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## 1) A Reexamination of the Agricultural Adjustment Problem in Japan

*Daisuke Takahashi<sup>1</sup> and Masayoshi Honma<sup>2</sup>*

*<sup>1</sup> Waseda University <sup>2</sup> The University of Tokyo*

*This study reexamines the classical notion of the agricultural adjustment problem in Japan. First, we explain the current conditions of Japanese agriculture and show why structural reform in the land-intensive agriculture sector has become an important policy agenda. Next, we review the historical development of farmland policy and examine the policy effort to promote structural changes of agriculture. Furthermore, we conduct an econometric analysis on rice production and show that scale economies of rice production have emerged since the mid-1960s owing to continuous farm mechanization. In addition, we propose statistical analysis for why the structural adjustment of Japanese agriculture has been very slow even with scale economies. This analysis indicates that transaction costs related to farmland, such as those associated with expectations of farmland conversion for non-agricultural use, are the main obstacles for farmland consolidation.*

## 1. Introduction

This study reexamines the classic notion of the agricultural adjustment problem in Japan. This problem is defined by Hayami (1988) as follows. It is the difficulty of reallocating resources (especially labor) from the agricultural to the non-agricultural sector corresponding to a relative contraction in the demand for agricultural products in the course of economic development at a sufficiently rapid speed to prevent a decline in the rate of return to labor used in agriculture relative to that of the rest of the economy.

The agricultural adjustment problem is the typical agricultural problem faced by developed Asian countries, such as Japan, South Korea, and Taiwan. Many past studies, including Hayami (2007), Honma and Hayami (2009), and Otsuka (2013), have used international comparisons to explain why structural reforms have thus far failed in Japanese agriculture. For example, Otsuka (2013) considered the problem of declining food self-sufficiency associated with the declining comparative advantage in agriculture at the high-income stage, referencing the Japanese experience.

While agriculture is a minor sector in the economy in Japan, as it is in most developed countries, structural adjustment remains essential for the country's welfare. Structural adjustment is important from three aspects. First, it can contribute to maintaining the multi-functionality of agriculture, such as its positive externality for the environment and food security, as well as the maintenance of the rural sector. Second, the structural adjustment of agriculture can promote trade liberalization. In Japan, where small-scale farmers are dominant, trade protection for agricultural products prevents participation in free-trade agreements. The country's five essential agricultural products, namely, rice, wheat, meat (beef and pork), dairy products, and sugar, were described as "sanctuaries" by a 2013 parliamentary resolution. If structural adjustment were achieved, there would be no such "sanctuaries" for Japan's diplomatic policy on trade liberalization. Third, massive imports of food due to low comparative advantage may affect food prices in the world market and threaten food security of net food-importing developing countries. Otsuka (2013) argues that massive imports of food grains to Asia, if they occur, would aggravate

the world food shortage and that Asia should expand farm size to reduce labor cost by adopting large-scale mechanization in order to avoid such a tragedy.

Why Japanese agriculture has failed to reform structurally remains an open question. Although Hayami (2007) and Otsuka (2013) point to the importance of institutional constraints and government regulations, the factors contributing to the failure are not specified. This study aims to fill this gap by focusing on failures in farmland, thereby revealing one source of the agricultural adjustment problem. This analysis offers insights for both developed and emerging Asian countries, as rapid economic growth would soon trigger the same problem in the latter group.

The rest of this paper is organized as follows. In Section 2, we offer an overview of the current state of Japanese agriculture and the historical development of farmland policy. In Section 3, we discuss the results of quantitative analysis regarding economies of scale in rice production, which are the results of technological progress. In Section 4, we statistically analyze why structural changes to Japanese agriculture have been so slow even with these scale economies. Finally, in Section 5, we discuss implications of the Japanese agricultural experience for development strategy.

## **2. Policy Background**

### *2.1. Current State of Japanese Agriculture*

We review the status of agriculture in the Japanese economy. Table 1 shows the basic statistics of the agriculture sector.

[Table 1]

As the Japanese economy has grown, the share of agriculture in GDP has continued to decline. Agriculture's share in labor and farm households is higher than in overall GDP as farmers earn most of their income from off-farm employment. As a result, the relative productivity of agricultural labor has continued to decline. The final row of Table 1 reports the ratios of agricultural GDP per worker to total GDP per worker. This can be considered an indicator of the

labor productivity of agriculture relative to that of the whole economy and shows a widening gap until 2005.

The agricultural adjustment problem in Japan mostly involves land-intensive agriculture, namely, rice farming and growing non-rice crops on diverted paddy fields in regions other than Hokkaido. Hokkaido is different from the rest of Japan in terms of its geographical and historical conditions. Overall, the structural adjustment problem is less severe for farms producing food other than rice. In contrast to rice, the production of vegetables and fruit is more profitable because of high value-added, while meat and dairy production is more profitable because of high intensity. As a result, in this study, we mainly discuss rice farming in regions other than Hokkaido.

Because of the low profitability of land-intensive agriculture, most of Japan's farmland is cultivated as small-sized farms. Figure 1 shows the distribution of farmland and the cumulative distributions in 2010, when 42.6% of all farmland was cultivated within farms of less than 2 ha. These small farms rely mostly on income from non-farm activities. Although the share of farmland cultivated within large farms has been increasing in recent years, it remains far from the government's target of at least 80% of all farmland in Japan being used by next-generation farmers within the next 10 years.

[Figure 1]

The low profitability of land-intensive agriculture has led to a decline in Japan's food self-sufficiency rate (SSR), shown in Figure 2. The grain SSR declined sharply from 82% in 1960 to 27% in 2010. Other indexes of food self-sufficiency, such as the total SSR in calories and production values, also declined. This is explained partly by a changing pattern of food consumption: Japanese people now consume less rice and more animal products, and thus, animal feed must be imported. The decline in the SSR is, however, also partly due to a decrease in domestic food supply. Figure 2 shows trends in the area of farmland and planted farmland. The total farmland area decreased from 6.071 million to 4.593 million ha between 1960 and

2010 owing to abandonment and conversion. Given the small current amount of farmland, the Japanese people can barely survive without food imports.

[Figure 2]

## 2.2. *Historical Development of Japanese Farmland Policy*<sup>1</sup>

### 2.2.1. Land Reform and the Agricultural Land Law

Right after the Second World War, land reform was carried out in accordance with the strong recommendations of the occupying authorities. The urgent need to increase agricultural production through increased production incentives to cultivators was sufficiently strong to overcome the opposition of landlords to strengthening the rights of tenants through government control of rents and land prices. During the 4 years from 1947 to 1950, the government purchased 1.7 million ha of farmland from landlords and transferred 1.9 million ha, including state-owned land, to tenant farmers, which amounted to about 80 percent of the land under tenancy before the land reform.

Although land reform resulted in a considerable change in the distribution of land ownership, the size distribution of operational holdings experienced no basic changes. As a result the traditional agrarian structure of Japan, characterized by small-scale family farms with an average size of about 1 ha, remained despite the rise and the fall of landlordism.

The Agricultural Land Law was established in 1952 in order to secure the results of the land reform. The Agricultural Land Law initially restricted ownership of arable land to less than 3 ha per farm (12 ha in Hokkaido). Tenancy rights were protected so strongly that it was almost impossible for landlords to evict tenants. In addition, land rent was controlled at a level so low that part-time farmers had little incentive to lease out their holdings. Together, these factors constrained the possibilities of increasing the operational size of farms.

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<sup>1</sup> This section draws heavily on Hayami (1988), Honma and Hayami (2009), and Takahashi (2012).

### 2.2.2. Amendment to the Farmland System

Japan entered the middle-income stage of economic development in the 1960s. Correspondingly, the major goal of agricultural policy shifted from increased production of food staples to reducing the rural–urban income gap. The need to assist farmers increased in the 1960s, as the rural–urban income gap progressively widened and the out-migration of agricultural labor accelerated. The difficulty of structural adjustment in agriculture as a result of the rapidly growing economy led to the enactment in 1961 of the Agricultural Basic Law, a national charter for agriculture. This law declared that it was the government’s responsibility to raise agricultural productivity and thereby, to close the gap in income and welfare between farm and non-farm people.

As the price of agricultural land exceeded the present value of agricultural income streams, it became unprofitable for farmers to enlarge their farms through land purchase. The alternative left for farm-scale expansion was land leasing. In order to activate a land rental market, the Agricultural Land Law was amended again in 1970, by which rent control was removed and landlords were able to claim a return of their land from tenants upon termination of long-term lease contracts for more than 10 years.

Furthermore, with the amendment of the Agricultural Development Act of 1975, short-term land lease contracts for less than 10 years were legalized, under which contracts were agreed jointly by numbers of villagers under village-level farmland utilization programs, as they are exempt from the application of the Agricultural Land Law. Finally, by the Farmland Utilization Promotion Act of 1980, short-term contracts agreed upon through the mediation of village headmen also became exempt from the application of the Agricultural Land Law and farmland under such contracts is to be returned automatically to landlords upon termination of the contract period. The Agricultural Land Utilization Law was incorporated into the Agricultural Management Reinforcement Law in 1993.

### 2.2.3. Recent Reforms to the Farmland System



The farmland system was reformed in 2009 to promote efficient land use through deregulation. The reforms relaxed the restriction on acquiring land-use rights through leasing in order to encourage new entrants into the farming sector. The entrance of general companies into agriculture through the leasing of farmland was fully liberalized in 2009. In the 3 years thereafter, 1,071 companies began agricultural businesses through leasing. In addition, many restrictions on farmland transactions, such as regulations on land rents, were abolished. Furthermore, the reforms strengthened regulations on farmland conversion and reinforced policy measures intended to solve the problem of abandoned farmland.

Under the current administration of Japanese Prime Minister Shinzo Abe, the efficient use of farmland is a key policy agenda. The administration's goal is to ensure that at least 80% of all farmland in Japan is used by next-generation farmers within the next 10 years as a way to reduce costs by aggregating and consolidating farmland. To achieve this goal, Farmland Intermediary Management Institutions, known as "farmland banks," have been created; these prefectural intermediary institutions are meant to consolidate the current fragmented ownership of farmland.



### 3. Scale Economies and the Farmland Market

#### 3.1. Descriptive Statistics on Scale Economies

The existence of scale economies, a necessary condition for farmland consolidation, can be checked using both descriptive statistics and econometric analysis.

Hayami (1988), based on the classic study by Kajii (1973), proposed “the necessary condition for the development of large-scale tenant farming” as the following:

Surplus of large farms

$$\geq \text{income of small farms} - \text{utility of family labor used in small farms}$$

where income is defined as the value of total farm output minus the costs of current inputs, hired labor, and capital services per area and surplus is income per area minus family wages. If this equation holds, the economic advantage of large farms over small ones is great enough that large-scale farmers can pay sufficiently high rents to induce small farmers to stop farming and rent out their land.

Recent data on rice production show that the productivity gap between large and small farms is sufficiently large that this condition is satisfied.

[Figure 3]

Figure 3 shows the total cost and gross revenue, including subsidies, per 60 kg of rice produced. The revenue is almost the same among different farm sizes because the yield, the farm gate price, and the amount of subsidy are almost the same. On the other hand, there is a wide gap in productivity between small and large farms. Indeed, for farms with less than 2 ha of land, the net revenue is negative. The ratio of production costs for farms with 0.5–1 ha of land to those of farms with more than 3 ha is 1.66. As such, the condition noted above is satisfied. At more than 5 ha, the surplus exceeds the incomes of farms of 0.5–1 ha and 1–2 ha. This indicates that the economies of scale are large enough to promote that transfer of farmland consolidation from small to large farms. In addition, such trends can be observed in regional data: production costs in 2012 ranged from 1.43 in Shikoku and 1.44 in Tohoku to 1.69 in Tohoku, 1.70 in Kyushu, and 1.85 in Chugoku.



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### 3.2. *Econometric Analysis of Economies of Scale*

An alternative indicator of the existence of economies of scale in rice farming in Japan is the elasticity of cost with respect to output, which is the inverse of the elasticity of scale. Past studies of Japanese agriculture examined the trend in the effect of scale economies. Hayami and Kawagoe (1989) estimated cost elasticities from 1951 to 1984 using cross-sectional data. Their results showed that cost elasticities began to decline sharply beginning in the mid-1960s. In addition, they undertook a time-series analysis of the value of the cost elasticity to show the effect of farm mechanization. Fujiki (1999) estimated cost elasticities from 1985 to 1991 using the same procedure and concluded that there were no significant changes in Japanese rice production. Kuroda (2013) estimated the multiple-product variable cost function and concluded that the degree of scale economies became greater for all farm sizes; this was particularly strong in 1975 owing to increased usage of medium- and large-scale mechanization.

Here, we update the estimation of the scale elasticity by Hayami and Kawagoe (1989) and Fujiki (1999), using data for 1992–2012. We assume that the scale elasticity is constant during the each period by Equation (1), while the constant term may vary by year. Primary cost is the total cost net of the value of byproducts, and total cost is the sum of primary cost, rent, and capital interest.

$$\ln(\text{primary/total cost})_{it} = a_t + b \ln(\text{output})_{it} + e_{it} \quad (1)$$

The estimates of the cost elasticity, as well as the estimates of the past studies, are plotted in Figure 4. All of the estimated parameters are significant at the 1% level. Since the mid-1960s, the elasticities have declined due to farm mechanization (Hayami and Kawagoe, 1989). Since the 1980s, however, this decrease has slowed as mechanization has been completed. Realizing that recent rice farming data cover larger farm sizes, it is clear that the trend of a slow decrease has continued until the present. The overall trend in economies of scale is consistent with the estimates of Kuroda (2013).

[Figure 4]



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### 3.3. *Effect on Resource Allocation*

In order to examine the effect of scale economies on resource allocation, we decompose the labor–land ratio of rice farming into the change of labor input and farmland input per household, as shown in Equation (2). The change in labor input per household represents the structural adjustment within the household to reduce abundant labor input, while the change in area per household represents the structural adjustment among the households in order to consolidate farmland into productive farms.

$$G\left(\frac{Labor}{Area}\right) = G(Labor\ per\ household) - G(Area\ per\ household) \quad (2)$$

The result of the decomposition is shown in Figure 5. The trend of the labor per area, labor per household, and farm size is standardized as 100 by the values in 2005–10.

[Figure 5]

The labor per area declined sharply by the mid-1980s because of the reduced labor input per household. This decline in the labor input is caused by farm mechanization; specifically, the surplus labor caused by farm mechanization led to intersectoral labor migration. On the other hand, the change in the labor per area has stagnated since the mid-1980s. This is because the reduction of labor per household has reached the limit and the farmland per household has not increased significantly during this period. This trend shows the limit of scale economies on structural adjustment; even with scale economies of rice farming, the failure of the farmland market has prohibited the further reduction of labor input per farmland.

### 3.4. *Discussion*

The results shown in Subsections 3.1 and 3.2 clearly show the existence of scale economies in Japanese rice farming. Past studies have often claimed the existence of “new prospects for structural adjustment” (Hayami, 1988). However, considering the fact that small-sized farms remain dominant even today, and considering the trend of labor per area shown in Subsection

3.3, we can conclude that the existence of scale economies could be a necessary but not sufficient condition for the development of large-scale tenant farming. Thus, the productivity gap in rents between large and small farms does not necessarily promote farmland consolidation. Regarding this point, Kusakari (1998) argues that Kajii's hypothesis is valid only when the factor market is competitive. Such competition does not exist in the real farmland market, however, because of the transaction costs arising from externalities.

#### **4. Transaction Costs and the Farmland Market<sup>2</sup>**

##### *4.1. Literature Survey*

The empirical findings of Section 3 suggest that there have been economies of scale in Japanese rice farming since the 1980s, resulting from medium-sized farm mechanization. In addition, as argued in Section 2, the farmland system has been reformed in order to promote consolidation through leasing. As such, why has progress in farmland consolidation been too slow to adapt to the changing economic conditions facing Japanese agriculture?

The recent literature on farmland consolidation in Japan has focused on the transaction costs related to leasing farmland. Such transaction costs arise through the processes of negotiation, measurement, and enforcement. Kusakari (1998) argued that farmland is associated with transaction costs derived from externalities because farmland has properties of both capital and a production factor, with the associated production activities affecting the environment. Fujie (2003) indicated search and mismatch costs incurred in association with information asymmetries and pointed out that information on farmland is difficult to obtain because farmland and its tenants and landlords are heterogeneous and some characteristics can be known only after cultivation. Arimoto and Nakajima (2010) focused on institutional barriers to farmland consolidation, including legal barriers, compensation for tenants' investments, transaction costs, and the high potential for farmland conversion.

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<sup>2</sup> This section is based partly on Takahashi (2012).

Among many causes of transaction costs related to farmland, two important factors are farmland fragmentation and expectation for farmland conversion. Farmland fragmentation increases production costs, reduces the advantages of scale economies, and increases the transaction costs. According to a survey by the government, core farmers cultivate on average 28.5 plots with average plot size of 0.52 ha. In addition, expectations for farmland conversion for non-agricultural use bring about transaction costs for landlords. The farmland price for non-agricultural use is much higher than the price for agricultural use. In addition, the latter price is much higher than the capitalized value. Farmers on small-sized farms are unwilling to lease out farmland because they are afraid that the expected capital gain from conversion may fall.

#### *4.2. Modeling the Farmland Lease Market*

Here, we propose a simplified version of the theoretical model in Takahashi (2012), in which there is one aggregate tenant and one aggregate landlord<sup>3</sup>. The tenant faces a rent higher than the market equilibrium rate, and the landlord faces a rent lower than the market equilibrium rate. The first-order conditions for profit maximization are given by Equation (3) for the tenant and Equation (4) for the landlord.

$$p \frac{\partial F_B}{\partial A} = r + t^{\text{in}} \quad (3)$$

$$p \frac{\partial F_S}{\partial A} = r - t^{\text{out}} \quad (4)$$

In Equations (3) and (4),  $F_B$  and  $F_S$  are the production functions of tenant and landlord, respectively, with the usual properties.  $A$  represents the amount of land used in agricultural production,  $p$  is the output price, and  $r$  is the rent on farmland.  $t^{\text{in}}$  represents additional

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<sup>3</sup> Takahashi (2012) assumes that transaction costs force tenants and landlords out of the farmland leasing market.



transaction costs, which are paid when borrowing farmland, whereas  $t^{\text{out}}$  represents transaction costs that accrue from a landlord when letting farmland.

The optimal amount of farmland used for production is determined by Equations (3) and (4). The supply and demand of farmland is the difference between the optimal input and the endowments of farmland. The demand and supply of the land lease market are functions of rent including transaction costs. Therefore, the demand and supply function can be expressed as  $D(r + t^{\text{in}})$  and  $(r - t^{\text{out}})$ , respectively. Because the demand for farmland,  $A_B$ , and  $A_S$  are decreasing functions of market rent,  $\frac{\partial S}{\partial r} > 0$  and  $\frac{\partial D}{\partial r} < 0$  are satisfied.

The equilibrium condition of the farmland lease market is that demand and supply of farmland are equal; in other words, Equation (5) must be satisfied.

$$S(r - t^{\text{out}}) = D(r + t^{\text{in}}) \quad (5)$$

Hereafter,  $r^t$  represents the market equilibrium rent when transaction costs exist, and  $Q^t$  represents the area of farmland leased. In addition,  $r^*$  is the market equilibrium rent and  $Q^*$  is the area of farmland leased when there are no transaction costs. By comparing  $Q^t$  with  $Q^*$  and  $r^t$  with  $r^*$ , the impact of transaction costs on the farmland lease market can be analyzed.

The changes to transacted farmland area and market equilibrium rents once transaction costs exist can be calculated by linear approximations of the demand and supply functions, as shown in Equations (6) and (7).

$$\frac{r^t - r^*}{r^*} = \frac{\epsilon_D \left(\frac{t^{\text{in}}}{r^*}\right) + \epsilon_S \left(\frac{t^{\text{out}}}{r^*}\right)}{\epsilon_S - \epsilon_D} \leq 0 \quad (6)$$

$$\frac{A^t - A^*}{A^*} = \frac{\epsilon_S \epsilon_D}{\epsilon_S - \epsilon_D} \left(\frac{t^{\text{in}} + t^{\text{out}}}{r^*}\right) < 0 \quad (7)$$

In Equations (6) and (7),  $\epsilon_S$  and  $\epsilon_D$  represent the elasticities of farmland supply and demand, respectively, with respect to the market rent. The inequalities hold because  $\epsilon_S > 0$  and  $\epsilon_D < 0$ . Equation (6) shows that the market rent would increase if the transaction cost were higher for the tenant and would decrease otherwise. Equation (7) shows that transaction costs for both the tenant and the landlord would decrease the amount of farmland transacted.

#### 4.3. *Econometric Analysis*

Next, we study the extent to which farmland leasing is affected by the characteristics of the farmland and local communities in order to investigate the source of the transaction costs for farmland. We use the updated data in Takahashi (2012); we use panel data of 42 prefectures from Japan's agricultural census from 1980 to 2005 conducted every 5 years<sup>4</sup>. Hokkaido and Okinawa are excluded because of different geographical conditions, and Tokyo, Kanagawa, and Osaka are excluded because of the strong effects of urbanization. The lease of paddy land is analyzed because “upland field” in the public statistics includes diverse types of land, such as orchards and pastures.

The dependent variable in the analysis is the tenancy rate—that is, the ratio of the area of leased-in paddy fields to the total paddy field area for the prefecture as a whole. The data on leased-in paddy field areas are obtained from the agricultural census and refer to the time when the survey was conducted. Leased-in farmland in the census includes not only farmland under formal contracts but also that under unofficial farming contracts and farmland where most cultivation activities are outsourced to other farmers.

The explanatory variables related to farmland transaction costs include farmland characteristics, size of the local farmland market, and characteristics of the rural communities within the prefecture. In addition, exogenous variables related to agricultural production are included. The variables are outlined as follows.

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<sup>4</sup> The agricultural census for 1985 and 1995 did not contain data on rural communities. Therefore, the data on rural communities for these 2 years were obtained from a linear approximation. In addition, some of the data missing for rural communities in the 2005 agricultural census was imputed. Data sources and a discussion of related surveys are included in Takahashi (2012).

(1) With regard to the characteristics of the farmland, we include variables for the portion of farmland within Agricultural Promotion Areas<sup>5</sup>, the rate of improved farmland, and the ratio of converted area to the area of the total paddy field.

(2) With regard to the size of the local farmland lease market, the model contains indicators for the total area of paddy fields in local communities and the share of farmers in local communities.

(3) With regard to the functions of local communities, we add variables for the portion of local communities within 30 minutes of the densely inhabited district (DID), portion of local communities with more than three meetings, and portion of local communities with producers' groups.

(4) With regard to production conditions, we introduce three variables: the share of acreage control areas within total paddy fields, the ratio of the rice price to the average off-farm wage, and the unit-cost ratio (the ratio of production cost per area between large and small farmers). These exogenous production-related variables affect farmland consolidation.

The individual effect is included to reflect time-invariant geographical and psychological factors. The effect of the regional variety in rural communities on farmland leases is included in the individual effect because regional classification of a given rural community does not vary. In addition, psychological considerations related to farmland, such as attachment to the land, are included in the individual effect. The trend term is included because the tenancy rate has generally followed an upward trend. The individual effect is controlled for using fixed-effects and random-effects models. As the 42 prefectures analyzed differ in their total areas of paddy fields, we also estimate a fixed-effects model, weighting prefectures by their area of paddy fields in the respective year and the average area of paddy fields over the full analysis period. The results of the estimations are shown in Table 2, excluding the constant term.

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<sup>5</sup> Farmland in an Agricultural Promotion Area can be leased through the farmland utilization program, which incurs lower transaction costs than a lease based on the Agricultural Land Law, and is less likely to be converted for non-agricultural use because of regulations on farmland conversion.

[Table 2]

As shown in Table 2, the coefficients on the variables for paddy field production conditions, farmland characteristics, the size of the local farmland market, and local community characteristics are all significant, and the signs are consistent with expectations. Most results are consistent with those in Takahashi (2012).

To consider the variables referring to farmland characteristics, the Agricultural Promotion Area and improved farmland shares have significant positive effects on farmland consolidation.

According to the estimated coefficients, increasing the portion of farmland within an Agricultural Promotion Area and the portion that is improved by 1% would raise the tenancy rate by 0.08% and 0.17%, respectively. In addition, the portion of paddy fields that have been converted has a significantly negative relationship with the tenancy rate: a 1% increase decreases the farmland lease rate by 2.8%.

Regarding the size of the local farmland market, the coefficients on total area of paddy fields in local communities and the share of farmers in local communities are insignificant. Among the variables related to local communities' characteristics, the producers' group indicator has a significantly positive effect on the tenancy rate, showing that local community activities promote farmland consolidation. The share of communities within 30 minutes of the DID has a significantly negative effect on the tenancy rate, indicating that proximity to an urban area may have a negative effect on farmland consolidation. The indicator for local communities holding more than three meetings has a positive effect on farmland leasing.

Finally, regarding the variable referring to production conditions, the ratio of the rice price to the average off-farm wage has a negative effect on the tenancy rate, suggesting that the lower the relative price of rice, the higher the tenancy rate. Contrary to Takahashi (2012), the share of total paddy fields that are acreage control areas has a significant positive effect on the tenancy rate. This may reflect the fact that farmers are compelled by community activities to conform to the requirements of the set-aside policy.

These results can be interpreted as follows. First, as certain variables related to farmland characteristics have significant impacts on the tenancy rate, policy interventions, such as implementing farmland improvement projects, proper zoning of farmland, and strengthening regulations on farmland conversion, could promote farmland consolidation by decreasing the related transaction costs. Furthermore, the significant effects of communities having producers' groups and regular meetings suggest that informal local systems decrease farmland transaction costs. Hence, policies that support the functioning of the local community could also promote farmland consolidation. In summary, the econometric results show the importance of formal and informal institutions for efficient use of farmland.

## 5. Conclusion

This study discussed the necessity for structural adjustment in Japanese agriculture. We argued that even though scale economies exist in Japanese rice farming, farmland consolidation remains inhibited by various transaction costs related to farmland. The findings imply that deregulation of the land system would not necessarily lead to efficient use of farmland because a variety of socioeconomic factors, in addition to production conditions, affect farmland consolidation. Rather, the government should develop and reinforce institutions to mitigate transaction costs, such as public investment in infrastructure projects, farmland zoning, and strengthening regulations on farmland conversion. Assistance for rural community activities would also help to support structural adjustment because these help to mitigate transaction costs. The efficient use of farmland through market mechanisms is possible only when governance systems linked to market transactions are developed adequately.

The experience of Japanese agriculture clearly shows the need for policy measures to promote structural reforms, in particular, to promote farmland consolidation for large-scale farmers. Economies of scale derived from agricultural mechanization are a necessary but not sufficient condition for farmland consolidation. As Hayami (2007) and Otsuka (2013) argued, the typical agricultural problem for middle-income countries is sectoral income inequality. However, if the economy is such that workers displaced by mechanization can find non-farm employment, the concentration of farmland into large-scale farms does not necessarily lead to an unequal income distribution, as argued by Hayami and Kawagoe (1989). In Asian emerging economies, the agricultural adjustment problem is highly relevant, but its solution has not been specified in the past studies. More research effort is needed on the experience of agriculture in Japan, as well as other developed countries in Asia, such as South Korea and Taiwan.



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Table 1. Economic growth and structural transformation in Japan

	1960	1970	1980	1990	2000	2005	2010
Real GDP per capita in 2000 constant \$ prices	5,594	13,755	18,745	27,639	29,778	31,380	31,453
Share of agriculture in GDP	9.0	4.4	2.6	1.9	1.3	1.0	1.0
Share of agriculture in economically active population	26.8	15.9	9.1	6.2	4.5	4.0	3.4
Share of farm household population in total population	36.5	25.1	18.3	14	8.2	6.6	5.1
Agricultural GDP per worker / total GDP per worker	33.6	27.7	28.6	30.6	28.9	25.0	29.4

Source: updated data in Honma and Hayami (2009)

Table 2. Results of the econometric analysis of the tenancy rate

Estimation method	Fixed Effects	Fixed Effects	Fixed Effects	Random Effects
Weight	Yearly	Average	-	-
Portion of farmland within Agricultural Promotion Area	0.0833** (2.073)	0.0830** (2.056)	0.0311 (0.816)	0.0360 (0.984)
Rate of improved farmland	0.173*** (6.829)	0.170*** (6.745)	0.166*** (7.164)	0.117*** (5.599)
Ratio of converted area to total paddy field	-2.807* (-1.798)	-2.922* (-1.847)	-3.251** (-2.091)	-2.412 (-1.541)
Log(total area of paddy fields in local communities)	0.0536 (1.309)	0.0478 (1.157)	0.0481 (1.212)	-0.0112 (-1.075)
Share of farmers in local communities	-0.0653 (-0.977)	-0.0710 (-1.058)	-0.0758 (-1.148)	-0.115** (-2.308)
Portion of the local communities within 30 minutes to DID	-0.0776*** (-3.165)	-0.0815*** (-3.253)	-0.0880*** (-3.412)	-0.0567** (-2.407)
Portion of local communities with more than three meetings	0.0510+ (1.625)	0.0458+ (1.453)	0.0561* (1.677)	0.0550* (1.679)
Portion of the local communities with producers' group	0.0327* (1.679)	0.0336* (1.724)	0.0356* (1.908)	0.0228+ (1.454)
Log(ratio of the rice price to average off-farm wage)	0.0310+ (1.623)	0.0303+ (1.588)	0.0217 (1.076)	0.00682 (0.349)
Share of acreage control areas within total paddy fields	0.0821** (2.133)	0.0771** (1.987)	0.0706* (1.757)	0.0117 (0.298)
Unit-cost ratio	-0.00497 (-0.561)	-0.00370 (-0.412)	-0.00292 (-0.331)	0.00145 (0.157)
Trend term	0.0187*** (4.090)	0.0190*** (4.134)	0.0186*** (4.056)	0.0162*** (4.204)
$R^2$	0.930	0.931	0.886	-

Note: t-statistics in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ , +  $p < 0.15$ .

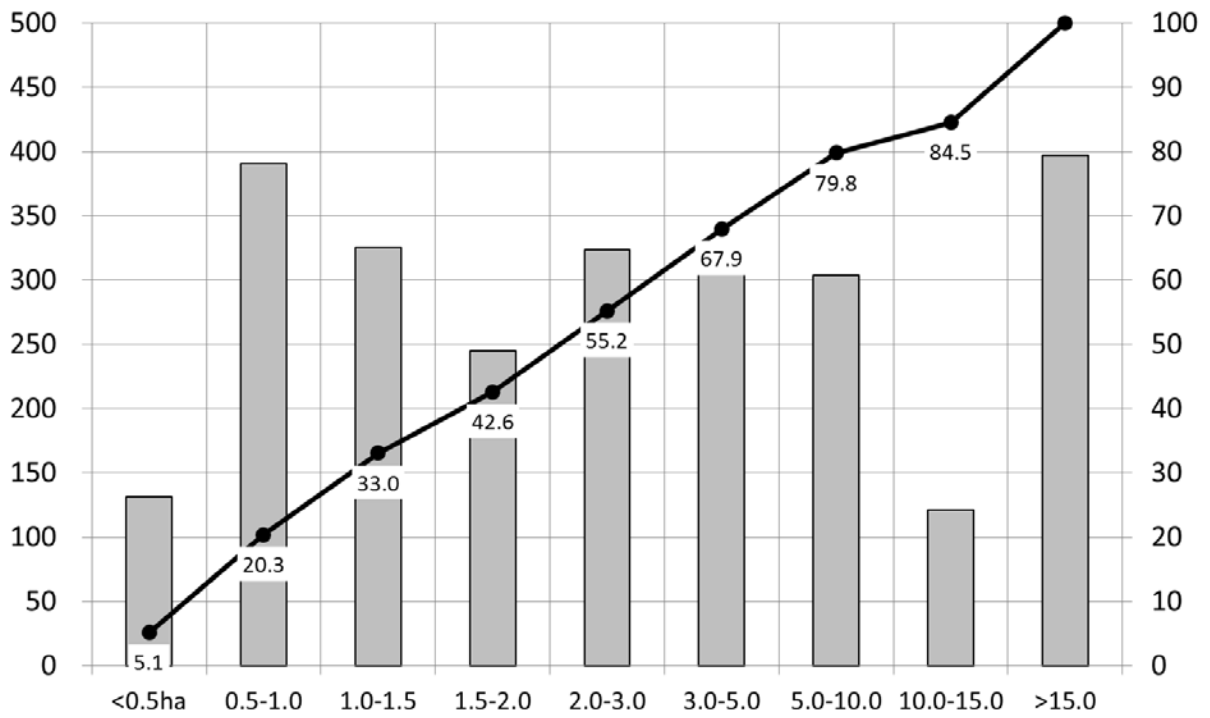


Figure 1. The distribution of farmland (in thousand ha) and its cumulative frequency (%) in non-Hokkaido in 2010

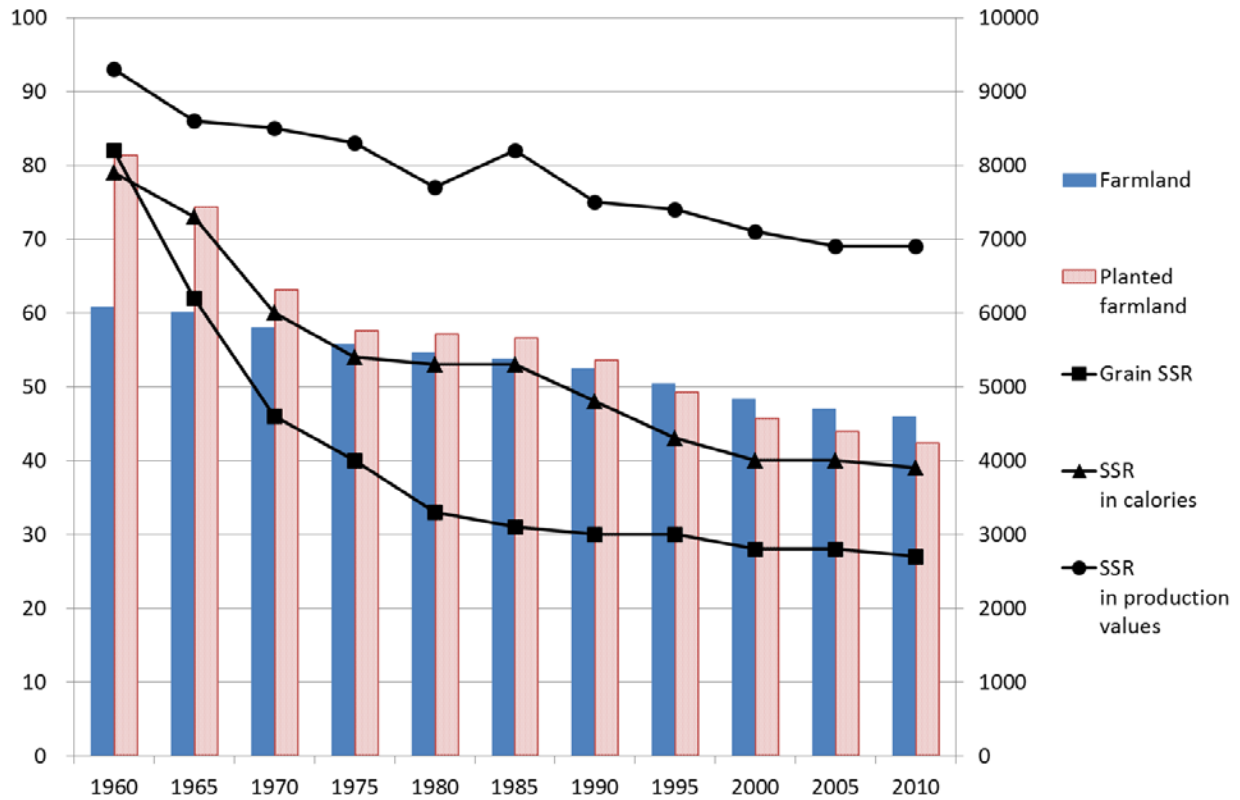


Figure 2. Area of farmland (in thousand ha) and indexes of food self-sufficiency (%)

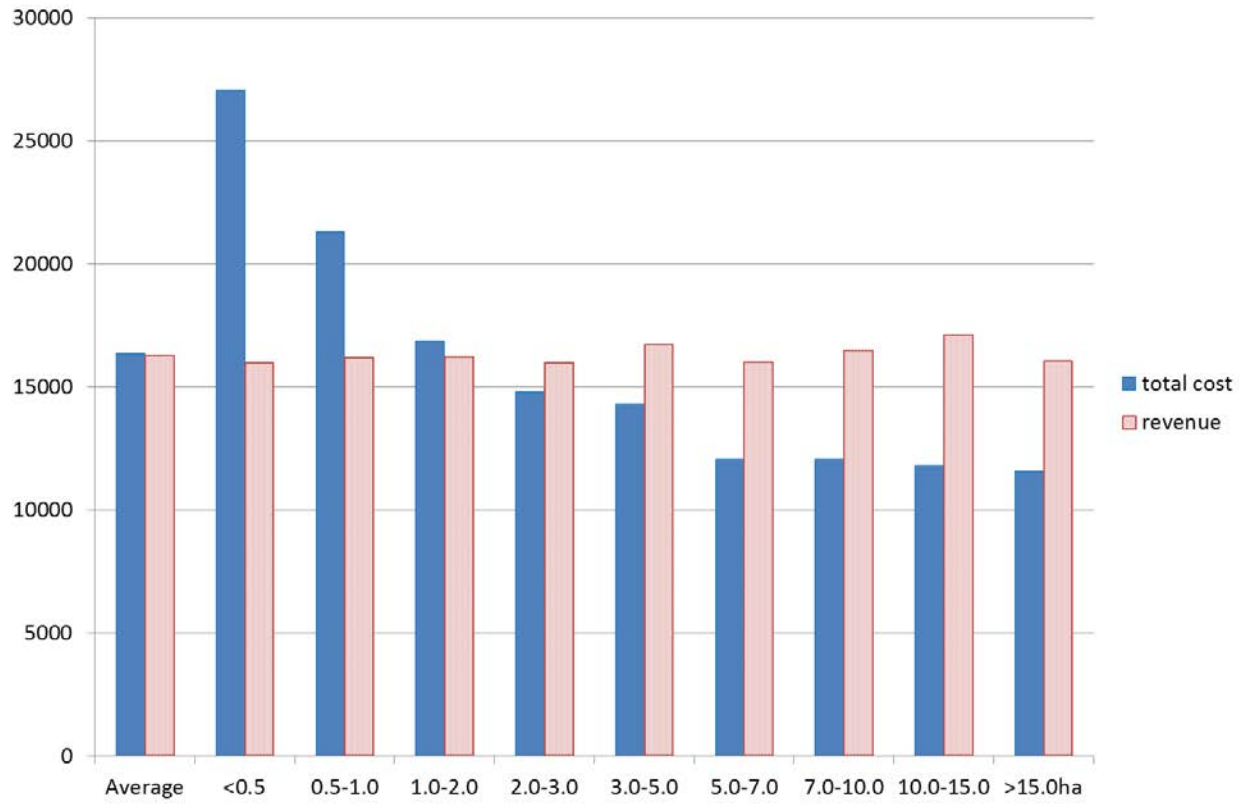


Figure 3. Total cost and revenue per 60 kg of rice production (yen) by farm size

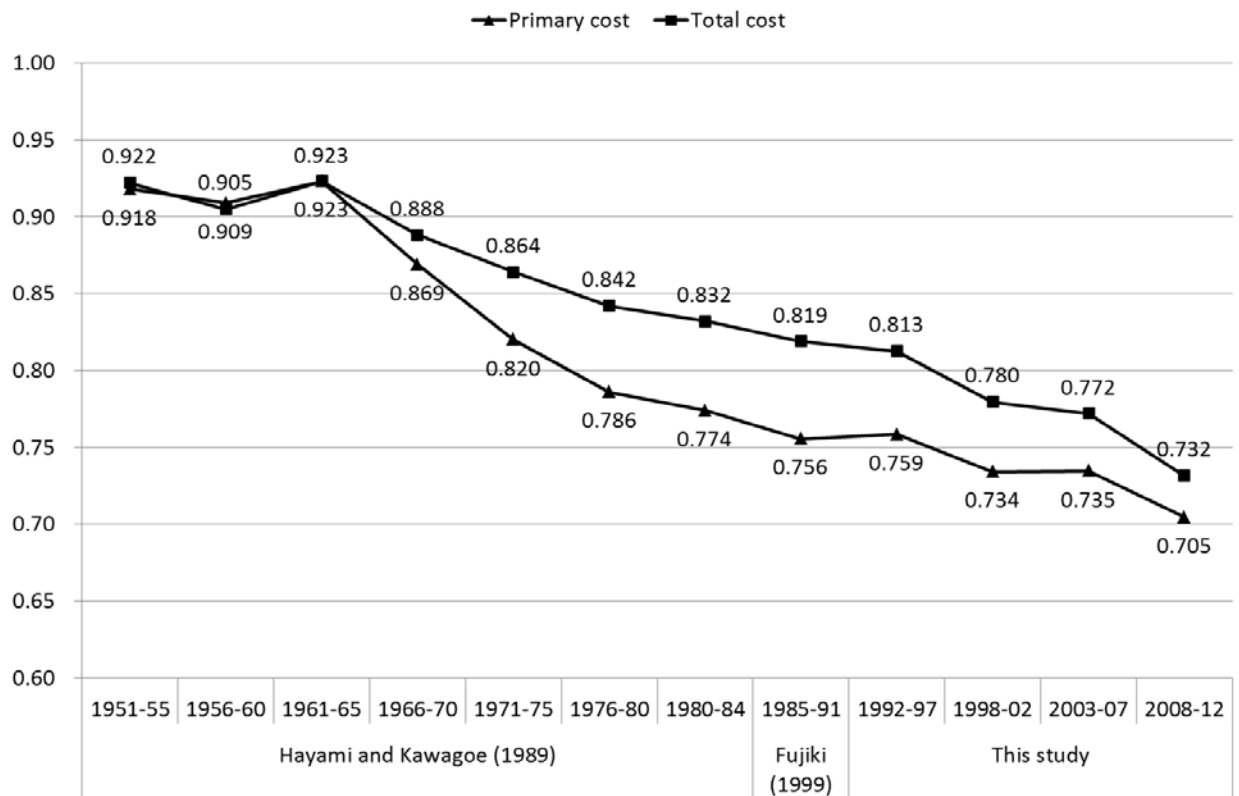


Figure 4. Estimated elasticities of total and primary costs with respect to output



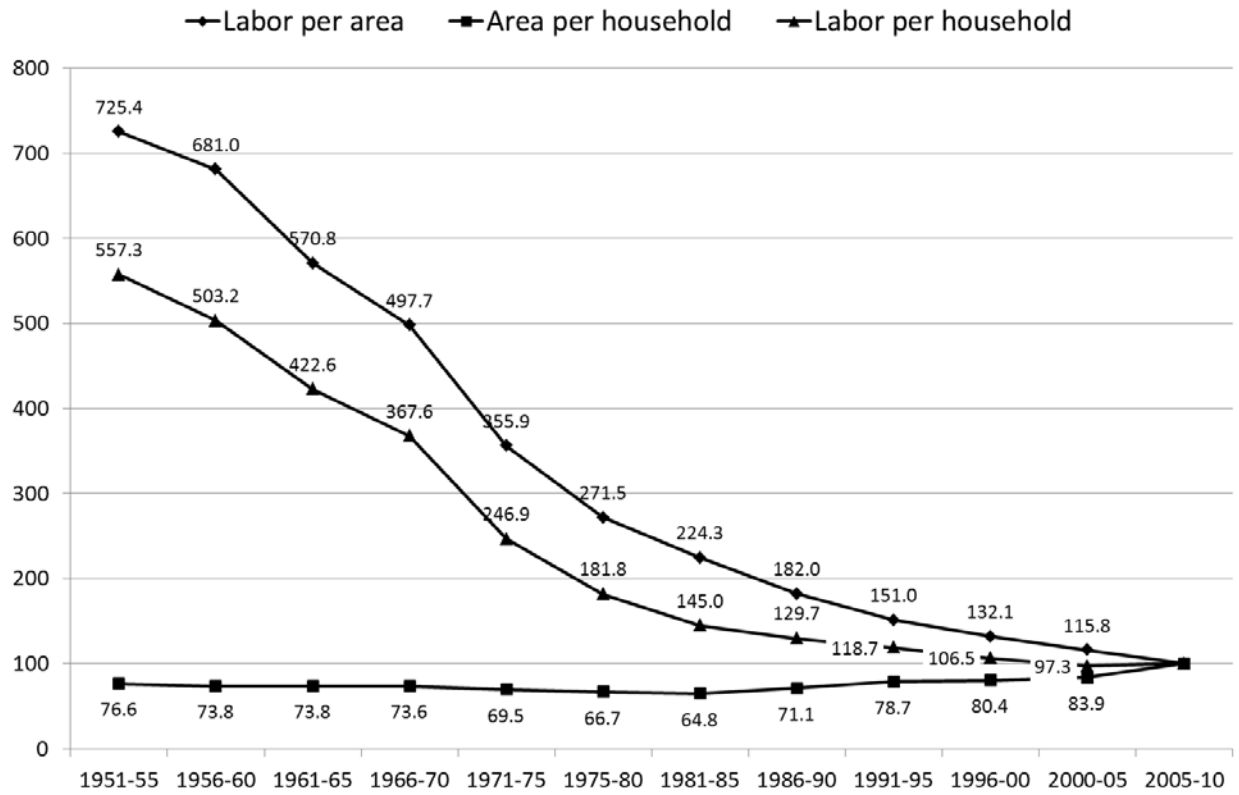


Figure 5. Decomposition of labor per area into area and labor per household (2005-10 = 100)