilitate tillage. Such lands were scarce and not uniformly distributed across farms. This condition raised conflicts regarding the valuation of individual properties because there were few clear benchmarks for comparison. Further, a critical problem was how to value the "excess water" that also varied across farms. A great deal of water was concentrated in certain parts of Owens Valley while other parts were comparatively dry. With limited arable land throughout the valley not all of the water in well-endowed areas could be translated into significant additional agricultural production. Accordingly, water-

intensive flood irrigation was common, and early observers commented on the profligate use of water by Owens Valley farmers (Sauder, 1994,⁹⁴).

Data shown in Table 1 below demonstrate the point. For all farms, the mean water acre feet per cultivated acre of land was 28, although this figure ranged from 18 to 69 a.f./cultivated acre among farms on irrigation ditches, and was 14 a.f./cultivated acre for farms located on drier areas not on ditches. All of these figures far exceed contemporary irrigation levels in California that range from 3 to 6 a.f/acre.¹⁸

The market in which negotiations took place was the agricultural land market. Water was bundled with the land under both the appropriative and riparian water rights doctrines. With appropriative rights, the priority and amount of water were linked directly to the property.¹⁹ Riparian rights also tied stream water to adjacent land. Accordingly, the Water Board had to purchase farm land in order to acquire the water for the aqueduct. In bargaining between farmland owners and the Water Board between 1924 and 1934 there were three general classes of problems that impeded agreement, although they overlapped: valuation disputes, bi-lateral monopoly conflicts, and third-party effects.

Valuation Disputes.

There were two conflicts in determining prices for Owens Valley lands. One was the basis for general valuation of farm properties—whether the estimated water supply on a farm should be valued as an input to agricultural production in Owens Valley or as an input to land value increases in Los Angeles. This was principally a negotiation issue. The second was the determination of the value of any particular property when farms were heterogeneous. This was both a measurement and a negotiation issue. In terms of

the first problem, the Water Board wanted to use Owens Valley farm values in determining the prices it offered land owners, whereas land owners wanted to use Los Angeles land and water values in determining the prices they demanded for their properties. For example, before the Board, one land owner claimed that she priced according to "the comparative value of what that water is worth to you... .because we

20

know you want water and not the land...that is what you want and all you want....

In terms of the second problem, the valuation of particular properties was a continuing and important source of contention because the value agreed to for a particular property determined the owners "share" of the aggregate rents from the exchange of Owens Valley water. The observed capital gains in Los Angeles from arrival of new water often were substantial, and each farmer in Owens Valley wanted as large a portion of those gains as possible. The valuation of water was a particularly contentious issue for farms with the most water. If the value of agricultural productivity in Owens Valley were the basis for water valuation, farmers with large amounts of water would be penalized because their extra water did not increase output correspondingly and instead was devoted to low-valued uses. These farmers typically held out for higher prices.

In negotiations, each farm owner had the most complete information about the agricultural potential of his property and the amount of water held, but at the same time, had incentive to exaggerate their values. Accordingly, to assemble offer prices, the Board relied upon a committee of expert appraisers to assimilate local farm price information. To reduce disputes with the land owners, the Water Board selected a committee that would be viewed as credible and acceptable to both parties.

In 1925, the Water Board assembled a special Appraisal Committee of "three of the leading citizens of Owens Valley:" George W. Nay]or, Chair of the Board of Supervisors of Inyo County (Owens Valley), V. L. Jones, Inyo Assessor, and U.G. Clark, former county Assessor.²¹ Even so, since the appraisal committee was employed by the Board, it was viewed with suspicion among land owners. During negotiations with some farmers in 1926, the credibility of the committee's prices was questioned: "You hired that committee; we had nothing to say about it...if you people hire these men, you expect them to go into the field and do as you tell them don't you?" Both the appraisals and the committee often were rejected: "They have been your committee for a long time. Let us forget them."²²

During the valuation process, Board land agents would collect information about each farm—location, water rights, amount of irrigated land in cultivation, pasture, "brush" land, orchards, improvements, and submit the information to the Appraisal Committee. The Committee, in turn, would compare this information with that for similar farms that had already been purchased to arrive at an "appraised value." The Water Board generally used a fixed multiple, usually 4.1 times appraisal value, to determine its offer or bid price.²³ The Board instructed its land agents to offer prices that were comparable to what had been paid for similar farms in that region: "It is also to be understood that these properties are to be appraised in the same manner and on the same basis that you have appraised other properties of substantially the same character and in accordance with previous values...."²⁴ The Board repeatedly resisted adjusting prices beyond what it had offered for other lands in an area.

Nevertheless, land owners challenged the committee's appraised values, and called instead for binding arbitration in price disputes, using outside arbitrators. Challenges were based on disputes both regarding the relevant comparison properties, as well as assessment of individual farm characteristics. For example, one owner, who had been offered \$3,100 for her property, complained that a neighbour had been offered \$10,500, even though he had 1.25 acres less than her, with only 2 inches of water from the ditch, while she had 3 inches.²⁵ Another wanted her land appraised against a different group of properties, selecting five farms whose owners had received more than she had been offered.²⁶

The disparities between the bid and ask prices due to measurement disputes could sometimes be very large. Owners of the 160-acre Parker ranch asked for \$30,000 for the property and improvements. Land agents for the Water Board offered \$11,496. At least part of the gap was based on the absence of comparison purchases in the area. Although the owners lowered their ask price to approximately \$23,000, negotiations languished for at least four years.²⁷ In another case, J.T. Otey rejected a bid of \$11,200 for his 50-acre farm, claiming it was undervalued by the Board. Using prices paid for neighboring properties he countered with an ask price of \$18,338.56, and held out for two years, selling the farm to the city for \$19,000.²⁸

In 1925, farmers who were in conflict with the Board over price asked that the two sides set up a "valuation commission" to resolve their valuation conflicts, saying that "no more honest attitude can be taken by either party." Even the special Appraisal Committee agreed, but the Board rejected this offer, claiming that "valuation by third

party would mean abandonment of purchase plan adopted with concurrence of your committee and thus far followed in dealing with your neighbors."²⁹

Agreement on property valuation also was complicated by a lack of trust on both sides. Board officials viewed land owners as making exorbitant price demands. Land owners, by contrast, viewed the Board as attempting to undervalue their lands while property values in the San Fernando Valley were rising rapidly. This limited trust meant that neither party held the other's pricing claims as credible or honest. This condition increased the transaction costs of negotiation and lengthened the time necessary for agreement (Coleman, 1984; Williamson, 1993; Glaeser, Laibson, Scheinkman, and Soutter, 2000).

Bi-lateral Monopoly Disputes.

Disputes over valuation of critical water-bearing properties took place within a bi-lateral monopoly context, and this condition increased the costs of negotiation apart from measurement issues. The Los Angeles Water Board generally was the only purchaser of Owens Valley lands and water rights. Once the Los Angeles aqueduct was constructed for over \$23 million, however, the city had a large fixed, immobile investment that depended upon Owens Valley water. While Board officials could walk away from stalled negotiations with one land owner, they could not walk away from Owens Valley as a whole. Land owners formed sellers' pools to collude in their negotiations with the Board. Although, these pools never included all of the farmers in Owens Valley, they did involve most of those who had the greatest amount of water.

Bi-lateral monopolies have indeterminate pricing outcomes because they depend upon the relative bargaining power of the parties. Each party has incentive to

misrepresent its position in order to extract a greater share of the gains of trade in such negotiations, and there is little competitive pressure to force more accurate information revelation. Accordingly, negotiations often break down and take a long time to complete (Williamson, 1975, 238-47; Blair, Kaserman, and Romano, 1989).

The ditch companies provided farmers with a collusive organizational structure not available to those who were not on ditches and were spread across the valley. Three sellers' pools were formed along three ditches in Owens Valley: the Keough pool on the Owens River Canal with 23-30 members, the Watterson pool of about 20 members on Bishop Creek Ditch, and the Cashbaugh pool of 43-48 members on Bishop Creek Ditch. These pools were negotiating groups, dominated by the largest land owner. The pool leaders were recognized as bargaining agents for all pool members by the Water Board.³¹ At most, the pools involved about a quarter of the farms along the major ditches in Owens Valley, but they covered much of the irrigated acreage. The limited numbers in the pools likely reflected both efforts to maintain more homogeneous negotiating groups, as well as the aggressive efforts of the Water Board to buy ditch properties before they joined a pool.

Indeed, anticipating a strengthening of the sellers' pools through greater membership and the formation of a larger bargaining organization, the Owens Valley Irrigation District, the Board moved quickly in 1923 and 1924 to buy properties on two large ditches as well as farms on other ditches that had not yet collusively organized. It bought virtually all of the farms on the McNally and Big Pine Ditches for \$1,000,000 and \$ 1,100,000, effectively ending efforts in Owens Valley to form an encompassing irrigation district across the major ditches.³²

Among the pools, the Keough group was the most concentrated and tightly organized with a Herfindahl index (based on farm size) of 1,583. The Watterson pool had a Herfindahl index of 1,163, the Cashbaugh, 410, and non-pool, ditch farmers, 216.³³ Negotiations between the Water Board and pool members, especially those in the Keough pool, were the most contentious and drawn out in Owens Valley.

The Board paid \$1,389,364 to buy out the properties in the Cashbaugh pool between 1924 and 1927. The largest land and ditch share owner in the pool, William Cashbaugh, held out through 1927, receiving a 21 percent premium over the city's initial offer price of \$145,180 or \$174,680.³⁴ The most successful pool was led by Karl Keough with 4,482 acres (60 percent) of the 7,862 acres on the Owens River Canal. In 1926, the Keough pool demanded \$2,100,000 for its properties, and the Board first offered \$1,025,000 and then increased its bid to \$1,250,000. The pool countered with a price of \$1,600,000, which was rejected by the Board.³⁵ Price negotiations for Owens River Canal properties, both in and out of the pool, continued through 1931. By the end of 1927, 60 percent of the 4,837 shares in the canal company were acquired by the Board, but the remaining 40 percent held by pool members were not secured until 1931. Pool member G. L. Wallace offered his lands in 1926 for \$417 per acre, while the city countered with \$254 per acre. Final agreement was not reached with him until 1931 at \$466 per acre.³⁶

Pool leaders resorted to violence to pressure the Board to meet their price' demands when negotiations broke down, threatening the security of the city's water supply. Between 1924 and 1931 the aqueduct and city wells were repeatedly dynamited, although the aqueduct was never seriously damaged (Wood, 1973, 30-37; Ostrom, 1953, 121-27). These episodes of violence attracted state and national attention, and pressured

the Board to reach agreement on price with recalcitrant property owners. The Board correctly viewed the dynamiting as a negotiating tactic, but at the same time, it was extremely worried about disruption of the aqueduct flow. Indeed, in November 1924, the Alabama Gates spillway was seized and opened, dumping the water into the desert and leaving the aqueduct dry. The Board responded by increasing its efforts to secure additional Owens Valley lands (Ostrom, 1953, 84-93; Hoffman, 1981, 185-8).

In contrast to negotiations with pool members, sales agreements with non ditch, non pool farm owners appear to have gone smoothly. Indeed, the Water Board reported that "the prices paid, with few exceptions, have been entirely satisfactory to the seller." Many of the 869 farm properties purchased between 1916 and 1934 were not on ditches or in pools. In the data set used below of 595 farms, 228 were not on ditches. These farms were purchased for their ground water and any riparian claims. Non-ditch properties tended to be the least productive in the region, and they received the lowest prices per acre of land as indicated in Table 1.

Part of the reason for smooth agreement for purchase of non ditch properties was the Board's fear of adverse court rulings under *Santa Barbara v. Riverside*, 186 California, 7, 15 (1921). Under that ruling any land owner who could demonstrate damage due to the drawdown of the water table from pumping and export of water by another party could secure an injunction halting *all* ground water pumping in the region. To maintain the flow of groundwater to the aqueduct the Board quickly purchased properties whenever pumping injunctions were threatened by land owners.⁴⁰

Another reason the ease of negotiations with these farmers was that they were better able to link their water with farm sales values. As described below, the Los

Angeles Water Board had to pay a minimum price for a farm in order to induce a land owner to sell and release his water. Because these farmers had limited water supplies the implicit per acre foot price of water received (farm sales price/water acre feet) was the highest in Owens Valley (Table 1).

Third-Party Effects.

Third-party effects involved issues of search (determining the relevant parties) measurement (assessing the extent of damage) and negotiation (agreeing on compensation). As Los Angeles purchased properties in Owens Valley and took them out of irrigated agriculture, there were complaints that this action was hurting the local economy and damaging property values within the five towns. The magnitudes of the effects were disputed by the Board and land owners. Merchants claimed to have lost 1/3 of their trade due to the decline in the agricultural economy (Nadeau, 1950, 96). The general deterioration in the national agricultural economy in the early 1920s also hurt the community, but this effect may have been difficult to separate from those resulting from the Water Board's purchase of lands and accompanying export of water. With declining commodity prices the value of Inyo County crops fell by 47 percent from \$1,503,195 to \$791,257 (Owens Valley was the only agricultural part of the county). This decline, however, occurred prior to most of the property purchases in the valley by Los Angeles. Further during that same five-year period, the number of farms in the valley fell only 7 1/2 percent, from 521 to 482, unlikely enough to account for the observed fall in the value of agricultural production (Miller, 1977, 164).

Nevertheless, town property owners blamed the actions of the Water Board for the deterioration in economic conditions. The Board countered by pointing to the

beneficial effects of its investments in the valley to develop water and power sites and the growth of recreational activities from Los Angeles due to construction of new roads.

Indeed, automobile registration and bank deposits in the region increased (Kahril, 1982, 144, 297).

California State Board of Equalization annual reports on the total value of all property within municipalities (real estate, personal, monetary) support the claims of the Water Board. In 1920 the total value of property in the largest Owens Valley town, Bishop, was listed as \$1,027,792. By 1929 it had risen to \$1,355,666 (a gain of 32 percent), and in 1930 with the onslaught of the depression was \$1,228,709, a gain of 20 percent over 1920.⁴¹ Any negative third-party effects may have been quite small.

Even so, in 1925, the Owens Valley Reparations Committee demanded either that the Board pay \$5,500,000 in reparations for the loss in town lot value or that the city purchase the properties for \$12 million (Ostrom, 1953, 123-7). Not only were the prices for town properties well above what Los Angeles had been paying for other lands, but they carried few or no water rights. Hence, the Board was uncertain that it had the legal authority under the city charter to purchase such lands, which did not "supply the City with an adequate supply of pure water..."⁴²

Legislation was enacted by the California Legislature in 1925, at the behest of Inyo County representatives and other rural legislators, requiring cities to compensate for damages to businesses and property owners when water was taken from the drainage area.⁴³ The statute added pressure on the Board to buy the town properties or be faced with hard-to-measure-and-agree-upon reparations demands. Los Angeles officials held off the purchase of town lots until there was a state Supreme Court ruling in 1929 that

authorized the purchase of town properties by the Water Board. After that, negotiations between the city and town lot owners were rancorous, requiring various appraisals, offers and counter offers.

A Committee of Ten was set up with five representatives from each of the towns and five members of a Special Owens Valley Committee of the Board to determine prices. But the property value appraisals prepared by the Board's land agents were rejected by the town representatives. Negotiators for the towns offered counter appraisals that raised proposed values in the towns of Laws and Independence by 45 to 50 percent, in Bishop by 120 percent, and Big Pine by 60 percent. Members of the California legislature who owned properties in the towns threatened new legislation in 1931, unless the new appraisals were accepted.⁴⁴ Ultimately, a compromise was reached and Los Angeles paid \$5,798,780 to 824 owners for 1,300 town parcels, most of which brought little or no additional water to the city.⁴⁵ The prices paid were based on 1923 values that existed prior to major purchases by the city in the valley, and they did not reflect the effects of the Depression on land values (Nadeau, 1950, 125-30). Funds to buy town lots and remaining agricultural properties in Owens Valley required a special bond election for \$38,800,000 that passed in 1930.⁴⁶

In the following section an analytical framework is provided to guide statistical analysis of the purchase of farm properties and accompanying water rights in the presence of transaction costs. The objective is to determine the factors that influenced the year of purchase and the per acre sale price of a farm.

IV. Analytical Framework.

Figure 2 illustrates the bargaining environment facing farmers in Owens Valley and representatives of the Los Angeles Water Board in the land market. The vertical axis represents the price per acre for land in Owens Valley and the horizontal axis represents acres of land in the valley. As noted earlier, farmland is heterogeneous with respect to its agricultural potential, and along the horizontal axis, land ranges from the least productive at the origin to more productive, moving to the right.

The value of the agricultural productivity of each acre of land is shown by ST , which has a positive slope.⁴⁷ The determinants of S_t are known by the farmer, and this supply schedule represents the *minimum* that an owner would have to receive from the Water Board in order to sell. The Water Board in contrast, has less complete information about the agricultural value of the land. Its Appraisal Board infers the value of productivity from assembled farm characteristics, observed output, and comparisons with similar properties. It also projects the amount of water associated with any land from shares of irrigation ditch water, any riparian rights to estimated stream flows, and anticipated potential to pump groundwater. As discussed earlier, limited arable land meant that not all water could be used to expand cultivation and agricultural productivity. Hence, not all water would map in the same way into higher farm values.

The Water Board uses information from the Board's appraisal to prepare per-acre offer prices S_o . These offer prices rise for lands of greater expected agricultural productivity. S_o represents the Board's willingness to pay for land in Owens Valley. Farmers, who do not accept the Board's offer, counter with per-acre demand prices S_d based on what they believe to be the value of water in Los Angeles.⁴⁹

This framework sets up the bargaining situation with Board officials offering prices along S_2 with some land owners accepting them and others holding out, demanding higher prices along S_1 .

The expected return from holding out for a higher price is:

$$(1) N = [P_r S_1 + (1 - P_r) S_T] - S_2,$$

where P_r is the probability of successfully receiving the higher price. P_r varies across owners and depends on the ability of owners to collude and the likelihood that negotiations will reveal new information that raises the estimated value of the farm and its water. The expected value of the hold out is a function of P_r and the gap between S_1 and S_T .

(2) If $S_2 \geq P_r S_1 + (1 - P_r) S_T$, which applies for farmers with land within the range $O A_M$ in the figure, then the Board's offer is accepted. P_r is small for this group if the value of their agricultural productivity is low and observable and they are known to have limited water. P_r also will be reduced if these farmers do not collude, which is likely if they are scattered and not located on ditches. Accordingly, the Board's offer price, S_2 , exceeds the minimum necessary for them to sell, S_T , and there is little chance of obtaining a higher hold out price, S_1 .

(3) If $S_2 < P_r S_1 + (1 - P_r) S_T$, which applies for farmers with land located between A_M and A^* , the offer price S_2 will be rejected with hold outs for S_1 . P_r will be greater for this group if they collude and if new information reveals even greater water endowments. These are the farms with the most water, not all of it observable or in productive use. Disagreement will focus on the value of a farm's agricultural production and water. The battle over rents will include **EC**, agricultural valuation disputes, and **DE**, disputes over

the valuation of water. Since the aqueduct's capacity is reached with cumulative land purchases at A_A , negotiations to fill it will be in the contested region.

In negotiations with farmers in the contested region, the Water Board would seek to stay on S_2 , adhering to a pricing rule that pays the *same* price for similar properties, but raising prices for lands of higher expected agricultural productivity. The Board has to credibly commit not to offer higher prices to others with similar properties. Failure to do so would make it very difficult to complete negotiations with any owner. Additionally, the Board would not want to set precedents by raising prices for some properties, based on higher water values, above those paid for comparable lands. Doing so would establish new baselines in subsequent price negotiations and push the Board's payments higher along a marginal supply cost curve **MSC** in the figure.⁵⁰

If farmers in the region $A_M A^*$ successfully colluded, then bi-lateral monopoly conditions would prevail, making final prices indeterminate, higher than S_2 and generally higher than S_T , but lower than S_1 , depending on the relative bargaining power of the two parties.

In negotiations, the Board seeks to acquire sufficient land and associated water rights to fill the aqueduct within its budget constraint. Farmers seek to obtain the highest per acre price possible for their lands. This framework yields the following testable implications about the time of farmland purchase and prices paid.

- A. The Board will seek to buy the farms with the most water earlier and will offer them higher prices per acre of land.
- B. These farmers, however, will hold out for price increases.
- C. Land owners who collude will hold out the longest and receive the highest land prices, all else equal.
- D. Land owners with the least productive land and least water will have their lands bought the latest and receive the lowest per acre prices.
- E. These farmers will not hold out and will accept the Board's offer price.

- F. Disputes will center on water valuation and involve farms with the largest amounts of water.

A related bargaining implication is that in negotiations with farmers, the Water Board will adhere to a pricing rule that paid the *same* price for all similar properties.

V. Empirical Analysis of Bargaining for the Transfer of Land and Water Rights: Timing and Prices Paid Per Acre.

In the analysis of bargaining between the Water Board and Owens Valley fanners, the data set of farm properties purchased between 1916 and 1934 by the Board includes 869 observations. Dropping those properties less than ten acres as not being farms, but town lots (analyzed separately elsewhere) as well as dropping incomplete entries leaves 595 observations. Of those 367, farms were on ditches and 228 were not on ditches, but scattered throughout Owens Valley. Table 1 provides mean values for farm property owners in Owens Valley by various classifications.

Table 1

As indicated by the mean values in the table, farms on ditches sold for higher prices per acre and greater total prices than did those that were not on a ditch. The former had higher percentages of cultivated land; had more water per acre of land; and their owners were more likely to be in a sellers' pool. Those fanners who were in the Keough pool commanded the highest price per acre of land; they sold the latest (held out the longest); and had the most water per acre to offer Los Angeles. Members of the other two pools, Cashbaugh and Watterson, also did better on average in terms of price per acre and total purchase price than did non ditch properties. Even non pool members who were on ditches earned more in total and per acre of land than did the non-ditch farmers.

These farmers benefited from the early actions of the Water Board to purchase their farms before joining a pool.

In contrast, non ditch properties sold for less in total and per acre of land. They typically had a smaller share of cultivated farmland, earned less water, and their owners were unorganized. Although they received less for their land, these farmers earned more per water acre foot than did farmers more favorably located on ditches. This outcome reflects the purchase of a bundled asset in the land market. At minimum the Board had to pay a price that equaled the agricultural value of a farm in order to secure it and its water from the owner. If not all additional water on a farm translated directly into increased agricultural production, then farmers with less water were likely to receive more per unit of water than did their counterparts who had larger water endowments.

This issue is examined in the econometric analysis below, but the mean values in Table 1 are suggestive that added water increased farm values at a declining rate. For non ditch, less productive farms, the average farm sale price was \$19,890, and this leads to an implicit \$473/a.f. water. The total farm sale price is somewhat less than the mean 1925 census farm value for the four comparable Great Basin counties (Lassen, California; Churchill, Douglas, and Lyon, Nevada) of \$21,167, but these non ditch farms were the least productive units in Owens Valley. A sale value of nearly \$20,000 corresponded to 6 years of gross farm receipts for Inyo County farms during a time of agricultural depression.⁵¹ It is no wonder then that non ditch farmers sold quickly whenever they had an offer, without discord.

The mean sales values for pool farms on ditches were higher than for non pool farms, and all ditch farmers received more in total than did their non ditch colleagues,

and their sales prices were considerably higher than the 1925 mean census farm value for the four Great Basin counties. These farmers also received per acre land prices that were at least three times those obtained by those not on ditches. Ditch farmers who had the most water, however, did less well per unit of water in their negotiations with the Board.

Table 2 provides descriptive statistics for econometric analysis of the bargaining over Owens Valley lands. The estimated equations in a 2SLS system are

$$(1) \quad y_{2i} = \gamma_0 + \gamma_1 x_{1i} + \gamma_2 x_{1i}^2 + \gamma_3 x_{2i} + \gamma_4 x_{2i}^2 + \gamma_5 x_{3i} + \gamma_6 x_{3i}^2 + \gamma_7 D_r + \gamma_8 D_k + \gamma_9 D_c + \gamma_{10} D_w + \gamma_{11} D_o + \gamma_{12} z_{1i} + \gamma_{13} z_{2i} + \eta_i$$

$$(2) \quad y_{1i} = \beta_0 + \beta_1 y_{2i} + \beta_2 x_{1i} + \beta_3 x_{1i}^2 + \beta_4 x_{2i} + \beta_5 x_{2i}^2 + \beta_6 x_{3i} + \beta_7 x_{3i}^2 + \beta_8 D_r + \beta_9 D_k + \beta_{10} D_c + \beta_{11} D_w + \beta_{12} D_o + \varepsilon_i$$

where y_{2i} is year of purchase; y_{1i} is per acre sales price; x_{1i} is cultivated acreage per farm; x_{2i} is total farm acreage; x_{3i} is water acre feet; and D_r, D_k, D_c, D_w, D_o are dummy variables for having riparian water rights, membership in the Keough, Cashbaugh, and Watterson pools respectively, or owning a farm on a ditch but not in a pool; and z_{1i} and z_{2i} are instruments, lagged precipitation deviation from the mean in Los Angeles and lagged population change in Los Angeles.

The 2SLS structure is used because some of the exogenous variables affecting year of purchase also likely influence the final per acre sales price. The estimated year variable is included in the price equation.⁵² Past drought conditions and population growth pressured the Water Board to more rapidly acquire Owens Valley lands.⁵³

In terms of the predicted signs for the coefficient estimates, greater cultivated acreage should delay purchase because farmers with more cultivation had the option of remaining in agriculture and postponing sale when dissatisfied with the offer price. These

were also the farms most likely to be involved in valuation disputes over agricultural value, delaying sale. Owners of farms with more cultivated acreage, however, should receive higher prices per acre, all else equal. The impact of farm size on time of sale is indeterminate, but it should reduce the per acre sale price because smaller farms tended to have more valuable improvements, including buildings and specialty crops. Greater amounts of water per acre on a farm should speed sale and raise the price paid for the land, all else equal. These were the farms of most interest to the Board. The squared term tests for non-linearity and the possibility that additional water would add to farm value at a declining rate. Additionally, holding riparian water rights should both speed sale and raise the sale price per acre. Membership in sellers' pools should delay sale relative to the baseline of non-ditch farms and bring higher per acre prices. Drought conditions and population growth also should speed sale.

Table 2

Table 3

As shown in panel 3a, farms with more cultivated acreage were sold later, while those with more water were sold earlier. Among the sellers' pools, members of the Keough pool on average held out .8 year, or 10 months longer than did those farmers not on ditches. Members of the less concentrated Watterson and Cashbaugh pools, however, sold to the city earlier than did members of the Keough pool and earlier than non-ditch fanners (about .6 and .4 of a year earlier, respectively). And fanners who were on ditches but not in pools sold about .8 year earlier than the baseline group, indeed, with among the earliest sales in Owens Valley. As noted earlier, the Water Board sought to secure all ditch properties as soon as possible since they contained the most water, but the

results indicate that pool membership delayed sale relative ditch farms that were not in pools. Finally, previous precipitation shortfalls in Los Angeles below normal also speeded sales as did last year's population change. A 10-inch deviation in rainfall from normal speeded sales by about 1 year. During the drought of 1924, for example, precipitation was almost 9 inches below normal. An additional 100,000 people moved up sales by .1 of a year.

Panel 3b reports regression estimates of the determinants of the price of land per acre. As shown in the table, the price paid per acre increased by \$35, reflecting the benefits of holding out, all else equal. Farmers with more land in cultivation earned more, gaining \$0.71 per acre for every added acre in cultivation, although the rate of increase declined with cultivation. Farm size reduced the per acre sale price by \$.36 per additional acre, with the negative effect declining as farm size grew. Holding riparian water rights added \$21 per acre to the mean sale price. Location of the farm on a mutual irrigation ditch raised sale prices relative to the baseline by about \$181 per acre. Among other ditch properties, members of the Keough pool earned about \$283 more per acre than did the 228 non-ditch property owners and \$102 more per acre than those farmers who were on ditches but not in pools. Members of the Watterson and Cashbaugh pools earned approximately \$145 and \$136 more per acre respectively than the baseline farmers. Members of these two pools, however, earned less than the ditch farmers who were purchased by the Board earlier to keep them out of a pool.

Finally, as suggested above, fanners were not able to uniformly increase the value of their properties with each unit of additional water. Water acre feet transferred with the property raised the sale price by almost \$7 per acre with an additional 10 a.f of water, but

the contribution grew at a declining rate. The fall off in the value of the marginal product of additional water varied across the sample, with the farms at the center of the most contested negotiations having the largest negative effects. The coefficient on the water squared term is -0.0002435, -0.0002857, and -0.0001187 for Keough, Cashbaugh, and Watterson pool farms respectively, but a larger -0.0000518 for the baseline farms.

Using the estimated coefficients on the water and water squared terms, it is possible to estimate when the value of the marginal product of water would be zero for a farmer. For Keough, Cashbaugh, and Watterson pool farms, this occurred when water holdings were 956, 1,344, and 1,192 acre feet respectively, between 2 and 2.6 times the actual water endowments on these farms. For the baseline non ditch farms, however, water holdings would have to have been 1,686 acre feet, or 6.5 times actual endowments before the contribution of an added unit was zero.

There is additional bargaining information for 135 farms in Owens Valley on farmer ask prices, Los Angeles bid prices, final prices paid, and appraisal values. Although the data are not consistently provided for all the observations across the groups there is enough information for further assessment of the relative effectiveness of pool members in their negotiations with the Water Board.

Table 4

The data in Table 4 are suggestive of the price adjustment process by the Board in bargaining with pool members. For the less effective Cashbaugh pool (in terms of the price premium shown in Table 3b), the price offered by the Water Board was virtually equal to the adjusted appraisal values (4.1 times appraisal according to the pricing rule),

whereas for the more intransigent Keough pool members, the Board raised its offer by 45 percent on average from the appraisal value in an effort to secure the properties.

Table 5

Table 5 reports the results of a regression of the ratio of the ask-to-final purchase price against a constant and a number of control variables, including pool membership for 135 farms. The results indicate that pool membership allowed those farm owners to get more than they initially asked for. They were able to do so by successfully holding out for an even higher price, whenever the Board rejected their initial demands. The results confirm also that the Keough Pool was a stronger sellers' group. The mean ask-to-purchase ratio for the entire group was 1.19. The coefficient results suggest that a Keough pool member had a 'ask-to-final price ratio of .86 and a Cashbaugh member had a ratio of .98.

All told, the analyses of the year of purchase, the purchase price per acre, and price negotiations are consistent with the implications drawn from the analytical framework outlined above. They explain which properties were purchased first, which held out, which received the most per acre, and which gained the most in price discussions. They also indicate which properties would involve the most contentious negotiations in addressing valuation disputes, especially regarding water, and bi-lateral monopoly conditions in Owens Valley. The negotiations over these properties helped to give the Owens Valley water transfer its contentious history.

VI. Impact of the Water Transfer: An Assessment.

Los Angeles spent more than \$18,580,000 through 1934 for agricultural properties, and more than \$5,800,000 for town parcels.⁵⁴ As Owens Valley lands were

purchased by the Water Board and their water was sent down the aqueduct to Los Angeles, irrigated agriculture was replaced by livestock. Farms and ranches were leased from the Water Board and consolidated into larger ranches. The evidence suggests that land owners in Owens Valley did better in selling their water than if they had stayed in agriculture.

Between 1900 and 1930 land values in Owens Valley rose by around a factor of 11, increasing from an average of \$13 per acre to \$143 (Barnard and Jones, 1987,¹⁰⁻¹²). By contrast, land values in Lassen County, California, a similar Great Basin agricultural county, rose by a modest 2 times over the same 30-year period, from \$10 per acre to \$21. These data suggest that most of the rise in land values in Inyo County (Owens Valley) was due to land purchases by Los Angeles and not due to changes in agricultural commodity and livestock prices. During the same period, the value of agricultural land ... and buildings in Los Angeles County rose by \$407,051,000, an increase of nearly 600 percent, and in Inyo County by \$11,568,000, also an increase of approximately 600 percent. By contrast, farm property values in Lassen County increased by \$6,306,000, or 172 percent.⁵³ Again, the baseline Great Basin county does not do as well. Property values reported by the California State Board of Equalization provide a similar picture.⁵⁶

An alternative way of assessing the impact of Owens Valley land sales is to consider the counterfactual of no Los Angeles purchase or export of Owens Valley water, the expansion of farm acreage in Inyo County at the same rate as occurred in Lassen County, and the same increase in land prices in Inyo as occurred in Lassen. Under this plausible counterfactual, farm land values would have been \$4,553,120 in 1930 in Owens

Valley.⁵⁷ But this value is \$7,000,000 *less* than what actually occurred. Broader comparisons with other Great Basin counties give the same result.⁵⁸

This assessment is in contrast to the usual negative view of the Owens Valley land sale and water transfer.⁵⁹ So where does the "water theft" notion come from? This charge appears to be result of the inability of the pool farmers (Keough, Cashbaugh, and Watterson) to capture more of the rents associated with their water holdings. These farmers were the center of negotiation conflicts with the Water Board, and although they had some of the largest holdings of water in Owens Valley, they received less per acre foot of water than did either the non ditch fanns or those farmers on ditches who were rewarded by the Board for selling and not joining a pool. In the bi-lateral monopoly negotiations that ensued, pool farmers were able to secure higher per acre land prices than the baseline, but not enough to fully compensate them for their greater water endowments.

VII. Concluding Remarks: Lessons of Owens Valley for Understanding Transaction Costs and Water Transfers.

The bargaining framework suggests why the Owens Valley negotiations were so rancorous, with such a negative legacy. There were critical problems of search, measurement, and negotiation. The farm lands were heterogeneous and there were intense disputes over valuation and hence, individual shares of the observed potential gains from trade.⁶⁰ The most contentious negotiations took place within bi-lateral monopoly conditions. Neither party could leave the exchange, but both had sharply "different prices in mind, with the most valuable properties, carrying the most water, holding out for higher prices than initially offered by the Water Board. The price gaps could not be easily narrowed because of competition over rents and a lack of trust

between the parties that made them suspicious of the offers of both sides with little means of resolving the suspicion. And there were third-party effects on the towns and uncertainty about their credibility and magnitude.

The legacy of the transfer has been a very negative one. Despite evidence that indicates both parties to the exchange benefited, the perceived assessment is one of theft. This view derives both from the inability of those farmers with the most water to secure commensurate increases in the values of their farms and from the imbalance in the distribution of the total returns. The overall gains to Los Angeles were 40 times or more than those of Owens Valley from the redistribution of water. The perception of unfairness over the terms of trade also was driven by the nature of supply and demand for water. Urban users had relatively inelastic demand, whereas farmers competing for sale had comparatively elastic export supply. Hence, Los Angeles residents gained considerable consumer surplus from the transaction.⁶¹ The effort of farmers to gain more of the rents in negotiation explains the formation and relative greater success of the sellers' pools.

When the gains from trade are very large, distributional issues in search, measurement, and negotiation move to the forefront as they did in Owens Valley negotiations. Generally, it may be the case that trades are smoother when the benefits are shared reasonably equally, but encounter more difficulties in completion when the distribution is very skewed toward one party.⁶²

This situation appears to be an issue in contemporary water transfer efforts. Although valuation issues and bi-lateral monopoly factors complicate measurement and negotiation between urban areas and irrigation districts, key inhibiting factors are third-

party effects. Concerns about the impact of water sales and farmland fallowing on agricultural labor and adjacent communities play key roles in limiting transfers.⁶³ Conflicts center on identifying who has legitimate damage claims, the size of the damage and the amount of compensation to be paid.⁶⁴ As in Owens Valley, such compensation demands that shift the distribution of the overall gains from trade are difficult to bound, assess, and measure. Naturally, they are controversial. The long and tortuous record of negotiations underlying the Owens Valley water transfer, despite large gains from exchange, provides evidence of the importance of transaction costs in determining the timing, extent, and terms of trade.

Table 1
Owens Valley Farm Property Characteristics, Mean Values

Property Type	Price /Acre	Total Purchase Price	Year of Purchase	Size (acres)	Price/Water A.F.	Total Water A. F.
All Properties*	\$198	\$23,425	1926	154	\$178	448
Farms Not on Ditch	82	19,890	1927	207	473	261
Keough Pool [†]	443	27,647	1928	79	77	366
Cashbaugh Pool [†]	242	32,156	1927	126	69	544
Watterson Pool	237	33,983	1926	147	75	584
Non Pool on Ditches	263	23,861	1926	122	112	581
	Water A.F./Acre	Total Cultivated Acreage	% Cultivated Land	Water A.F./Cultivated Acre	Riparian Rights %	#
All Properties*	4	.17	17	28	35	595
Farms Not on Ditch	1	19	9	14	31	228
Keough Pool	6	16	20	69	96	23
Cashbaugh Pool	4	15	14	33	19	43
Watterson Pool	4	27	21	18	25	20
Non Pool on Ditches	5	14	22	30	36	281

*Properties 10 acres or larger purchased by Los Angeles between 1916 and 1934. Smaller properties were not farms, but town lots and addressed separately: "Porter files," LADWP Archives.

Table 2
Descriptive Statistics

Variable (595 observations)	Mean	Standard Deviation	Minimum	Maximum
Land Price/acre	\$198	\$163	\$3.00	\$955
Year of Purchase	1926	1.87	1917	1932
Farm Size (acres)	154	267	10	3,502
Cultivated Acreage	17	40	0	422
Water Acre Feet	448	1267	0	21,072
Riparian Rights (Y/N)	0.35	0.48	0	1
Keough Pool (Y/N)	0.04	0.19	0	1
Cashbaugh Pool (Y/N)	0.07	0.26	0	1
Watterson Pool (Y/N)	0.03	0.18	0	1
Other Ditch (non-pool) (Y/N)	0.47	0.50	0	1
LA Annual Population Change (000) 1916-1934	123	75	23	283
LA Annual Precipitation Deviation from Mean in inches (1910-40)	0.11	4.98	-8.51	4.25

Table 3
Determinants of Year of Purchase and Price Received Per Acre

a.) First Stage Results

DV = Year of Purchase

Variable	Coefficient	SE
Constant	1928.17*	0.22
Total Farm Acres _t	2.3E ⁻⁰⁴	6.2E ⁻⁰⁴
Total Farm Acres ²	9.4E ⁻⁰⁸	2.6E ⁻⁰⁷
Total Cultivated Acreage _t	0.02*	0.004
Total Cultivated Acreage ²	-2.4 E ^{-05***}	1.3E ⁻⁰⁵
Water Acre Feet _t	-8.8E ^{-04*}	1.8E ⁻⁰⁴
Water Acre Feet ²	3.7E ^{-08*}	8.7E ⁰⁹
Riparian Rights _t	0.06	0.14
Member of Keough Pool _t	0.74**	0.35
Member of Cashbaugh Pool _t	-0.42***	0.27
Member of Watterson Pool _t	-0.61***	0.37
Farms on Ditches but not in Pool _t	-0.81*	0.16
Precipitation Deviation _{t-1}	0.09*	0.01
LA Annual Population Growth _{t-1}	-0.01*	0.002
595 obs., R ² = .33, F(13,581) = 23.54)		

*significant at the 1% level or better.

**significant at the 5% level

***significant at the 10% level

b.) Second Stage Results

DV = price per acre

Variable	Coefficient	SE
Constant	-67,180.71*	13,237.77
Estimated Year of Purchase _t	34.92*	6.87
Total Farm Acres _t	-0.36*	0.05
Total Farm Acres ²	8.6E ^{-05*}	2.1E ⁻⁰⁵
Total Cultivated Acreage _t	0.71**	0.33
Total Cultivated Acreage ²	-2.2E ^{-03**}	1.1E ⁻⁰³
Water Acre Feet _t	0.07*	0.01
Water Acre Feet ²	-3.0E ^{-06*}	7.5E ⁻⁰⁷
Riparian Rights _t	20.68***	11.10
Member of Keough Pool _t	282.99*	28.57
Member of Cashbaugh Pool _t	136.38*	21.14
Member of Watterson Pool _t	145.24*	29.31
Farms on Ditches but not in Pool _t	180.90*	14.03
595 obs.		

*significant at the 1% level or better.

**significant at the 5% level.

***significant at the 10% level.

Table 4
Analysis of Bid Prices and Appraisal Values by Owner Group

	Cashbaugh Pool Properties	Keough Pool Properties
Mean Ratio of LA Bid Prices to LA Appraisal Values	.99 (N=35)	1.45 (N=8)

Source: LADWP Archives, Tape GX0008, Appraisal Files, "McNally Ditch Stockholders;" Tape GX0004, "Sale of Lands, 1920-27 File," Keough Pool, Owens River Canal; Miscellaneous File, Appraisal and Ask Values; 1927 Appraisal Values; Tape GX0001, "Fish Slough File," Cashbaugh Pool; Tape GX0002 McNally Ditch.

Table 5
Analysis of Ask to Final Purchase Price by Owner Group
D.V.=Ratio of Ask Price to Final Purchase Price

Variable	Coefficient	SE
Constant	-86.37	28.56
Total Farm Acres	-0.0002	0.0002
Year of Purchase	0.05	0.01
Keough Pool	-0.33	0.12
Cashbaugh Pool	-0.21	0.11
135 Obs. , R² = .07, F(4,130) = 3.66		

Figure 1
Owens Valley

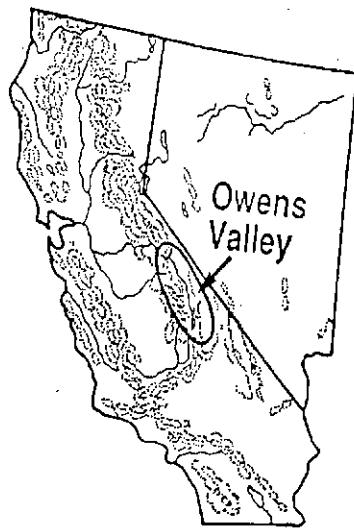
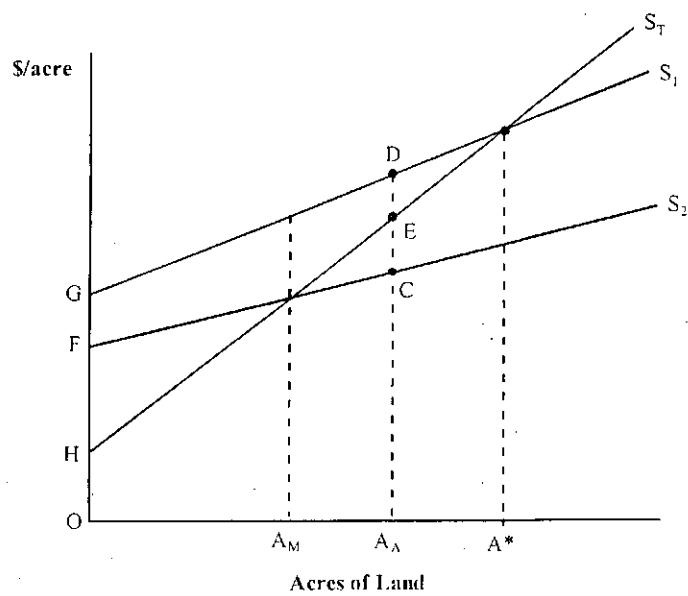


Figure 2
The Bargaining Framework



Bibliography

- Allen, Douglas W., "Transaction Costs," Boudewijn Bouckaert and Gerrit De Geest, eds, *Encyclopedia of Law and Economics*, Volume 1, 893-926, 2000.
- Anderson, Terry L., & Pamela Snyder. *Water Markets: Priming the Invisible Pump*. Washington, D.C.: Cato Institute, 1997.
- Archibald, Sandra O. and Mary E. Renwick, "Expected Transaction Costs and Incentives for Water Market Development," K. William Easter, Ariel Dinar and Mark W. Rosegrant, eds, *Markets for Water: Potential and Performance*. Boston: Kluwer Academic Publishers. 1998. 95-117.
- Barnard, Charles and John Jones, *Farm Real Estate Values in the United States By Counties, 1850-1982*, Washington DC: USDA, ERS, Government Printing Office, 1987.
- Barzel, Yoram, "Measurement Cost and the Organization of Markets," *Journal of Law and Economics*, 27-48, 1982.
- Blair, Rodger D., David L. Kaserman, and Richard F. Romano, "A Pedagogical Treatment of Bilateral Monopoly," *Southern Economic Journal*, 55(4): 831-41. 1989.
- Burt, Ronald S. "A Note on Social Capital and Network Content," *Social Networks*, 19: 355-73, 1997.
- Carter, Harold O., Henry J. Vaux, Jr., and Ann F. Scheuring, ed., *Sharing Scarcity, Gainers and Losers in Water Marketing*, Davis, CA.: University of California Agricultural Issues Center. 1994.
- City of Los Angeles Board of Public Service Commissioners. *Owens Valley and the Los Angeles Water Supply*. Los Angeles, 1925.
- Coase, Ronald H., "The Nature of the Firm," *Economica* 4: 386-405, 1937.
_____, "The Problem of Social Cost," *Journal of Law and Economics*, 3: 1-44, 1960.
_____, "Durability and Monopoly," *The Journal of Law and Economics* XV (1): 143-49, 1972.
- Colby, Bonnie, & David Bush. *Water Markets in Theory and Practice*. Boulder: Westview Press, 1987.
- Colby, Bonnie, "Regulation, Imperfect Markets, and Transaction Costs: The Elusive Quest for Efficiency in Water Allocation," in Daniel Bromley, ed, *Handbook of Environmental Economics*, Cambridge, MA: Blackwell. 1995.
- Coleman, James, "Introducing Social Structure into Economic Analysis," *American Economic Review*, 74 (2): 84-8. 1984.
- Dahlman, Carl J. "The Problem of Externality," *Journal of Law and Economics* 22: 141-62. 1979.
- Demsetz, Harold, "The Exchange and Enforcement of Property Rights," *Journal of Law and Economics* 7: 11-26. 1964.
_____. "The Cost of Transacting" *Quarterly Journal of Economics* 82: 33-53.
- Eggertsson, Thrainn, *Economic Behavior and Institutions*, Cambridge: Cambridge University Press, 1990.
- Glaeser, Edward L., David I. Laibson, Jose A. Scheinkman, Christine L. Soutter, "Measuring Trust," *Quarterly Journal of Economics*, 115 (3): 811-46, 2000.

- Glennon, Robert Jerome. *Water Follies: Groundwater Pumping and the Fate of America's Fresh Waters*. Washington, D.C.: Island Press, 2002.
- Gould, George A., "Transfer of Water Rights, *Natural Resources Journal*, 29: 457-77.
- Haddad, Brent M. *Rivers of Gold: Designing Markets to Allocate Water in California*. Washington, D.C.: Island Press, 2000.
- Hanak, Ellen, *Who Should Be Allowed to Sell Water in California? Third-Party Issues and the Water Market*, San Francisco: Public Policy Institute of California, 2003.
- _____, *Stopping the Drain: Third Party Responses to California's Water Market*, Working Paper No. 2004.11, San Francisco: Public Policy Institute of California, 2004.
- Hoffman, Abraham. *Vision or Villainy: Origins of the Owens Valley-Los Angeles Water Controversy*. Texas A&M University Press. 1981.
- Howe, Charles W. "Increasing Efficiency in Water Markets: Examples from the Western United States," in Terry L. Anderson and P.J. Hill, eds, *Water Marketing-The Next Generation*, Lanham, MD: Rowman and Littlefield Publishers, 79-100, 1997.
- Howe, Charles W., Carolyn S. Boggs, and Peter Butler, "Transaction Costs as Determinants of Water Transfers," *University of Colorado Law Review*, 61: 393-405, 1990.
- Howitt, Richard, "Empirical Analysis of Water Market Institutions: The 1991 California Water Market," *Resources and Energy Economics* 16: 357-71, 1994.
- _____. "Water Market Based Conflict Resolution," in R.G. Sanchez and J. Wolid, eds, *Resolving Conflict in the Management of Water Resources*, Proceedings of the First Biennial Rosenberg International Forum on Water Policy, September 28-30, 1997, San Francisco. Water Resources Report 93. Davis, California: Center for Water and Wildland Resources. 1998.
- Hundley, Norris Jr. *The Great Thirst, Californians and Water: A History*. Revised edition. Berkeley: University of California Press, 2001.
- Johnson, Ronald N., Micha Gisser, and Michael Werner, "The Definition of a Surface Water Right and Transferability," *Journal of Law and Economics*, 24: 273-88, 1981.
- Joskow, Paul L, "Contract Duration and Relationship-Specific Investments: Empirical Evidence from Coal Markets," *American Economic Review*, 77(1): 168-85, 1987,
- _____. "Price Adjustment in Long-Term Contracts: The Case of Coal," *Journal of Law and Economics* 31: 47-83. 1988.
- Just, Richard E. and Wen S. Chern, "Tomatocs, Technology, and Oligopsony," *The Bell Journal of Economics*, 11(2), 584-602, 1980.
- Kahrl, William L., *Water and Power: The Conflict over Los Angeles' Water Supply in the Owens Valley*, Berkeley: University of California Press, 1982.
- Kennan, John and Robert B. Wilson, "Bargaining with Private Information," *Journal of Economic Literature*, 31 (1): 45-104, 1993.
- Knapp, Keith, Marcia Weinberg, Richard Howitt, and Judith Posnikoff, "Water Transfers, Agriculture, and Groundwater Management: A Dynamic Economic Analysis," *Journal of Environmental Management* 67(4): 291-301, 2003.
- Literary Digest*, "California's Little Civil War," December 6, 1924, 13-14.

- Los Angeles, Department of Public Service, *Complete Report on the Construction of the Los Angeles Aqueduct*, Los Angeles, 1916.
- Los Angeles Department of Water and Power, Archives.
- Miller, Gordon R. *Los Angeles and the Owens River Aqueduct*, PhD Dissertation, Claremont Graduate School, 1977.
- Miller, Kathleen A. "The Right to Use Versus the Right to Sell: Spillover Effects and Constraints on the Water Rights of Irrigation Organization Members," *Water Resources Research* 23 (12): 2166-2174, 1987.
- Nadeau, Remi A. *The Water Seekers*. Garden City: Doubleday, 1950.
- National Research Council. *Water Transfers in the West: Efficiency, Equity, and the Environment*, Washington D.C.: National Academy Press, 1992.
- Northwest Economic Associates, *Third Party Impacts of the Palo Verde Land Management, Crop Rotation and Water Supply Program*, Sacramento: Entrix, Inc., 2004.
- O'Brien, Kevin, M. "Water Marketing in California," *Pacific Law Journal*, 19: 1165-1200, 1987.
- Osborne, Henry Z., "The Completion of the Los Angeles Aqueduct," *Scientific American*, CIX (10), November 6, 1913.
- Ostrom, Vincent, *Water and Politics: A Study of Water Policies and Administration in the Development of Los Angeles*, Los Angeles: Haynes Foundation, 1953.
- _____, *Institutional Arrangements for Water Resource Development: The Choice of Institutional Arrangements for Water Resource Development*, Arlington, VA.: National Water Commission, 1971.
- Pisani, Donald J., *From the Family Farm to Agribusiness: The Irrigation Crusade in California and the West, 1850-1931*, Berkeley: University of California Press, 1984.
- Reisner, Marc. *Cadillac Desert: The American West and its Disappearing Water*. New York: Viking, 1986.
- Rose, Carol, "Energy and Efficiency in the Realignment of Common-Law Water Rights," *Journal of Legal Studies*, 19: 261-94, 1990.
- Sauder, Robert A. *The Lost Frontier: Water Diversion in the Growth and Destruction of Owens Valley Agriculture*. Tucson: University of Arizona Press, 1994.
- Smith, Rodney T. *Troubled Waters, Financing Water in the West*, Washington D.C.: The Council of State Planning Agencies, 2001.
- Stavins, Robert N., "Transaction Costs and Tradable Permits," *Journal of Environmental Economics and Management*, 29: 133-48, 1995.
- Thompson, Barton H. "Water Markets and the Problem of Shifting Paradigms," in Terry L. Anderson and P.J. Hill, eds, *Water Marketing-the Next Generation*, Lanham, MD: Rowman and Littlefield Publishers, 1-30, 1997.
- U.S. Department of Commerce, *Census of Agriculture*, various years.
- Vorster, Peter. "The Development and Decline of Agriculture in the Owens Valley." In *The History of Water*. Clarence A. Hall, Victoria Doyle-Jones, and Barbara Widawski, eds. Eastern Sierra Nevada, Owens Valley, White-Inyo Mountains, White Mountain Research Station Symposium, Volume 4, 1992.
- Walton, John. *Western Times and Water Wars: State, Culture, and Rebellion in California*. Berkeley: University of California Press, 1992.

- Wheeler, Mark, "California Scheming," *Smithsonian*, 33(7), October 2002, 104-113.
- Wallis, John and Douglass C. North, "Measuring the Transaction Sector in the American Economy, 1870-1970," in Robert Gallman, ed, *Long Term Factors in American Economic Growth*, Chicago: University of Chicago Press, 95-148.
- Wiggins, Steven N. and Gary D. Libecap, "Oil Field Unitization: Contractual Failure in the Presence of Imperfect Information," *American Economic Review*, 75: 368-85, 1985;
- Williamson, Oliver E., *Markets and Hierarchies: Analysis and Antitrust Implications*, New York: Free Press. 1975.
- _____. "Transaction-Cost Economics: The Governance of Contractual Relations," *Journal of Law and Economics* 22: 233-61. 1979.
- _____. "Contract Analysis: The Transaction Cost Approach," Paul Burrows and Cento G. Veljanovski, eds. *The Economic Approach to Law*, London: Butterworths, 39-60. 1981.
- _____, 1993, "Calculativeness, Trust, and Economic Organization," *Journal of Law and Economics*, 36: 453-502, 1993.
- Wood, Richard Coke, *The Owens Valley and the Los Angeles Water Controversy, Owens Valley as I Knew It*, Pacific Center for Western Historical Studies, Stockton, University of Pacific, 1973.

¹ For instance, groundwater for farming near Marana, Pima County, Arizona costs approximately \$25 per acre-foot (approximately 325,000 gallons), whereas the same water for urban use costs \$200. In recent efforts to secure Imperial Irrigation District water, San Diego offered \$225 per acre foot for water that farmers used for \$15.50 (Dean E. Murphy, "Pact in West will Send Farms' Water to Cities, New York Times.com, October 17, 2003). There is a large literature discussing contemporary water problems. A very incomplete list includes Glennon (2002), National Research Council (1992), Anderson and Snyder (1997), Rose (1990), Johnson, Gisser, and Werner (1981), Knapp, et. al (2003), and Howitt (1998). Legal impediments and other constraints on water transfers are discussed in O'Brien (1987), Gould (1989), Howe (1997), and Thompson (1997).

² Ostrom (1953, 127). Under the appropriative water rights doctrine, water rights can be secured through land purchases and the water transferred out of the drainage area. Since the 1930s, additional regulations on transfers have been enacted. The Water Board represents the Los Angeles Board of Water and Power Commissioners, which was made up of five members, appointed by the mayor to staggered terms and confirmed by the City Council. The Board had authority to set water rates, purchase properties, and manage water bond funds, among other responsibilities. The Board of Water and Power Commissioners eventually became the Department of Water and Power. See Kahrl (1982, .17).

³ Ostrom (1953, 23). LA hosted the Xth Olympic Games in 1932. See also Kahrl (1982, 227-230).

⁴ A search of the Westlaw "ALL NEWS" data base of Owens Valley, for example, provides large and negative press accounts. More balanced views are in Nadeau (1950, 126-28), Hoffman (1981, xviii-xiv), Vorster (1992), Walton (1992, 192-97), and Sander (1994, 124-34, 151-64).

⁵ The perception of land theft and community destruction continues in the press. For example, see New York Times, August 8, 2004, p. 14, "Los Angeles Mayor Seeks to Freeze Valley Growth. Century-Old Land Grab Still Contentious," by John M. Broder.

⁶ As described below, recent negotiations between the Metropolitan Water District of Southern California and the Imperial Irrigation District and Palo Verde Irrigation District have encountered similar issues.

⁷ Mean precipitation for Los Angeles, 1921-2002 from

www.nwsla.noaa.gov/climate/data/cqt_monthprecip_cy.txt and mean for Chicago, 1871-2003 from home.att.net/~chicago_climo/CFIIPRCP.gif.

⁸ Ostrom (1953, 23) provides data on the various sources of water for Los Angeles, 1920-1950.

⁹ 1925 U.S. Agricultural Census; Ostrom (1953, 118) for irrigation acreage in 1910. Walter Packard, "The Future Agricultural Development of Owens Valley," January 22, 1925, Tape GX0004, Special Owens Valley File, LADWP Archives.

¹⁰ Tape GX0007, Owens Valley Lands file, Report to Ralph Criswell of Owen Valley Lands, August 6, 1927 from John T. Martin, Right of Way and Land Agent and "Tabulation Showing Status of Ranch Land Purchases Made by the City of Los Angeles in the Owens River Drainage Area from 1916 to April 1934," Prepared in Right of Way and Land Division by Clarence S. Hill, Right of Way and Land Agency, Compiled by E. H. Porter, April 16, 1934, Tape GX0004, LADWP Archives, hereafter referred to as "Porter file."

¹¹ Early bond elections were contentious because of political allegations of land speculation as described in the movie Chinatown. See also, Hoffman (1981, 141-54), Kahrl (1982, 90-103, 195), Ostrom (1953, 58, 149-54), and Nadeau (1950, 29-41). Contemporary water financing issues are discussed in Smith (2001).

¹² Sander (1994, 122), Ostrom (1953, 148). The beneficial use requirement meant that water had to be used and not stored (hoarded) for future use.

¹³ A controversy over a proposed Reclamation Service project for drainage and irrigation in Owens Valley may have helped to set the stage for contentious negotiations later. The project was cancelled in 1907, and many in the valley blamed the city. Recent research, however, suggests that the decision was based on limited funds and more favorable sites elsewhere. See Hoffman (1981, 50-79), Kahrl (1982, 39-79, 85-140), Miller (1977, 66-79), and Pisani (1984, 302).

¹⁴ "Porter file." Memo by land agent, AJ Ford for the Investigation file, March 11, 1931, Tape GX0002, Investigating Committee File, LADWP Archives.

¹⁵ Useful summaries of transaction cost issues and concepts are in Allen (2000) and Eggertsson (1990).

¹⁶ Empirical studies of transaction costs in exchange include Joskow (1987, 1988), Stavins (1995), Archibald and Renwick (1998), Howe, Boggs, and Butler (1990), and Wallis and North (1986).

- ¹⁷ Miller (1977, 53-55). US Census and Barnard and Jones (1987). The agricultural potential of Owens Valley generally is exaggerated in the literature. For instance see Kahrl (1982, 38).
- ¹⁸ In the Imperial Irrigation District use ranges from 5.6 to 6.6; in the San Joaquin Valley they range from 2.5 to 6 acre feet/acre. Data provided by Ellen Hanak.
- ¹⁹ Under appropriative water rights that dominated in the West, water could be moved to a particular property from its natural source, and priority among competing claimants was based on the date of diversion.
- ²⁰ Tape GX0003 Owens River and Big Pine Canal File, Transcript of Proceedings, August 13, 1926 Ladies Committee to Board of Water and Power Commissioners, testimony by Mrs. Wallace. LADWP Archives.
- ²¹ Tape GX0004, Sale of Lands File, Letter from Board of Public Service Commission to land owners, C.P. Crowell and S.F. Zombro, LADWP Archives.
- ²² Testimony from Mrs. G.L. Wallace, Transcript of Proceedings, August 13, 1926, Ladies Committee to Board of Water and Power Commissioners, Tape GX0003, Owens River and Big Pine Canal File, LADWP Archives.
- ²³ Tape GX0004 Special Owens Valley Committee File, Resolution, July 20, 1925, Board of Water and.. Power Commissioners. LADWP Archives.
- ²⁴ Tape GX0003 Owens River and Big Pine Canal File, letter to the Owens Valley Appraisal Committee from E.F. Leahey, September 10, 1926, LADWP Archives.
- ²⁵ Tape GX0003 Owens River and Big Pine Canal File, Transcript of Proceedings, August 13, 1926 Ladies Committee to Board of Water and Power Commissioners, testimony by Mrs. R. C. Clapp. LADWP Archives.
- ²⁶ Tape GX0003 Owens River and Big Pine Canal File. Transcript of Proceedings, August 13, 1926 Ladies Committee to Board of Water and Power Commissioners, testimony by Mrs. Wallace. LADWP Archives.
- ²⁷ Tape GX0006, George W. Parker File, LADWP Archives. Search of the "Porter file" shows no entry for the Parker ranch.
- ²⁸ Tape GX0004, Sale of Lands file, Letter to E.F. Leahey, Water Board land agent from J.T. Otey, February 4, 1927 and "Porter file," LADWP Archives.
- ²⁹ Tape GX0004, Special Owens Valley Committee file, telegram 7/22/25 to W.B. Mathews, Special Counsel, from the Keough Pool committee and telegram from Board President R.F. Del Valle to Karl Keough, 7/28/25. LADWP Archives.
- ³⁰ Joskow (1987) discusses the hazards of relationship-specific investments and how parties to long-term coal contracts contracted around them to promote trade.
- ³¹ Tape GX0002, Memo, July 26, 1928, E.F. Lahey, DWP Land Agent, to W.B. Mathews, DWP, E.F. Leahey File, LADWP Archives.
- ³² The role of the purchase of the McNally and Big Pine Ditches in thwarting the effective organization of the Owens Valley Irrigation District that would have united all of the sellers' pools is described in a letter, September 22, 1924 to the Grand Jury of Inyo County from W.W. Yandell and Ione Seymour of the Farmers Ditch Company regarding Los Angeles purchase of McNally Ditch. Tape GX0007, Town Properties File. Tape GX0001, Ditches File, "Percentage of Water Stock Owned by City of Los Angeles in Private Ownership in the Following Ditch Companies," LADWP Archives. See also, Kahrl (1982, 279), Nadeau (1950, 95), Sauder (1994, 140-43).
- ³³ Herfindahl indices based on water acre feet give similar relative values.
- ³⁴ Tape GX0001, Fish Slough File "Cashbaugh Pool," LADWP Archives.
- ³⁵ Memo, July 21, 1926 by Board of Water and Public Service Commissioners, Tape GX0004, Special Owens Valley Committee File, "Owens River Canal Properties," Tape GX0004, Sale of Lands File, and Letter, July 21, 1925 to the Board of Water and Power Commissioners from the Purchasing Committee, Tape GX0003, Owens River and Big Pine Canal File, LADWP Archives.
- ³⁶ "Owens River Canal Properties" and "Letter," February 24, 1926 from various individuals to F. Del Valle, President, Los Angeles Water Board, Tape GX0004, Sale of Lands File and "Porter file."LADWP Archives.
- ³⁷ *Literary Digest* December 6, 1924, 13-4. Tape GX00086, Letter May 9, 1924 from land agent John Martin to William Mulholland claiming that the dynamiting was an effort to force the city to buy at "exorbitant prices."
- ³⁸ Tape GX0001, Miscellaneous File, "The Dynamite Holdup," Statement by the Board of Water and Power Commissioners," LADWP Archives.

³⁹ Tape GX0004, Sale of Lands File, Letter from LADWP to two land owners, C.P. Crowell and S.F. Zombro reporting on the status of land purchases in Owens Valley and "Porter file" LADWP Archives.

⁴⁰ Miller (1977, 161). *Katz v. Walkinshaw* 141 Calif 116, 140 (1903) also protected correlative rights by limiting draw down through pumping.

⁴¹ Schedules E and F, Annual Reports of the California State Board of Equalization, Sacramento: State Printing Office, 1920-1930. There was virtually no inflation in the 1920s that could have affected appraisals.

⁴² Statement to Mayor's Advisory Committee Prepared by the Special Owens Valley Committee of the Board of Public Service Commissioners, December 16, 1924, Tape GX0004, Special Owens Valley Committee.

⁴³ Chapter 109 of the Statutes and Amendments to the Codes of California, 1925; 1925 Laws of California, 251, enacted and approved by the Governor, May 1, 1925. Support was dominantly from rural and Northern California legislators. The latter were concerned about the growing political influence of Southern California. California Assembly and Senate Journals, 46th Legislature, 1925.

⁴⁴ Tape GX0002, Investigating Committee File, see demands by Senators Joe Riley and Dan Williams from Inyo County regarding their properties, and resolution by Senator Herbert Johnson Evans, March 9, 1931, Chair of the Conservation Committee, LADWP Archives.

⁴⁵ Ostrom (1953, 126), Tape EJ0086, Correspondence January-March 1929 File, "Owens Valley Situation, Synopsis," Tape GX0002, Investigating Committee File, Memo by A.J. Ford, land agent for the investigating file, March 11, 1931, LADWP Archives.

⁴⁶ Hoffman (1981, 253). \$6,600,000 was used for Owens Valley and the rest for land purchases in Mono County.

⁴⁷ $S_T = F_A / F_M \cdot S_2$, where F_A = actual productivity and F_M = mean productivity for land in the area. As described in the text, there is little evidence that Board purchases significantly affected productivity. Moreover, as noted in the text, at this time, damage from groundwater draw down due to pumping on other lands could spark court injunction halting all pumping in the area.

⁴⁸ $S_T = S_2 \cdot V_L / V_O$, where V_L = value of water in Los Angeles and V_O = value of water in Owens Valley.

⁴⁹ Oligopsony is discussed by Just and Chern (1980). For problems facing a monopolist when the product is durable, see Coase (1972). See also Kennan and Wilson (1993) for other discussions of bargaining problems.

⁵⁰ 1925 Agricultural Census, value of farm production per farm, Inyo County, was \$3,412.

⁵¹ A Hausman test suggests endogeneity with a Chi-square test statistic of 6.54, 1 df, and a p value of .0105.

⁵² The instruments are relevant and an OIR test indicates that the instruments are valid. Annual precipitation data from 1910 to 1940 are for Long Beach from <http://climvis.ncdc.noaa.gov/cgi-bin/ghcn/precp.chncgi>. Long Beach data are virtually the same as those for Los Angeles for which the data were more limited. Annual Los Angeles population is estimated and provided at <http://www.lacp.org/target/science/population/table.html>. The estimations are based on decennial census data and estimates provided by the California Taxpayers Association, the Los Angeles Chamber of Commerce, and those compiled by the Los Angeles County Regional Planning Commission.

⁵³ "Porter file;" Memo by land agent, AJ Ford for the Investigation file, March 11, 1931, Tape GX0002, Investigating Committee File, LADWP Archives.

⁵⁴ Census data are from <http://fisher.lib.virginia.edu/cgi-local/censusbin/census/cen.pl>. These figures are only representative of the actual gains from trade. The data for Los Angeles do not include increases in urban land values which are not available. The amount of agricultural land in Los Angeles declined by 369,000 acres between 1900 and 1930. Similarly, the amount of farm land in Inyo County declined by 46,000 acres, whereas in Lassen County, farm land grew by 94,000 acres. Nevertheless, the data are indicative of the values involved.

⁵⁵ Schedules E and F, Annual Reports of the California State Board of Equalization, Sacramento: State Printing Office, 1900-1935.

⁵⁶ These values are calculated as follows: Using census data for 1900 and 1930, Inyo County had 141,059 acres in farms in 1900 and Lassen 381,109 acres. In 1930, Lassen had 473,268 acres, an increase of 24%. Had Inyo farm acreage grown in the same way, then in 1930 there would have been 175,120 farm acres. Lassen farm acreage values doubled over the 30 years, and 1900 Inyo per acre values were \$13. Using the

Lassen increase, gives a 1930 per acre value in 1930 of \$26 and multiplying this times the 1930 estimated acreage gives a value of farm acreage of \$4,553,120.

⁵⁸ Churchill and Lyon Counties in Nevada and Lassen in California.

⁵⁹ Most recently, see New York Times, August 8, 2004, p. 14 where the Owens Valley transfer is labeled a "Century-Old Land Grab."

⁶⁰ This is similar to efforts to define unitization shares in oil fields. See Wiggins and Libecap (1985).

⁶¹ Ellen Hanak reminded me of the nature of supply and demand forces in generating this result.

⁶² P.J. Hill made this point in assessing the results of the Owens Valley transfer.

⁶³ There are other efficiency concerns if the export of water involves extraction of subsurface, common-pool ground water basins. For discussion, see Hanak (2003, 2004) and Knapp, et al (2003).

⁶⁴ Third-party effects are discussed by Colby (1995), Howitt (1994), Carter, Vaux, and Scheuring (1994), Howe (1997), and others. Major, on-going negotiations in the U.S. West involve the Imperial and Palo Verde Irrigation Districts in California. Third-party effects are discussed by Northwest Economic Associates (2004).