

**Norm Impacts on States-building:  
A Hierarchical-Coalition Game Model of the State-building of Japan**

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**Abstract**

This paper shows (1) that both Shinto and Bushido have rational bases for having prevailed in Japan, (2) that the norms of Shinto and of Bushido promoted the society or state-building process of the chiefdom, kingdom, and feudalism of Japan, and (3) that those societies can be formulated by a hierarchical-coalition game, and (4) that they can be classified by differences in how to share leaderships for commons' preservation, agricultural production, and enforcement services, the "increasing returns to scale" effect of which are crucial factors for determining how or by whom those leaderships are shared.

*Keywords:* States, Social Norms, Commons, Public Goods, Hierarchical Teams

*JEL Codes:* H76, H77

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## 1. Introduction

Both Shinto and Bushido are the main elements of the Japanese identities in the sense that both originated in the daily life of the people living in the Japanese Archipelago, and that despite not only being exposed to but also assimilating various external shocks, both have been affecting the subconscious ethos and social norms of the Japanese in their deepest hearts. Though Shinto is subsumed in animism and Bushido is strict samurai ethos, it is natural to consider that so long as both originated in the daily lives of those people, they can be traced back to its own rational origins. If, furthermore, they were accepted and prevailed through an “evolutionarily-rational” selection (Hayek, 1973), it is also natural to hypothesize that the states-building of Japan can be not only traced back to, but also influenced by, those norms of Shinto and Bushido.

In order to construct the economic models of any state-building process on the basis of the evolutionary rationalism, we have to start from specifying the initial situations just at the time of the states-building, and then have to examine how special norms emerged from daily lives under those situations and then were transformed into formal institutions in the end. The initial situations in common where the state-building of Japan had just begun were rice-planting agricultural communities of a unique type, more strictly speaking, those rice-planting agricultural communities equipped with a set of massive irrigation systems which can be maintained by preservation of natural-common-pools, assisted by various pre-agricultural activities inherited from the preceding ages. Shinto norms had been instilled into those people living there and were established not only as authorized religion but also as one of the political activities of monarchical kingdom. Likewise, Bushido norms had been prevailing among those samurai leaders who had to secure the territoriality of newly developed rice-planting communities under then existing monarchical political systems, and then were established as the social norms of samurai communities when territoriality over their cultivated lands was taken over by themselves. Those Shinto and Bushido norms promoted the processes of establishing ancient kingdom and feudal society, respectively, and both functioned as the basis of formal institutions in the end.

This paper explores why Shinto and Bushido originated in the daily lives of those rice-planting agricultural communities, derives their rational foundations in an evolutionary sense, and examines the influences of those social norms on the state or society-building, based on a hierarchical-coalition game model which can

catch the hierarchical-teamwork characteristics of the agricultural communities of Japan.

For the above purposes, I start from the hypothesis that those rice-planting agricultural communities had to provide three types of collective goods in common as follows: (i) irrigation systems for rice-planting agriculture, (ii) homeostatic ecosystems of natural common pools (hereafter, commons), and (iii) fundamental enforcement functions.

The first collective goods, i.e., *irrigation systems*, have been the most crucial precondition for rice-planting agriculture under the climate and geographical conditions of the Japanese Archipelagos. These climate conditions allowed only a special species of rice, named *Temperate Japonica*, to be grown on a large scale, which, however, need a massive water supply during a growing period. The geographic conditions of steeply-sloped arable lands needed irrigation systems such as reservoir canals and ponds to retain rain water falling down intensively in a rainy season.

The second collective goods, i.e., *commons*, are also the preconditions for the rice-planting agriculture. Above all, mountain forests are located in the riverheads of all water resources, and function as natural reservoirs of rain water as well as woods resources. They also function as the cradle of phytoplankton, and so contribute to both marine and river fishing resources. Therefore, preservation of the mountain forests has been one of the main governing activities up till now.

It is needless to say about importance of the third collective good, but one of the characteristics of the ancient state-building is a low defense cost, reflected by metropolis without tough walls. This is because the ancient kingdom was built through a federation process of half-autarchic chiefdoms in order to consolidate defense powers against dynasties in the neighbor continent.

All of those collective goods had to be provided as one set from a scratch, and each of them was of an “increasing returns to scale” nature, the extent of which is dependent on the norms’ factors. These characteristics of the collective goods motivate us to examine the state-building of Japan by the analytical framework of hierarchical-coalition game. This paper tries to construct some economic models of the state-building of Japan by recourse to the analytical framework of hierarchical-coalition games with the “increasing return to scale” effects of those collective goods. The positive effects of the social norms above mentioned are derived, and the chiefdom, kingdom, and feudalism of Japan are classified and

characterized by differences in how to share leaderships for provision of those three types of collective goods.

The economic models of society-building presented by well-known predecessors can catch various aspects of Japanese history. It is sure that the “voluntary” element of Buchanan (1975), “self-management” element of Ostrom (1990), “rational bandit” element of Olson (1993, 2000), and “coordinated teamwork” element of Hardin (1996) and Ridley (1996) can be observed in Japanese history. All of them should be taken into consideration despite no explicit mention, except that the rational bandit element is omitted in this paper because the cooperative aspects of the ancient Japanese history are emphasized in this paper. However, that element must be taken into consideration when we examine the historical process of leading to the modern age.

In what follows, this paper is organized as follows: In the next section, some methodological backgrounds are summarized. In the third section a brief history of the chiefdom and kingdom and feudalism of Japan is reconsidered from the view point of this paper. In the fourth and fifth section, the rational origins of Shinto and of Bushido, in turn, are derived. In the sixth section, the basic hierarchical-coalition model is presented. In the seventh section, hierarchical-coalitions and their hierarchical outputs are proved to exist. In the eighth to tenth section, the norm effects on the chiefdom, kingdom, and feudalism of Japan, in turn, are examined in the analytical framework of hierarchical-coalition games, and the main results are derived. In the last section, the main conclusions are summarized.

## **2. Methodological Backgrounds**

Some methodological backgrounds are explained in this section. They are on the evolutionary rationality and on the classification of collective goods indispensable for the society-building of Japan.

### **2.1 Evolutionary Rationality**

The criterion for rationality is *survivability*. In this sense, it is called *evolutionary rationality* defined by Hayek (1973). It is the criterion on which human beings had to rely at the time of decision-making under the condition of limited information. When human beings had a lesson from experiences, they wanted it to take hold as a norm in their community or to be inherited as wisdom for their future

generations. In order for such a lesson to be accepted by others, however, instinctive myopic response patterns had to be overcome first of all, because any norm can not prevail without instilling some future-consciousness in those decision-makers.

When the selfish genes had been just parasitic on a living organism, its behaviors were originally programmed so as to put the first priority on protecting itself (Murakami, 2003). During the ages of *Homo sapiens* living in native woods, they could survive by following those programmed behaviors called *instincts*. Since driven out from the native forests *Eden*, however, they have been under the necessity of self-controlling their behaviors in order to constrain those instinctive behaviors in such a way as to adapt to new natural or social environments for survival. Group formations or group norms were an evolutionary response to this self-controlling problem of the selfish genes (Dawkins, 1976; Ridley, 1996). Animism, monotheism, and Buddhism were religious forms of those group norms, and the main characteristics of each religion were dependent on the natural and social conditions to which each grouped community had to adapt by recourse to its norms.

*Animism* originated in those communities whose natural endowments were not so affluent as to allow those people to be freed from diligent work or from devastating shocks inflicted regularly by nature, but so sufficiently rich as to induce them to expect positive rewards to their diligent work. By contrast, *personified monotheism* originated in those communities who had to survive under so desperately severe or oppressed natural or social conditions as to reject the assurance of any positive reward to their hard work in this world. For their survival, those communities were required to rely on the notion of “something absolutely-enforceable” in order to constrain their members from abandoning themselves to despair and to induce them to accept any hardship in this world.<sup>1</sup> On the other hand, *Buddhism* was accepted by those people who were living under those natural conditions in between the above two extremes, where only very hard work can bring about some positive rewards.

In order for those religious norms to instill the evolutionary rationality in their believers, first of all the time-spans of those believers must be so long as to be able to evaluate the effects of their present behaviors on their future well beings.

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<sup>1</sup> Both Judaism and Islam have their own commandments as well as beliefs. The former seem to be stricter than the latter, and Allah seems to be more generous than Jehovah. In spite of both being born in desert lands, such a difference in strictness may reflect a difference in their economic backgrounds in the sense that while the Israelites had to make a living by recourse to donkeys, the Arab people could by camels, i.e., whilst the former were half-nomadic tribes subordinate to neighbor agricultural and trading tribes, the latter were nomadic tribes engaged in trading activities.

However, the “future” ranges from tomorrow, via future generations, to the other world. The longer the future time-spans are, the more easily severe hardship in this world can be accepted and the more easily farsighted views can be accepted.

*Shinto* is the Japanese version of animism, in the sense not only that it originated with the nature worship of hunting-gathering and half-agricultural tribes living in the Japanese Archipelagos, but also that after inherited by the subsequent rice-planting agricultural communities, ancestor worship was incorporated into the nature worship and then established as authorized religion in the end. In order to make intertemporal decisions on ecosystems and on future generations, time-span must be so long enough to take into allowance the external effects of their present behaviors. Such a long time-span had been instilled into those people, thanks not only to narrowly-limited land space of the Japanese Archipelagos, but also to the nature worship of Shinto. However, thanks to moderately affluent natural endowments, those people did not have to invent the notion of such a long time-span as to extend to the other world, which induces them to give up any reward to diligent work in this world. Furthermore, the ancestor worship induced those people to stick to any evolutionarily rational norm, because it tends to promote a conservative way of thinking.

On the other hand, *Bushido* is the Japanese version of the “noblesse oblige,” in the sense that it originated in the samurai communities whose leaders were required to prove leaderships not only for common interests such as a territory defense but also for venturous development of rice-planting agricultural communities. Only those samurai leaders who could retain a high reputation for the Bushido norms could secure and expand their territory in a more successful way. Thus, those norms of Bushido prevailed among samurai communities in such an evolutionarily-rational way in spite of their strict behavioral appearance. They promoted the process of feudalistic society-building, and in the end were established as authorized ones under the feudal society of Japan. Those samurai communities had already accepted the Shinto norms, and their time-span was long enough to be able to take into consideration the effects of their present behaviors on their reputations and on their future lives.

## **2.2 Three-types of Collective Goods for Rice-Planting Communities**

In order to examine the influences of Shinto and Bushido on the states-building of Japan, we have to start from the hypothesis that the pre-industrial societies of

Japan can be classified by how they solved the problems of three types of collective goods, and by how leaderships for solving those problems were shared. Those problems are classified into three categories as follows: (a) the problem of the commons, (b) the problem of irrigation systems, and (c) the problem of defense and security. All of these problems were inevitable, whoever governed rice-planting agricultural societies in Japan, as explained below:

First of all, the religious feelings and spiritual life of the people living in the Japanese Archipelago crucially influenced how to cope with the problems of preserving the commons. For those people, it was a natural recognition or natural feeling that the ecosystems of natural common-pools are indispensable conditions for their survival. Though such a recognition of or feeling to nature tends to prevail in other hunting-gathering societies in common, in Japan it was not only uninterruptedly inherited from the preceding societies but also continued to be accepted by later agricultural societies. This is because its main agricultural industry, i.e., *rice-planting agriculture*, crucially depends on irrigation systems due to steeply-sloped arable lands and thus, had to preserve the ecosystems of those mountain forests and mountain rivers which function as the springheads of irrigation canals and reservoir ponds.

The primitive animism induced people to feel that “something great” or “something awful” governs nature and its spirits reside in those natural lives on which the survival of those people were crucially dependent. Later in the era of rice-planting agriculture, such a sentiment to nature was extended to the spirits of the “great ancestors” who had developed new cultivated lands through a series of hard efforts. It is because those lands, inherited by their descendents, assured them of a rich livelihood every year.

The leadership for preserving the ecosystems of those commons took various ritual forms of animism at first. After the ancestor worship was incorporated into the primitive animism, leadership for religious activities gradually became hereditary, and in the end entrusted to only one authority in each community, for example, to the chief of each chiefdom community, and then to the monarchical king in monarchical society. Under the hereditary system, wisdoms on how to preserve the commons were accumulated and inherited more efficiently. It was natural that the persons in charge were gradually recognized and accepted as the representative of the common interests of each society, and in the end, recognized as the priest authority when their leadership for ecology-preservation and for ancestor-adoration was established as a religious institution called *Shinto*. This is the origin of the

authority and representation power of the monarchical king, called *Tennou* in Japanese, whose status can not be taken over by any other agents.

Secondly, the technological characteristics of agricultural production influenced the society-building of Japan. Rice-planting agricultural communities had to set up hierarchical coalitions in order to construct and maintain irrigation systems from a scratch. Accordingly, any rice-planting society had to start as a set of production team, i.e., the economic organization whose members had to share the benefits and costs of those irrigation-infrastructures. Thus, leadership for constructing and maintaining irrigation systems, i.e., leadership for agricultural entrepreneurship, was indispensable for rice-planting agriculture. It is the case that the territory size of each rice-planting society was influenced by the “increasing returns to scale” effects of the irrigation infrastructures or leadership for them. This leadership for agricultural enterprises was taken by chiefs both in the chiefdom era and in the kingdom era, and then by samurais in the feudalist era.

Thirdly, the size of a society was also crucially influenced by the “increasing returns to scale” effects of defense and security services. The benefit and cost of those services are generally crucial factors for demarcating a territory, but in chiefdom and feudalist society without serious external threats, the scope of those effects are restricted to the territory size of each unit of those societies, except for the existing military balances being drastically broken. Only when military threats from overseas became serious, the “increasing returns to scale” effects extended to the boundary line of the whole society. The leadership for organizing defense and security activities was taken by the chiefs, king, and samurais, in turn, depending on a change in the scope of the increasing returns to scale effects of defense and security activities.

The best combination of three types of leadership for solving the above three problems are dependent on the “increasing returns to effects” of the leadership for solving each problem. In this paper it is shown that Shinto and Bushido exerted crucial influences on those combinations through their influence on those increasing returns to scale effects.

### **3. The Relations to Social Norms of the Chiefdom, Kingdom, and Feudalism**

In this section, a brief history of the chiefdom, kingdom, and feudalism of Japan is summarized in line with the hypothesis of this paper.

### 3.1 The Natural Backgrounds of the Japanese Animism

It is the natural conditions of any type of animism that foodstuffs can continue to be gained with moderately diligent effort of transforming natural conditions in such an adaptable way that the homeostasis of natural ecosystems can be maintained. Those foodstuffs can be brought about regularly, as long as the homeostasis of natural ecosystems can be maintained. On the other hand, nature is not always so affectionate or not so generous as to be freed from any devastating shocks. The primitive ideas of animism originated in those hunting-gathering communities whose members could feel like earning their livelihood by such a diligent work under the condition of regular hard shocks inflicted by natural disasters. They could feel like they are assisted by Mother Nature's favors but at the same time they are inflicted devastating damages on by uncontrollable awful nature. Natural conditions surrounding the Japanese Archipelago met those conditions. It is natural that the people living there recognized foodstuffs gained by their gathering-hunting activities as the products of forests, the sea, and rivers, i.e., as the favors of Mother Nature, and at the same time that they considered her to be something awful because some devastating natural disasters could not be controlled by their efforts. They had to endure those disasters until something awful passed through as soon as possible.

The succeeding half-agricultural communities such as slash-and-burn farming and/or horticultural ones, considered to have developed around more than several thousands before D.C., could not dismiss the preceding hunting-and-gathering activities, because those half-agricultures could not so sufficiently provide foodstuffs, in particular, animal proteins, as to be able to dismiss the hunting-gathering activities. Thus, the primitive animism continued to be accepted by those half-agricultural communities, too. Not only that, rice-planting agricultural communities, having systematically begun around one thousand before D.C., also continued to accept the primitive animism, because they had to maintain the ecosystems of those mountain forests and rivers which served as the springheads of irrigation canals and reservoir ponds. Furthermore, they could not dismiss the preceding hunting-gathering works, either, because of their requirement to supplement a source of animal proteins.<sup>2</sup>

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<sup>2</sup> More strictly speaking, as cultivated paddy-fields were extended away from the mountain-foots areas in the rice-planting societies, response to the weather conditions such as rains and sun lights became more crucial factors for survival than the fertility of the earth itself the symbol of which was snakes representing the fertility of the earth in the preceding half-agricultural communities. The sun became the main symbol of the

Owing to the limits of scientific knowledge, the people in those days tried to take care of natural ecosystems by recognizing natural creatures as something spiritual on which the spirits of “something great” or “something awful” reside. That is, every living organism was considered as the creature of nature in which something spiritual or something great resides, usually giving favors but sometimes harming awfully. Those people accepted a new birth of creature life as the supreme bliss, because it can enrich a means of livelihood. Teamwork was accepted as a joyful but not painful cooperation not only with other community members but also with Nature, because it can enhance their living standard by bringing about means of livelihood. They were grateful to Mother Nature for her favors, and so paid tributes to her in token of their gratitude whenever their teamwork could bring about foodstuffs. Those tributes were considered as their fulfillment of unwritten contracts with Nature.

Since rice-planting agriculture was begun, ancestor worship was gradually accepted. This is because the rice-planting agriculture required a long endured work for land development and irrigation systems, and because therefore those descendents inheriting the cultivated lands felt grateful to their ancestors.

After the ancestor worship was incorporated into the primitive animism, the status of the religious leaders became gradually hereditary, inherited from a family line leading to the worshiped ancestors. Under the hereditary religious leadership, wisdoms on how to conserve the commons and how to organize agricultural activities could be more efficiently inherited and accumulated into one data file. In this sense the hereditary system had an economic rationality. In the end, those religious leaders were recognized as the representative of not only the common interests but also the society itself, reflecting not only the leadership status of conserving the commons but also the status as heirs to the common ancestors of the society. This religious authority was inherited from each chief to his heirs in the chieftain era. In the end, it was consolidated into the monarchical king, called *Tenno* in Japanese or *Emperor* in English. Therefore, the supreme authority of *Tenno* has been residing in his religious authority to conserve the commons and to represent common interests of the whole society.

The present constitutional monarchy of Japan originated in the ancient rice-planting agricultural communities, governed at first by the chiefs of the

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rice-planting societies, because of the indispensability for a growing period of rice, and because the sun was considered to influence on rain waters. In this sense, the sun worship has a similarity to the worship for weather god around Ugarit of ancient Syria. A little later around 2000<sup>th</sup> B.C., Crete was flourishing

chiefdom societies which had been gradually transformed from the preceding tribes' communities, if we would skip the pre-rice planting eras. Those chiefs took a leadership not only in organizing agricultural production but also in organizing religious activities. Therefore, those chiefs as a social organizer of rice-planting communities were required to show not only talents for an agricultural entrepreneur so that the production activities of community members can be coordinated as a teamwork to make efficient use of a club-good type of irrigation systems, but also wisdoms on how to maintain the ecosystems of natural common pools so that in particular, mountain forests and rivers can be well preserved. This latter role of those chiefs as the patron of homeostatic ecosystems took the form of a religious leadership, and their wisdoms on ecological life and ecological production were synthesized into the *primitive version of ecology*.

As cultivated lands for rice-planting agriculture were extended, the notion of "something great" has been, in an extrapolative way, applied to the spirits and souls of the ancestors of rice-planting communities who had taken a leadership indispensable for developing those newly cultivated lands and then to those great persons who had shown extraordinary energies and spirits to contribute to the common interests of community. Through synthesizing such worship for ancestors and great men into the primitive animism under the hereditary system and consolidating the authorities entrusted to those hereditary priest chiefs into *Tenno* in the political process of constructing a federation, *Shinto* was established as the authorized religion in the ancient era of Japan, in the end.

### **3.2 Criteria for Classifying Chiefdom, Kingdom, and Feudalism**

As was said in the second section, in order to earn means of livelihood from rice-planting agriculture under the geographical conditions of the Japanese Archipelago, three types of collective goods had to be provided for each agricultural community. *First of all*, man-made agricultural infrastructures such as irrigation canals and reservoir ponds must be equipped from a scratch, because her arable lands are steeply sloped, and therefore not suitable for natural reservoirs, a vivid contrast to flat paddy-fields of other East Asian countries. Since those irrigation systems had to be constructed and be maintained by deliberately-coordinated teamwork, collective action and leadership for the construction and maintenance of irrigation systems were indispensable for the rice-planting agriculture. *Secondly*, the springheads of the irrigation systems had to be preserved. Mountain forests and rivers are those natural common-pools which serve as the springheads. *Thirdly*,

enforcement systems such as defense and security services for each community have to be provided in order for any established social system to be maintained. From many archaeological findings, it is conjectured that conflicts over water supply must have been inevitable between tribes' communities in the upstream area and those in the downstream area, even if military threats from overseas could be ignored.

Three types of leadership functions for meeting those three conditions were taken on or shared by the chiefs, *Tenno* and samurais, in correspondence to three historical phases, the chiefdom, kingdom, feudalism of Japan, in turn. The simplified correspondences are summarized in *Table 1*.

(Table 1)

Era \ Leadership	Chiefdom	Kingdom	Feudalism
Team work	Chiefs	Chiefs	Samurai
Commons	Chiefs →	Tenno	Tenno
Enforcement	Chiefs	Tenno & Chiefs	Samurai

It should be noted beforehand that samurais in the feudalism era were authorized to have the territoriality of their cultivated lands. But this governance over their territories were ensured by constitutional contracts between *Tenno* and a hierarchical coalition of samurais, according to which the power of enforcement was entrusted to *Shogun*, i.e., the top post of the hierarchical coalition which was formed by “give-and-take” contracts among Shogun and other samurais. Each correspondence is explained more in detail in the next two subsections.

***A Brief History of Monarchy System:*** The ancient agricultural society of Japan began with community units led by seniors and then by hereditary chiefs. These basic units of the agricultural society had to be a *hierarchical team* from a scratch. This is because of the indispensability of collective actions both for organizing rice-planting agricultures based on irrigation systems and for preserving the ecosystems of the springheads of those irrigation systems.

At first, tribes' communities and chiefdom' communities were located in riversides or river-basins at the foot of mountain forests owing to the geological and technological restrictions of those days. Roughly speaking, one riverside or one river-basin area had one agricultural community. Then, a group of them located in

the same riverside areas were combined into a chiefdom society, as technologies of irrigation systems could have been more developed and combined into a wider unit. As new technologies, in particular, at first bronze materials and later iron materials, were introduced to both production processes and conflict resolutions, the basic units of chiefdom societies gradually grew larger thanks to the enlarged “increasing returns to scale” effects of irrigation systems and military activities, and through both federation process and conflicting process, those chiefdom societies were gradually consolidated into the kingdom of the ancient era, formally established in the 7<sup>th</sup> century in the end when the increasing returns to scale effects of defense activities jumped up, when confronted with military pressures from the *Sui* and *Tau* dynasty established in the neighboring continent. In both political and religious field, pyramidal systems were established, at the top of which *Tenno* was authorized to reign over.<sup>3</sup>

***A Brief History of Samurai Communities:*** As irrigation technologies were further innovated in the latter half of the ancient era, new rice-planting communities were developed by the entrepreneurship of a group of *Mononofu* or *Tuwamono* in Japanese (hereafter, *samurai*) and new cultivated lands were extended to much wider plains areas in the riversides of middle and down streams. At first a typical community of samurais was comprised of the combination of indigenous agricultural entrepreneurs with the high-born samurai leaders who had once served as guardsmen for the royal families or as local governors dispatched by the monarchical government, usually descendants of royal families and later settled to their developed lands. Such a combination continued until the 16<sup>th</sup> century when the total inner wars among samurai lords began over territoriality.

At first, those new leaders of newly-developed agricultural communities, however, had yet to be authorized by the monarchical dynasty to govern their newly-cultivated lands. Therefore, those samurais had to take a leadership not only in developing and managing new agricultural communities, but also in battles for ensuring territoriality. Therefore, they had to be not only an *agricultural entrepreneur* but also a *warrior entrepreneur*. In the end, their territoriality was formally established in the 12<sup>th</sup> century when the samurais were authorized to govern their territories under a pyramidal system of hierarchical coalitions, at the top of which a *general* called *Shogun* was authorized to enforce social contracts

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<sup>3</sup> Actually, the establishment of these pyramid systems was stimulated by the military and diplomatic pressure of the *Sui* and *Tang* dynasty.

among those samurais. Since then, the political systems of Japan have been separating governance powers from authority.

On the other hand, during the political process of establishing their territoriality, those samurais gradually developed their own self-disciplined norms, summarized by two major codes as follows: (i) self-sacrifice for the common interests of their own community, and (ii) fair compassionateness to their subordinates and junior members. Though the first and second code can be expressed by *Gi* and *Jin* in terms of the Japanese versions of Confucianism, respectively, it should be noted that the essential characteristics of these concepts originated in lessons and wisdoms learned from the daily experiences of those samurais in those days. The first code was indispensable for a talented warrior entrepreneur,<sup>4</sup> and on the other hand, the second for a considerate administrator.

The optimal size of a hierarchical team extended far beyond the core territory of each samurai community, thanks to the “increasing to scale” effects of irrigation systems which had been brought about by innovations of irrigation technologies of those days. Furthermore, introduction of firearms reduced the net cost of conflict resolutions by violence. These technological factors stimulated samurai leaders to expand their territories. However, only the samurai leaders who could have a high reputation for those samurai norms could expand their territories, because without such a reputation any samurai leader could not attract other samurai members to form teamwork for military enterprises. That is why they dared to stick to those norms.

Today, it is a common sense of the ordinary Japanese that the commons such as mountain forests and rivers are common infrastructures indispensable for the production processes of manufactured industries as well as of primary industries. Those industries which are apt to suffer the influence of those commons are the most-conscious of the necessity to coordinate their behaviors for sustainable use of those commons. Such an ecology-consciousness is the same as the primitive backgrounds of Shinto. It has been so long in the subconscious of the people living in the Japanese Archipelago without perceiving it as some religious feeling or religious sentiment.

Likewise, it is a common sense that some teamwork is indispensable for

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<sup>4</sup> The Bushodo of Nitobe (1900) overlooked this aspect of the original samurai norms. It is perhaps because he wrote it in order to emphasize the morals and ethics common to both Bushdo and Christianity.

improving economic welfares. Such a team-spirit has a long history originating in the rice-planting communities. In these capitalistic societies, any teamwork must be carried out under competitive pressures, and so requires for leadership both in organizing teamwork and in challenging to rival competitors. Such leaderships for teamwork formation and for economic warfare have the same elements in common with the norms of Bushido. Thus, those Bushido norms are invoked even without being conscious of Bushido, whenever a stubborn leadership of business entrepreneurs is required for the survival of private companies.<sup>5</sup>

#### **4. The Rational Foundations of Shinto**

In this section, the rational foundations of Shinto are derived by relating its norm behaviors to its essential ethos.

##### **4.1 The Fundamental Ethos of Shinto**

It is the essence of Shinto that all creatures of nature are recognized to have something spiritual on which the spirits of something great or something awful resides. Such recognition of nature induced people to be affectionate to natural creatures, to abstain from destroying their ecosystems, and to accept a new birth of any creature life including the products of teamwork as the supreme bliss, which is summarized by the most essential concept of Shinto, called "*Musuhi*" in Japanese. Ancestor worship was incorporated into such nature worships after hard cultivation ventures by the ancestors of rice-planting tribes communities were thanked by their descendants. The great spirits of those ancestors were also enshrined in the status of "something great." Whilst it is believed that if the homeostasis of natural ecosystems were destroyed or diligent work were neglected, something great is sure to inflict punishments such as devastating harms or bad harvests, they were grateful for its favors, and expressed their gratitude by regularly paying tributes, the ritual ceremonies for which, called *Matsuri* in Japanese, actually meant one of the governing activities in those days. Even today, governance activities in Japan are elegantly called *Matsurigoto*.

By contrast, Shinto abhors any enfeeblement of vital force or that of survival ability. Such enfeeblement is called *Kegare* in Japanese, and Shinto considers that weakening life force should be cheered up and can be resuscitated by some effort, called *Misogi* for physical enfeeblement and *Harai* for mental enfeeblement.

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<sup>5</sup> For example, see Kanno (2004) as to recent revival of Bushido norms.

Thus, it is the essential ethos of Shinto that diligent and cooperative work should be joyfully done with heartfelt gratitude to nature and their ancestors in order to create something beneficial, and survival ability should be kept up at any time.

Their adaptive responses to natural environments have been nurturing delicate sentiments and feelings toward nature. Such sentiments to nature inspired the people living in the Japanese Archipelago to create their own cultures. Furthermore, the ancestor worship induced those people to take inter-temporal decision making. Why, however, did Shinto have to be established as an authorized religious institution? Why was it insufficient to leave the conservation of natural common-pools to those voluntary sentiments and feelings toward nature, which originated in the daily life of rice-planting communities as well as in that of the preceding eras? In the next subsection, I try to derive the rational bases of Shinto.

#### **4.2 The Rational Bases of Shinto**

The ethos of Shinto induces people to live up to a sustainable way of economic activities, to concentrate their energy expenditure on creative activities, to activate those selfish genes which can inspire creative ideas, to inactivate those selfish genes which control the behavior programs leading to death, and to take the long-run effects of present behavior into allowance. This subsection derives the rational foundations of Shinto by showing its positive effects on the preservation of commons, and on the creative teamwork, in turn.

*The Homeostatic Functions of Shinto:* Not only the people in the era of the preceding half-agriculture and hunting-gathering activities but also those in the era of rice-planting agriculture felt like earning their daily living by assistance of the favors of Nature, i.e., by adapting to nature but not by conquering her, thanks to moderately-conditioned natural environments. From a long history of their experiences, those people had the lesson that as long as they did not destroy the homeostasis of natural ecosystems, they could continue to enjoy the favors from Nature. Owing to their limited scientific backgrounds of those days, however, they could not synthesize their empirical wisdoms on the natural ecosystems into a consistent scientific logic. This led those wisdoms to taking various ritual forms, such as worship for those mountain forests or rivers which served as the headsprings of irrigation systems, or worship for those natural big rocks at mountain ridges and at capes which reveal the most fragile points of the ecosystems

of mountains and capes. Those sites or points were considered as the sacred places where something spiritual or something awful visits regularly. By marking those places by ritual buildings or signs, entrance into those places have been inviolably tabooed up till now. Thus, without an appeal for consistent scientific logic, those natural ecosystems have been preserved as a result of the ritual self-controlling systems or taboos. If those commons had to be conserved by other enforcement systems but not by ritual self-controlling systems, all members of a community would have to share the heavier burden of monitoring and punishing activities. The cost of monitoring and enforcement would have been heavier than the cost of maintaining ritual systems such as religious buildings and ceremonies, i.e., the cost of entrusting preservation of the commons to some religious authority.<sup>6</sup>

***The Productivity-Enhancing Functions of Shinto:*** Shinto puts the supreme value on the birth of a creature life including agricultural outputs produced by coordinated teamwork. Therefore, in spite of hard work being sure to be accompanied, any productive teamwork is considered as a joyful social activity, but not a painful labor, assisted by Mother Nature and helped by their ancestors' investment in agricultural infrastructures. So, agricultural communities held not only solemn but also enjoyable ceremonies to express their gratitude to them for the favors. They paid tributes to something great or awful in token of their gratitude. In a sense, those tributes meant the fulfillment of their unwritten contracts with it. Those tributes may be considered to be received by the religious authority, and to having contributed to a financial base of their outstanding status.

Firstly, through those ritual ceremonies, those community members could not only refresh themselves but also confirm that rich harvests were also the outcome of their teamwork under the leadership of their seniors or chiefs. This confirmation process could enhance trustworthiness among them and reduce the monitoring and enforcement cost of coordinating their production activities to a minimum level.

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<sup>6</sup> The Gilgamesh Epos, a legend of the ancient Sumer around 2500 B.C., conveys a serious message on the destructive effects of woods-cutting in riverheads on the soils and water resources in lower areas, even though those societies had animism. It is because those mountain forests were exposed to the working of the "tragedy the commons," probably due to the high cost of enforcement. A little later in 2000<sup>th</sup> Century B.C., Crete also had animism similar to that of Sumer, the sacred symbols of which were bulls and snakes, and flourished by marine-trading woods, bronze wares smelted by woods, and ship building made of woods, but resulted in rocky deserted lands. It is because whilst agriculture on that island did not so depend on water supply, those woods resources had so high commercial values.

Secondly, those ceremonies promoted the sense of belonging to a community, which contributed to putting membership relations in longer-term frameworks, i.e., in repeated-game frameworks, and to promoting voluntary cooperation. In these senses, the ritual ceremonies of Shinto could contribute to accumulating the social capital of those communities. Thus, Shinto could promote the teamwork and cooperative actions of community members at a low cost.

***The Time Spans-Extending Functions of Shinto:*** The ancestor worship of Shinto induces people to feel like they are a bridge between the past and future generations. Whilst it induces those people to tend toward a conservative way of thinking, it also encourages them to take into allowance the future generations. The conservative tendency is inspired by consciousness of their ancestors, and the future-oriented tendency is by consciousness of descendents' assessment on their present behaviors. Thus, traditions and commons are more plausible to be preserved, until their irrationality is proved in an evolutionary sense.

***The Vital Energy-Enhancing Functions of Shinto:*** According to a hypothesis on genes programs (Murakami, 2003), more than 95 percents of the original programs of genes are inactive. Though some of them inspire creative ideas and activities, others of them are dangerous programs to activate a tendency to death such as cancers. It is an empirical wisdom that the most essential ethos of Shinto called *Musuhi* can activate the former programs, and that its opposite called *Kegare* can inactivate the latter dangerous programs, leading to cheering up of life power.

Dietary habits in accordance with the Shinto ethos put the first priority on fresh and pure food materials in balance. It is because those foodstuffs were considered to contain more powers of life. Japanese-style meals have been prevailing under the influence of such a Shinto ethos.

## **5. The Rational Foundations of Bushido**

The basic norms of Bushido appear to be of a sternly self-sacrificing nature, so sternly that the samurai must always be determined and be ready to sacrifice his own physical life for the sake of the common interests of the communities to which he belongs. That is, he must always be ready to behave as a daring warrior for common interests, and to fight to defend community's interests at any cost. On the other hand, he must be fair and compassionate to his subordinates and junior

members. That is, he must be a fair and compassionate patron of his community members. Why did these norms originate in the daily life of samurai communities? This section shows that the basic norms of Bushido have their own rational bases in an evolutionary sense, and that they functioned both as a self-control system for the survival of not only his communities but also himself, and as a solution to the incomplete-contract problems.<sup>7</sup>

*The First Norm as A Self-Control System:* A well-known text of the Bushido<sup>8</sup> exclaims that it is the essence of Bushido that whenever he is faced with two ways to cope with a hardship, the samurai must choose the way to physical death but not the way to physical survival. This aphorism, however, does never mean beautifying death and suicide. The main point is in encouraging samurais to be determined to choose the harder way whenever he has two options, even if such a choice may invite his physical ruin. Even if it sounds self-sacrificing, however, we can find the rational reasons why it was accepted by samurai communities. The rational logic is as follows:

As a proverb goes, any great purpose can be achieved only after having made a great effort or gotten over a great hardship corresponding to it. Roughly speaking, the greater is the former, the greater is the latter. In general, it takes anyone a long time and many lessons to grasp this wisdom by himself. A defense against outsiders' invasive attacks is one example for the great purposes in the sense that without it all members of a community may lose their physical life. However, if the defense action is taken only after much time has been taken to make the final decision, it is often too late to be effective. The response must be sufficiently quick in order to be effective, because a moment hesitation of any community member to respond quickly may lead to a ruin of the community as a whole.

To make the matters worse, the actual cost of taking a new action is much heavier than expected, owing to the problems of the "present-biased preference" or the "dynamic inconsistency."<sup>9</sup> That is, any positive action can be taken only after an *initial accelerative energy* has been expended, or just after an initial cost to jump-start has been borne. Likewise, any negative action of breaking off, say, bad

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<sup>7</sup> This paper focuses on the original samurai norms but not more-refined versions developed later in the era of the Tokugawa shogunate. Regarding it, see Kasamatu (2001).

<sup>8</sup> Yamamoto, Tunetomo(1717), *Hagakure Monjo*.

<sup>9</sup> As to the concept of the present-biased and dynamic consistency, refer to O'Donoghue and Matthew (1999), Pollark (1968), and Strotz (1956).

habits can be taken only after an *initial decelerating power* is exerted. Such an initial extra cost for starting or stopping is usually not taken into allowance at the time of making an inter-temporal decision-making. Therefore, the true cost hiding behind the door always enters into the mind of an action-doer, whenever he just has to take the action. Such an initial cost is felt prohibitively heavy, in particular, in the case of risking the doer's life. This is because the *selfish genes* programmed each host individual to take instinctive actions of avoiding any risk for the sake of host's physical survival when they once had been parasitic on the individual host<sup>10</sup>. Those programmed instincts always order each host individual *to keep to inertia*, i.e., to discourage him to take a new positive action, and *to avoid risks*, i.e., to discourage him to stop habits for example. Thus, an extra cost and energy is required to break off the inertia or to stimulate taking the risky actions. Accordingly, both "procrastination" and "preproperation" tendency are natural results from the present-biased tendency caused by the initial extra costs which were not taken into due allowance at the time of inter-temporal decision-making.

Only those persons who have learned a lesson from many regrettable experiences can grasp these wisdoms by themselves. However, any samurai community could not allow its members to have so much time to grasp those wisdoms through many first-hand experiences. For its survival, the samurai community had to devise a self-control system under which its samurai members are programmed to take immediate positive actions without any moment hesitation. The most effective action-program is the "priority of death" option. The rational logic of this death option is shown by a two-stage game presented below.

***A Two-Stage Model:*** In order for the death option to be rational, first of all, the life-span of a samurai must be such a long-term that he can take into allowance his payoffs gained in the periods succeeding after he chose an option. For this purpose, the time-span of an individual samurai life was divided into two stages as follows: (i) the samurai life in active service during which he has to support his dependants such as family members and subordinates, and (ii) the samurai life in retirement during which despite his dignity sustained he has to be supported by his heirs.

The death option at the first stage is rewarded at the second stage not only with a high reputation but also, more importantly, with special privileges guaranteed to his heirs, or family members of the bereaved when he dies. However, another option,

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<sup>10</sup> "The basic human genetic codes programmed each individual to escape from risky circumstances." (Murakami(2003), pp.108)

i.e., "not-to-die" option at the first stage, is followed at the second stage by punishments such as a disgraced status of both himself and his family members, or ostracism amounting to an actual death, because it is impossible for such a disgraced samurai family to find a new samurai community which is willing to accept them as its community member.

On the other hand, more importantly, the death option at the first stage need not necessarily lead to an actual death with the probability of 100 percents at that stage. Far from it, the daringly-determined action can usually enhance the probability of living through any crisis. "*The goddess of good lucks visits on daring activists only.*" Samurais had known this truth. Thus, the death option at the first stage can lead to a positive expected net-payoff in the end, which is larger than the payoff of zero obtainable from the "not-to-die" option.

Samurai community devised such a self-control system as to ensure its survival by programming its members to take the stern self-sacrificing action functioning like a conditioned response. That is the program called "the priority of death" option, which could free *Hamlet* from the well-known distress, "To be or not to be, that is the problem," or which could save *Beethoven* from advocating "Durch leiden freude." Furthermore, it overlaps with "Die Protestantische Ethik," defined by Weber (1920).

Samurai communities accepted those Shinto norms, above all, the ancestor worship. It is because they originated in those agricultural entrepreneurs who had to develop new rice-planting lands by themselves. Therefore, the Shinto norm promoted those samurais to accept the first norm of Bushido. Afterward, the essential ethos represented by this first norm was called *Gi* in the Japanese version of Confucianism. As those samurai communities for the interests of which each samurai takes the death option were extending from a group of samurai families to those organizations the heads of which were feudal samurai lords, the concept of *Gi* was in an extrapolate way extended to including loyalty to his superiors under the condition that the superiors stand for common interests. This loyalty was later called *Cyu* in the Japanese version of Confucianism.

***The Second Norm as A Solution to the Incomplete-Contract Problems:*** The rational bases of the second norm of Bushido, called *Jin*, can be explained by another model of two-stage game as follows: Any teamwork organized by a samurai leader has to motivate his junior members and subordinates to do their best to achieve their common interests. Quite often, very risky tasks had to be fulfilled by at least a part

of community members. However, without some guarantee of satisfactory rewards worth those risks, no one dares to take those risks, but it is impossible to make complete contracts to guarantee those rewards in advance. Thus, those risky tasks must be able to be taken under the condition of so-called incomplete contracts. Therefore, a reputation for *fair judge* is indispensable for organizing the best cooperative teamwork even without concluding detailed contracts beforehand. The reputation for fair judge is also indispensable to enhancing the trustworthiness of samurai leaders without which conflicts over how to share the outputs of teamwork are expected to increase unnecessarily.

Furthermore, a reputation for not only fair judge but also *compassionate judge* is indispensable, because even if a challenge to risky tasks could not bring about successful results, the challenge itself must be evaluated as praiseworthy in order to encourage future challenges or to avoid being dispirited. That is, unsuccessful challengers including even losers have to be treated with a sufficient reward or praise. Only under such *unwritten contracts*, all team members of a samurai community can be motivated to dare to do their best even at any cost. The above logic is summarized in *Fig. 1* below.

(Figure 1: A Two-Stage Game under Incomplete Contracts)

First Stage		Second Stage
Without complete contracts:		Under a fair and compassionate judge:
(Action)	(Result)	(Expected Payoff)
<i>Take risky action</i>	→ Success	→ <i>High reward</i> > 0
	↘ Failure	→ <i>Some reward</i> > 0
<i>Avoid risky action</i>	→ Status Quo	→ <i>No reward</i> = 0

Thanks to trust in the fair and compassionate judge, the expected payoff of the strategy, “taking risky action at the first stage,” is positive under the incomplete-contract condition. Therefore, each member of a samurai community can be motivated to dare to take it rather than avoid it. The trust in samurai leader as a compassionate and fair judge could stimulate all members of the samurai community to dare to take such a risky challenge.

The Bushido norm of such a fair and compassionate samurai leader has been

often applied to their enemy losers. This extension to enemy losers may be considered as a strategic decision which can appease the feeling of future revenges. One example of this norm, “The samurai must not throw stones at any lame duck,” is called “Sokuin no Jo” in Japanese, which means a fair compassionateness to losers even if they are former enemies. Such a reputation for fair compassionateness to losers could ease the surrender of other hostile enemies when they hesitated to do it.

## 6. The Basic Model of Rice-Planting Agricultural Society

In this section, the basic social units of the chiefdoms, kingdom, and feudalism of Japan are formulated by a game model of hierarchical coalitions. This formulation is based on the basic assumption that the agricultural society of each historical era had basic social units of rice-planting communities described by hierarchical coalitions. The effects of both Shinto and Bushido on agricultural productivity are formulated by a game model of hierarchical coalitions.

***Agricultural Society:*** Suppose an agricultural society consisting of  $n$  members, defined by  $N := (1, 2, \dots, n)$ . Agricultural outputs are produced with a combination of manpower and physical capital organized by agricultural entrepreneurship under both religious and defense leadership. The physical capital is represented by irrigation systems such as irrigation canals and reservoir ponds, provided by an agricultural leadership. The defense services are provided by a defense leadership. The commons are conserved by a religious leadership.

Take up a coalition  $S \subseteq N$ , and define  $s$  as  $s := |S| \leq n$ . If one member of  $S$ , numbered  $1$ , takes on the agricultural leadership and organizes other  $s-1$  members, numbered  $2, 3, \dots, s$ , in order to induce them to join in a teamwork for agricultural production, this coalition is called *hierarchical coalition of  $S$* . More than two hierarchical coalitions can be combined into a more inclusive hierarchical-coalition, such as a more-vertical and more-horizontal hierarchical coalition. The coordinated production activities of the manpower under the three types of leadership are defined by a hierarchical coalition.

***Production Function and Characteristic Function:*** The basic unit of agricultural production is comprised of one-ranked hierarchical coalition. If a hierarchical coalition  $S \subseteq N$  is organized by the leadership of its member  $1$ , he is at the top of the

hierarchy, and other  $s-1$  members are direct subordinates to him. It is assumed that each organized member of the coalition  $S$  puts a fixed manpower effort, denoted by  $e$ , in the production process. This assumption is justified by the technological and social conditions of those days that the rice-planting communities had to be nearly engaged in full-time work. Thus, the total manpower efforts amount to  $(s-1)e$  for  $S$ . The disposable outputs of agricultural production are determined not only by the manpower efforts but also by three types of collective goods as follows; the quality level of physical capital denoted by  $q_1$ , that of defense and security services denoted by  $q_2$ , and that of services conserving the commons or religious readership, denoted by  $q_3$ . Denoting by  $f(q_1, q_2, q_3)$  the total effects of the qualities of the above three collective goods services, then the final output level is defined as follows:

$$f(q_1, q_2, q_3) (s-1)e, \text{ s.t., } \partial f / \partial q_j \geq 0, \partial^2 f / \partial q_j^2 \leq 0 \text{ for } j=1, 2, 3.$$

The physical capital with a quality level  $q_1$  which is provided for a coalition  $S$ , is assumed to have the technological characteristics of congestion effects, and of increasing returns to scale. It is because irrigation canals and irrigation ponds are required for a fixed capital to be equipped. The marginal cost of extending the canal system to any member of a community in the same riverside area can be assumed to be constant. However, if new members living in a remote riverside area join in the existing canal system, it can be extended to them at a jumped-up cost. Denoting by  $K(q_1, s)$  the cost of the physical capital in terms of leadership effort, those assumptions are expressed by  $\partial K / \partial q_1 > 0$ ,  $\partial^2 K / \partial q_1^2 > 0$ ,  $\partial K / \partial s = \text{constant} > 0$ , and  $\partial (K/s) / \partial s < 0$ ,<sup>11</sup> for  $S$ , a coalitional community in the same riverside area.

Likewise, it is assumed that the cost of the defense and security services with a quality level  $q_2$ , in terms of the leadership effort, is defined as  $F(q_2, s)$ , subject to  $\partial F / \partial q_2 > 0$ ,  $\partial^2 F / \partial q_2^2 > 0$ ,  $\partial F / \partial s = \text{constant} > 0$ , and  $\partial (F/s) / \partial s < 0$ , for  $S$ , a coalitional community in the same riverside area. These assumptions are justified by the geographical characteristics that each rice-planting community must be enclosed by walls and/or moats in a closed riverside area, and that if new members living in a remote riverside join in the existing coalition, those services can be extended to them only at a jumped-up cost.

The definitions of an “increasing return to scale” in the above are identical to the following relations, respectively:  $\partial K / \partial s < K/s$ , and  $\partial F / \partial s < F/s$ .

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<sup>11</sup> As to these definitions of the congestions and increasing returns to scale, refer to Dmange (2005).

The cost of conserving the commons, denoted by  $C(q_3, s)$ , is also assumed to have the similar characteristics to those of  $q_1$  and  $q_2$ . That is,  $\partial C / \partial q_3 > 0$ ,  $\partial^2 C / \partial q_3^2 > 0$ ,  $\partial C / \partial s = \text{constant} > 0$ , and  $\partial (C/s) / \partial s < 0$ , for  $S$ , a coalitional community in the same riverside area. However, if taking into consideration the characteristics of religious authority or representation power, it is also possible to assume that  $\partial C / \partial s = 0$  for any  $S \subseteq N$ .

Then, the net agricultural outputs, denoted by  $v(S)$ , are defined as a characteristic function by Eq.(1).

$$(1) \quad v(S) = f(q_1, q_2, q_3) (s-1)e - (s-1)e - w_1 [K(q_1, s) + F(q_2, s) + C(q_3, s)], \text{ for } S \subseteq N,$$

in which  $w_l$  means the unit cost to the member  $l$  of providing leadership functions on the assumption that he takes on the three leadership functions.

Whether or not the super-additive conditions are met is dependent on the relations between  $f(q_1, q_2, q_3)$  and  $\{K(q_1, s) + F(q_2, s) + C(q_3, s)\}$ .

**Utility Functions:** The leader offers *proposals*, denoted by  $a = (\rho, q_1, q_2, q_3, S)$ , to the other  $s-1$  members of a coalition  $S \subseteq N$ .  $\rho$  is the share to the leader in the final outputs. The utility of  $i$  member is denoted by  $U_i(a)$  on the assumption that he is a organized member of the coalition  $S$ . Then, on the assumption that after a share of  $\rho$  in the final outputs is given to the leader, numbered  $l$ , the rest is distributed to the other members of the coalition on an equal basis, the utility function of the member  $i$  is defined as Eq.(2).

$$(2) \quad U_i(a) = (1 - \rho) f \{q_1, q_2, q_3\} e + I_i - e, \quad \text{for } i \in S - \{l\}$$

in which  $I_i$  is the initial endowment, and  $e$  is the fixed inputs of the  $i$  member's work.

On the other, the payoff of the leader is defined by Eq. (3).

$$(3) \quad U_l(a) = \rho f \{q_1, q_2, q_3\} (s-1) e + I_l - w_l \{K(q_1, s) + F(q_2, s) + C(q_3, s)\}, \text{ for } l \in S$$

in which  $w_l$  is the unit cost to the member  $l$  of those leadership functions in terms of the numeraire good. In what follows, it is assumed without loss of generality that  $w_1 \leq w_2 \leq \dots \leq w_n$ .

**Feasibility:** A proposal  $a = (\rho, q_1, q_2, q_3, S)$  is called *feasible* for  $S$ , if  $U_i(a) \geq I_i$  for any  $i \in S - \{1\}$ , and  $U_1(a) \geq I_1$ . In what follows, the initial endowments are normalized to zero, i.e.,  $I_i = 0$  for any  $i \in N$ , and thus the reservation utility is assumed to be zero.

**Super-Additivity:** There are gains to a coordination if two disjoint coalitions can improve the prospects of their payoffs by acting together. This becomes possible if  $a = (\rho, q_1, q_2, q_3, S)$  is of a *super-additive* nature, which is defined by the following relations:

For  $S \cup T, S \cap T = \phi$ , and a feasible  $c$  for  $S \cup T$ ,

- (i)  $U_j(c) \geq U_j(a)$  for any  $j \in S$ , any feasible  $a$  for  $S$ , and
- (ii)  $U_j(c) \geq U_j(b)$  for any  $j \in T$ , any feasible  $b$  for  $T$ .

Under the super-additive condition, the characteristic function for coalition  $S$ , denoted by  $v(S)$ , is defined by Eq.(1). Then, under the condition that the utilities are *transferable*, the sufficient condition of the super-additivity is given by (4).

$$(4) \quad v(S \cup T) \geq v(S) + v(T), \text{ for any } S, T \subseteq N, \text{ s.t., } S \cap T = \phi.$$

It depends on the effect of an increase in  $s$  on  $f(q_1, q_3, q_3)(s-1)e$  and  $\{K(q_1, s) + F(q_2, s) + C(q_3, s)\}$  whether or not the characteristic function  $v(\cdot)$  defined by (1) can meet the sufficient condition (4). In the next section, we take up the case where the super-additivity can hold true over the full range of  $s \leq n$ .

## 7. Hierarchical Outcomes: Conditions for Centralized Pyramidal-Hierarchy

This section derives the conditions for a centralized hierarchical coalition to be established. If the super-additivity is assumed, the agricultural society consisting of *one* leader and his direct subordinate members of a hierarchical coalition can be described as a principal-agent model. It is, therefore, natural to suppose that the leader maximizes his payoff subjected to the condition that each subordinate member is assured of his reservation utility, normalized to zero level. If, however, we allow the reservations to be more flexible, they are called *guarantee levels*, defined by Demange (2005). For a given hierarchy consisting of the leader at the top and his subordinates at the bottom, and for  $(A, U)$  where  $A :=$  the set of  $a = (\rho, q_1, q_2,$

$q_3, S$ ) and  $U := \{U_1, \dots, U_s\}$ ,  $S \subseteq N$ , the algorithm to calculate those guarantee levels along the logic of Demange (2005) is as follows:

**Step 0:** For each  $i \in N$ ,  $g_i(1)$  is defined as his guarantee level when only he is the member of coalition  $S = \{i\}$ , as follows:  $g_i(1) = \max \{U_i(a), \text{ for } a = (\rho, q_1, q_2, q_3, \{i\}), \text{ given}\} = 0$ , if the reservation utility is normalized to zero. It is because anything new can not be produced without organizing a team with other members.

**Step 1:** Suppose one member, say  $i$ , takes on the leadership to form the best two-member hierarchical team with, say, the member  $i+1$ , subject to the condition that this member  $i+1$  is assured of his guarantee level,  $g_{i+1}(1)$ . Then, the guarantee level of the leader, denoted by  $g_i(2)$ , is defined by the following:

$$g_i(2) = \max \{ U_i(a) \text{ over } a = (\rho, q_1, q_2, q_3, \{i, i+1\}) \in A(\{i, i+1\}), \text{ s.t., } U_{i+1}(a) = g_{i+1}(1) \geq g_{i+1}(1) = 0 \}.$$

**Step 2:** Suppose a member, say  $i$ , takes on the leadership to form the best three-member team with, say, member  $i+1$  and  $i+2$ , subject to the condition that both  $i+1$  and  $i+2$  are assured of their guarantee levels,  $g_{i+1}(2)$  and  $g_{i+2}(2)$  respectively. Then, the guarantee level of  $i$ , denoted by  $g_i(3)$ , is defined by the following:

$$g_i(3) = \max \{ U_i(a) \text{ over } a = (\rho, q_1, q_2, q_3, \{i, i+1, i+2\}) \in A(\{i, i+1, i+2\}), \text{ s.t., } U_{i+1}(a) = g_{i+1}(2) \geq g_{i+1}(2), \text{ and } U_{i+2}(a) = g_{i+2}(2) \geq g_{i+2}(2) \}.$$

**Step s:** Suppose a member  $i$  takes on the leadership to form the best  $s$ -member team making a hierarchical coalition  $S$ , subject to the constraint that each organized member,  $j \in S - \{i\}$ , is assured of his guarantee level,  $g_j(s-1)$ . Then, the guarantee level of  $i$ , denoted by  $g_i(s)$ , is defined by the following:

$$g_i(s) = \max \{ U_i(a) \text{ over } a = (\rho, q_1, q_2, q_3, S) \in A(S), \text{ s.t., } U_j(a) = g_j(s) \geq g_j(s-1), \text{ for } \forall j \in S - \{i\},$$

and so on.

To the extent that the member  $1$  is the most talented leader, only he can take on the leadership for forming the best full-hierarchy with other  $n-1$  members. Then, at the step  $n-1$ , the guarantee level of the leader player  $1$  is defined by (5).

$$(5) \quad g_1(n) = \max \{ U_1(a) \text{ over } a = (\rho, q_1, q_2, q_3, N) \in A(N), \text{ s.t., } U_j(a) = g_j(n) \geq g_j(n-1), \text{ for } \forall j \in N - \{1\} \}$$

At the step  $n-1$ , the guarantee level of the leader,  $g_1(n)$ , is defined, and a proposal that solves (5) is called *hierarchical outcome*.

**Theorem 1.** Assume that the functions  $U_i(a)$  are *continuous* over  $a = (\rho, q_1, q_2, q_3, S)^{12}$ , and that the set of  $a$ ,  $A := \{a\}$ , is compact. Given the super-additivity condition,

1. The guarantee levels are finite, and a hierarchical outcome exists.
2. The hierarchical outcome is not blocked by any sub-team coalition.

*Proof of 1:* It is obvious that  $g_j(a)$  is finite for any  $j \in S \subseteq N$ , because if the player  $j$  is the leader of coalition  $S \subseteq N$ ,  $U_j(a)$  is continuous and weakly-concave over the compact set  $A$ . For each  $S \subseteq N$ , therefore, there exists the maximum of  $a = (\rho, q_1, q_2, q_3, S)$ . *Q.E.D.*

*Proof of 2:* Assume, on the contrary, that by using  $b \in A(T)$ , a  $t$ -member hierarchical coalition,  $T = \{i, i+1, \dots, i+t-1\}$ , can block the hierarchical outcome. Then, for each member of  $T$ , the blocking conditions must be met as follows:  $U_j(b) > U_j(a) \geq g_j(t)$ , for  $\forall j \in T$ . However, according to their definitions,  $g_j(t)$  must be the maximum value among  $t$ -member coalitions, *contradiction*. *Q.E.D.*

## 8. The Rational Basis of Independent Chiefdoms

Suppose neighboring communities are so distant that the costs of irrigation systems and of defense services jump up drastically provided it must be extended to a new member living in other community, usually located in other riverside areas. Taking into consideration such a geographical characteristic of rice-planting communities located in different riverside areas, it is obvious that those two conditions of the super-additivity are not met provided that  $N$  is considered as the whole society. The loss of the super-additivity conditions is caused by the congestion effects on the physical capital and/or defense services. The whole society is divided into many sub-societies called *chiefdoms* each of which is located in a riverside or river-basin area. This section formulates a society consisting of more than two chiefdoms as a *stable network of hierarchical coalitions*, based on the previous model.

A *coalition structure* is defined as a family  $(a_j, S_j)_{j=1,2,\dots,m}$ , where  $S_1 \cup S_2 \cup \dots \cup S_m = N$ , and  $a_j$  is feasible for  $S_j$ ,  $j=1,2,\dots,m$ .

The above coalition structure is called *blocked by coalition T*, if a proposal  $b$  feasible for  $T$  makes every member of  $T$  better off than in the existing coalition

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<sup>12</sup>  $s$  is assumed to be a continuous variable.

structure, i.e., for any  $i \in T$ ,  $U_i(b) > U_i(a_h)$ , if  $i$  belongs to  $S_h$ .

Let's assume (i) that the super-additivity conditions are satisfied inside each chiefdom territory, and (ii) that if irrigation canals, and/or defense and security services must be extended beyond its territory to new members living in other chiefdom's territory, the cost has to jump up, so drastically that the super-additivity conditions can not hold. Such technological characteristics are formulated by the assumption as follows: Denoting by  $K_j$  ( $F_j$ ) the physical capital (defense and security services) provided for the  $j$  chiefdom,  $\partial K_j / \partial s$  ( $\partial F_j / \partial s$ ) for  $i \in S_j$  is drastically less than  $\partial K_j / \partial s$  ( $\partial F_j / \partial s$ ) for any  $h \notin S_j$ .

If there are  $m$  riversides or river-basins communities, then it is natural that one chiefdom is established in one riverside or river-basin area, and the whole society is described by a coalition structure,  $(a_j, S_j)_{j=1,2,\dots,m}$ . Denoting by  $g_{ji}(S_j)$  the guarantee level of the  $i$  member of the  $j$  coalition,  $S_j$ , they are defined as follows:

**Step 0:** For each  $i \in S_j$ ,  $g_{ji}(1)$  is defined as his guarantee level for the coalition of  $\{i\}$ , and is determined as follows;

$$g_{ji}(1) = \max \{U_{ji}(a_j), \text{ for } a_j = (\rho_j, q_1(j), q_2(j), q_3(j), \{i\})\} = 0.$$

**Step 1:** Suppose one member of  $S_j$ , say  $i$ , takes on the leadership to form the best two-member hierarchical team with, say, member  $i+1$ , subject to the condition that this member  $i+1$  is assured of his guarantee level,  $g_{j,i+1}(1) = 0$ . Then, the guarantee level of the leader, denoted by  $g_{ji}(2)$ , is defined by the following;

$$g_{ji}(2) = \max \{U_{ji}(a) \text{ over } a_j = (\rho_j, q_1(j), q_2(j), q_3(j), \{i, i+1\}) \in A(\{i, i+1\}), \text{ s.t., } U_{j,i+1}(a_j) = g_{j,i+1}(1) = 0\}.$$

**Step 2:** Suppose a member of  $S_j$ , say  $i$ , takes on the leadership to form the best three-member team with, say, member  $i+1$  and  $i+2$ , subject to the condition that both  $i+1$  and  $i+2$  are assured of their guarantee levels,  $g_{j,i+1}(2)$  and  $g_{j,i+2}(2)$  respectively. Then, the guarantee level of  $i$ , denoted by  $g_{ji}(3)$ , is defined by the following;

$$g_{ji}(3) = \max \{U_{ji}(a_j) \text{ over } a_j = (\rho_j, q_1(j), q_2(j), q_3(j), \{i, i+1, i+2\}) \in A(\{i, i+1, i+2\}), \text{ s.t., } U_{j,i+1}(a_j) = g_{j,i+1}(2) \geq g_{j,i+1}(1), \text{ and } U_{j,i+2}(a_j) = g_{j,i+2}(2) \geq g_{j,i+2}(1)\}.$$

**Step  $s_j - 1$ :** Suppose a member  $i$  of  $S_j$  takes on a leadership to form the best  $s$ -member team making a hierarchical coalition  $S_j$ , subject to the constraint that each organized member,  $h \in S_j - \{i\}$ , is assured of his guarantee level,  $g_{jh}(s_j - 1)$ . Then, the guarantee level of  $i$ , denoted by  $g_{ji}(s)$ , is defined by the following;

$$g_{ji}(s_j) = \max \{U_{ji}(a_j) \text{ over } a_j = (\rho_j, q_1(j), q_2(j), q_3(j), S_j) \in A(S_j), \text{ s.t., } U_{jh}(a_j) = g_{jh}(s_j - 1) \geq g_{jh}(s_j - 2), \text{ for } \forall h \in S_j - \{i\}\}.$$

If the first member of  $S_j$ , denoted by  $1(j)$ , is assumed to be the most talented leader, only he can take on the leadership for forming the best full-hierarchy with other  $s_j-1$  members. Then, at the *step*  $s_j-1$ , the guarantee level of the leader member  $1(j)$  is defined by (6).

$$g_{j1(j)}(s_j) = \max \{U_{j1(j)}(a_j) \text{ over } a_j = (\rho_j, q_1(j), q_2(j), q_3(j), S_j) \in A(S_j), s.t., U_{jh}(a_j) = g_{jh}(s_j) \geq g_{jh}(s_j-1), \text{ for } \forall h \in S_j - \{1\}\}$$

When the super-additivity were met for  $N$ ,  $g_{ji}(s_j) = g_i(n)$ . If not,  $g_{ji}(s_j) \geq g_i(n)$  in general. As to the stability nature of a coalition structure, we can derive *Theorem 2* as follows:

**Theorem 2.** Assume that the super-additivity is satisfied only for each chiefdom coalition. Then, under the same conditions as *Theorem 1*,

1. Guarantee levels  $(g_{ji})_{j=1,2,\dots,m, i \in S_j}$  exist.
2. There is a non-blocked coalition structure  $(a_j, S_j)_{j=1,2,\dots,m}$ , subject to the condition that  $U_{ji}(a_j) \geq g_{ji}(s_j)$ , for all  $i \in S_j$ , and for all  $j = 1, 2, \dots, m$ .

*Proof of 1:* It is obvious that  $g_{ji}(a_j)$  is finite for any  $i \in S_j$ , because if  $U_{ji}(a_j)$  is continuous and weakly-concave over the compact set  $A_j$ . For each  $S_j$ , therefore, there exists the maximum of  $a_j = (\rho_j, q_1(j), q_2(j), q_3(j), S_j)$ . *Q.E.D.*

*Proof of 2:* Assume, on the contrary, that by using  $b \in A(T)$ , a  $t$ -member hierarchical coalition,  $T = \{i, i+1, \dots, i+t-1\}$ , can block the coalition structure. Then, for each member of  $T$ , the blocking conditions must be met as follows:  $U_{jh}(b) > U_{jh}(a_j) \geq g_{jh}(t)$ , for  $\forall h \in T, h \in S_j, t \leq |S_j|$ . However, according to their definitions,  $g_{jh}(t)$  must the maximum value among  $t$ -member coalitions, *contradiction*. *Q.E.D.*

The above theorem provides the logic to support the existence and stability of the society consisting of independent chiefdoms separated from each other. The stability of such independent chiefdoms is considered to be ensured by the geographic and technological characteristics which restricted the working of the “increasing returns to scale” effects to each chiefdom territory. In particular, the restrictions of the “increasing-returns to scale effects of irrigation systems” to each riverside area are considered to be crucial to the existence of independent chiefdoms separated from each other. Actually, the territory of each chiefdom was located along a river, distant from other riversides. The original meaning of

“country,” called *Kuni* in Japanese, stood for such a community of chiefdom size, and later on under the centralized monarchical kingdom, such chiefdom functioned as the largest local political unit called *Gun*. This concept of *Kuni* is still prevailing today.<sup>13</sup>

The chief took on the leaderships for agricultural undertaking, for defense and security services, and for conservation of the commons (i.e., religious activities). Strictly speaking, therefore, the chiefs in those days can be called a *priest chief*.

## 9. The Rational Basis of Monarchical Kingdom

Even if the working of “the increasing returns to scale effects of the irrigation systems” are restricted narrowly to each chiefdom territory, those of the leadership for defense services and those of the commons-preserving religious activities can be extended beyond it. In fact, the “increasing returns to scale” effects of the defense leadership grew much larger in the 6<sup>th</sup> and 7<sup>th</sup> century when the despotic dynasties, *Sui* and *Tang* in turn, emerged in the neighbor continent. Under the circumstances where the power-up of defense against military threat from them was recognized to be indispensable for the survival of all chiefdoms communities, the production function defined by  $f(q_1, q_2, q_3)$  shifted up with respect to  $q_2$ , and the main factors influencing  $F(q_2, s)$  changed from the cost of coping with irregular conflicts with adjacent chiefdoms to that of a defense against attacks coming from overseas. Those changes in the production and cost function could enlarge the working of the “increasing returns to scale” effects to the whole society covering up all chiefdoms. Under such an external pressure, it was rational for those independent chiefdoms to leave both their defense and religious leadership to one authorized agent. For this purpose, however, the person entrusted with both military and religious leadership must be restricted to coordinating and promoting the common interests of those chiefdoms.

To whom can such an authority be entrusted? The best candidate is such a type of person as to have reputations for military strength and economic power. The reputation for military strength is always the most crucial qualification for any military leadership, because without it, other participants’ incentives to forming a coalition with him grow weak. If, furthermore, the candidate for the leader has a

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<sup>13</sup> The concept of *Kuni* which means “country” is in a stark contrast to the concept of “states” in China where they mean a kind of *polis* surrounded by walls inside which kings lived.

reputation for innovative entrepreneurship, he can give innovative technologies to those participants and therefore the function  $f(q_1, \cdot)$  can be shifted up through the technological effects.

Furthermore, a reputation for fairness and compassionateness can be a solution to the “incomplete contract” problems with which those participants in the coalition had to face, because each participant in the federation had to engage in risky military activities for a common defense quite often under unverifiable conditions. The reputation for fairness, in particular, was a crucial qualification for the leadership, because each participant in the federation was in conflict with others over any cost-sharing and/or over pie-sharing, leading to the need of a trustworthy judge. It has the effect of enhancing  $f(\cdot, q_3)$  by reducing the cost of social decision-making and by promoting teamwork.

The chief which was recognized to have a long history and high technological knowledge was chosen as the coalition leader. The necessity of forming such a defense federation of all chiefdoms brought about the centralized monarchical kingdom to Japan in the end.

## 10. The Rational Basis of Feudalistic Society

The rational basis of the centralized federation system was being lost, when the military threat from overseas was mitigated. The process of the rational basis being lost began with weakening of the *Tao* dynasty. Turning our eyes to the domestic side of the monarchical kingdom, on the other hand, new innovative technologies to construct irrigation systems stimulated new agricultural entrepreneurs to develop new rice-planting communities, which were extended to wider plains areas of riversides in the middle and low stream. They extended beyond the originally-developed riversides and/or basins located in the upstream areas. Those newly-developed rice-planting communities were the cradle of samurai communities. But those agricultural entrepreneurs were not yet authorized to have their territoriality. Through their meeting and parting accompanied by violent conflicts for about two hundreds years, the agricultural society of Japan was transformed into a feudalistic society, the basic units of which were administrated and policed by newly established feudal lords. They had been both a worrier and agricultural entrepreneur, but in the end they won governance power over their territories as a feudal lord. The local governance shared by aristocrats under then monarchical kingdom was taken over by those feudal lords in the end.

In the process of establishing the territoriality of newly-developed samurai communities, Bushido norms prevailed over the samurai communities. As was shown in the sixth section, the higher reputation for the Bushido norms a samurai leader won, the wider territory he could secure. This interrelation can be described by the function  $f(\cdot, q_2)$  being shifted upward and  $F(q_2, s)$  being shifted down.

Those characteristics of the feudalistic society of Japan are that the religious leadership, agricultural leadership and military leadership were separated. The first leadership was still left to the monarchical king, but the second and third leadership to the new establishment, samurai lords. These samurai lords formed hierarchical coalitions at the top of which the chief of them, called *Shogun*, was authorized by the dynastic king to govern the whole samurai communities. Each samurai lord made the so-called feudalistic “give-and-take” contracts with Shogun. According to those contracts, the territoriality of each samurai lord was ensured by Shogun in return to their fulfilling the obligations to participate in coordinated military activities at his request in case of emergency, usually for the purpose of keeping a peace and order of the feudal society.

Like the status of the monarchical king, the status of Shogun has the rational basis in his brave, fair, and compassionate leadership, because someone had to take on this leadership to coordinate all samurai communities, and to win and protect the territoriality of their cultivated lands from the traditional establishments and/or from each other. The qualifications for the best candidate for Shogun are the same as the circumstance under which the chiefs of the chiefdom age backed up the monarchical king in order to form their centralized federation to enhance and protect their common interests. High reputations for military and economic power, fairness, and compassionateness were those qualifications. Therefore, it was natural for those samurai leaders with renowned family-lines to have the status of leader. In fact, the origins of almost all outstanding samurai leaders including Shogun are traced back to the former princes of the monarchical kings.

## 11. Main Conclusions

In this paper, first of all, I showed the rational bases of Shinto and Bushido, as follows: (i) that Shinto could contribute to enhancing the homeostasis of the commons' ecosystems, the productivity of a coordinated teamwork, the vital energy of each person, and the intertemporal consciousness, and (ii) that Bushido could

function both as self-control systems for enhancing the survivability of samurai community, and as a solution to the incomplete-contracts problems.

Secondly, I showed that rice-planting agricultural communities were basic social units of Japan, and that each agricultural society had to be equipped with three types of collective goods, which are natural-common pools, irrigation systems, and enforcement functions, and that who took on the leaderships for providing those collective goods characterized the historical eras, such as the chieftdom, monarchy, and feudalism of Japan.

Thirdly, based on the game model of hierarchical coalitions, I showed that the increasing returns to scale effects of each type of collective good influenced on the best combination of those leadership functions, and that Shinto and Bushido influenced the scope of those increasing returns to scale effects.

The economic model of states-building presented by this paper may reflect more of the view points emphasizing coordinating factors which was argued, in particular, by Hardin (1995) and Ridley (1996). Actually, recent archaeological findings are revealing that though some violent conflicts were sure to arise in the course of integrating then existing tribe-communities or chieftdom-communities into a chieftdom or kingdom, respectively, many of the integration processes were carried out through coalitional contracts among interested parties. Such a process of integration is considered to have been made possible, if one powerful tribes-community or chieftdom-community had sufficiently a large “increasing returns to scale” effect in at least one of the collective goods. This is because forming hierarchical coalitions with such a community can share in a bigger payoff thanks to that effect. Of course, those interested parties are in conflict with one another over sharing the total payoff. The constitutional contracts of a slave-contract type (Buchanan, 1975) are considered to have been concluded in order to solve the sharing problems. In this paper, the process of solving those conflicting problems was omitted.

On the other hand, it is conjectured that the “rational bandits” model of states (Olson, 1993; 2000) is not fit well to the state-building process of Japan. That model fits well to those countries conquered by aggressive nomadic tribes. Japan did not have powerful nomadic tribes and was not conquered by them in any state-building process. However, the “rational bandits” factor should be taken into consideration, if we should construct economic models of the state-building of the modern age.

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