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Effects of Socio-Institutional and Emotional Factors on Japanese Farmland Rental Transactions

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Farmland reallocation between farmers through rental transactions is critical for improving Japanese rice productivity. This study examined effects of socio-institutional and emotional factors as well as economic factors on rental transactions. A stochastic choice model was applied to contingent valuation data by considering regional heteroscedasticity. Empirical results showed (1) existence of economic inefficiencies, 3% loss of economic surplus due to socio-institutional restriction, which is probably reflected in transaction costs; (2) a 15% reduction in surplus due to emotional reluctance of farmers; and (3) strong influences of rice price, wages, and geographical location on the rental rate and agreement level.

Key Words: contingent valuation questionnaire, economic inefficiency, regional heteroscedasticity, rental agreement level, rental rate, stochastic choice model

JEL Classifications: C25, D44, Q12, Q15, Q38, R58

Improvement in rice productivity is important in Asian monsoon regions and in Japan where economies of scale have little effect because each farmer manages only a small area. To encourage farm management on large scales, agricultural policies are now trying to accelerate farmland rental transactions (FRT); large subsidies have been mobilized for this purpose. In spite of official support, the area rented remains less than 20% of the total paddy-field area, although this is larger than the annual purchased area of paddy fields, which is only 1%, according to the 2000 Agricultural Census (Ministry of Agriculture, Forestry and Fishery [MAFF]). Many previous studies have pointed out that this low rate is the result of socio-institutional factors that have protected the farmland possession rights of small farmers, as well as emotional factors that affected decisions of farmers after the agricultural land reforms of 1952 (Shogenji). However, few empirical studies have been made of the extent of these socio-institutional and emotional influences, and few models have been proposed to describe individual decisions and the mutual interaction of farmers in FRT.

This study aims to analyze FRT in the light of the rental rate and rental agreement level and evaluate the impact of socio-institutional and emotional factors as well as economic fac-

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tors on FRT in Japanese paddy fields. Supply and demand (S-D) functions over renting were derived as a stochastic choice model from production theory by considering technological differences, farmers' emotional reluctance (ER), and regional heteroscedasticity. Contingent valuation (CV) questionnaire data were used to estimate the S-D functions with overcoming constraints in actual FRT. Simulation based on the model revealed socio-institutional factors originating in the actual rental market as economic inefficiencies besides ER factors.

The second section explains the survey design, the empirical model, and the data. The third section presents the results of estimation and simulation that relate to socio-institutional and emotional factors as well as economic factors. Finally, the findings are summarized and the implications for stimulating FRT are discussed.

Methodology

Survey Design

Previous studies based the economic influence of farmland on estimates of the hedonic price function. The hedonic price approach sheds light on several factors, including soil characteristics (Elad, Clifton and Epperson); urbanization (Plantinga and Miller); and environmental characteristics (Boisvert, Schmit and Regmi; Xu, Mittlehammer, and Barkley). However, there have been few hedonic analyses of Japanese farmland because of data limitation. Japanese farmland transactions, whether for renting or purchasing, have been restricted by local governments, so that variances of the price data in official statistics are too small to allow an estimate of the hedonic price function. Even if such estimation is possible, the hedonic price function from data on S-D equilibria involves problems of identification, and primary factors are scarcely separated into each S-D side (Brown and Rosen).

Production functions have also been estimated to find the derived demand for farmland in previous studies (Demir and Mahmud; Godo; Ito; Kuroda). These results show the inelastic adjustment of farmland demand to the price at the aggregated level. However, the aggregate production function is unsuited to treat individual differences originating from technological differences between farmers. Kumbhakar and Chambers and Quiggin therefore proposed a stochastic production function approach; these analyses involved a convergence process that sometimes failed.

In this study, a stochastic choice model, derived from production theory, was used in S-D functions to describe individual decisions originating from technological differences. Consideration of individual technological differences is critical in the analysis of FRT, because variation in farmers' decision making is the driving force behind renting. Furthermore, socio-institutional and emotional factors can be introduced into the model only when data from individual farmers are used. Accordingly, the stochastic choice model was preferred to conventional methods that use aggregate data.

CV data were also used to secure adequate variability in the rental rate of Japanese FRT and to estimate the model based on the behavior of individual farmers. The following question was proposed to supply-side farmers: "If you have a chance to rent out one parcel of paddy field (dA) to another farmer, would you agree to a unit annual rental rate of B^s?" Demand-side farmers were asked the following question: "If you have a chance to rent one parcel of paddy field (dA) from another farmer, would you pay a unit annual rental rate of B^d? Assume that you can use other agricultural machinery as well as your own and employ help to cultivate the field, if needed. Also, assume that the obligation rate of the set-aside program is equal to the average rate for your town." Here, one parcel of paddy field (dA) was taken as 0.3 hectare (ha), which is common for Japanese paddy fields. Superscripts s and d, respectively, show the S-D sides.

Five rental rates of 50,000, 100,000, 200,000, 400,000, and 700,000 yen/ha/year for B^s and B^d were set in the questionnaire in order to maintain variability. Each value was proposed to each group of farmers, assigned randomly to one of five equal groups. A simple yes-no answer was requested so as to replicate the actual FRT. A simpler method could have been sought by letting the respondents write their acceptable price or select their preference from prelisted values, but their answers would probably have been swayed by the value that local governments have proposed as the standard rental rate, leading to a lack of variation in the data.

After giving their discrete choice answers, farmers who answered negatively were asked the reasons for their refusal. This was to ascertain whether their decision was the result of emotional factors such as dislike of renting, disinclination to enter troublesome financial negotiations, or fear of losing their autonomy in farm operations. Farmers who selected emotional reasons were assigned to the ER group.[1]

The cross-sectional pooling data, gathered from questionnaire surveys at different sites and regions, were needed to introduce price indexes such as the price of rice and wages into the model. If data from a single site were used, price indexes would effectively be constant, because they were almost identical for each farmer. To avoid this, the same questionnaire surveys were conducted in several regions having different prices and wages, and regional heteroscedasticity was treated in the stochastic choice model.

Before the survey, the S-D side farmers were classified *a priori* at 3.0 ha to simplify the question and facilitate comparison of the results with real transactions. This division of 3.0 ha was based on an official notice of MAFF to farmers as a necessary condition for providing subsidies for Land Improvement Projects at all research sites. The 2000 Agricultural Census also indicates that 3.0 ha was the division point for farmers who decreased (or increased) management areas, mostly by renting. These facts indicate that farmers over 3.0 ha should be the target of Japanese agricultural policy for improving the average scale of management.

Empirical Model

There are two facets to the empirical model used here. The first is the definition of S-D functions, which describe farmers' decisions about renting based on individual differences in rice production technique. The second is simulation of the S-D equilibria as theoretical rental agreements (Kunimitsu). The S-D functions are derived from the production function and modified in line with the stochastic choice model as follows.

Each farmer is assumed to produce rice (Q) according to the Cobb-Douglas production function, $Q = aA^b\mathbf{V}^c\mathbf{E}^d\exp(u)$, $(b + c < 1)$, with predetermined farmland area (A), which is a given factor); other input factors such as labor, machinery, fertilizer, and pesticide ($\mathbf{V}$); and attributes of farmers and farmland ($\mathbf{E}$). Bold characters denote vectors, and the lowercase characters *a, b, c,* and *d* are rice production parameters. Here, u is the stochastic element that represents technological differences relating to the skills and knowledge of individual farmers. These technological differences yield different profits, even if farmers have the same management resources, and consequently indicate different decisions over renting.

Supposing that farmers aim to maximize profit $R = PQ - P_A A - \mathbf{P}_\mathbf{V}\mathbf{V}$ under the technical constraints of the production function, the first-order condition with respect to $\mathbf{V}$ is $\mathbf{P}_\mathbf{V} = P(\partial Q/\partial \mathbf{V}) = PacA^b\mathbf{V}^{c-1}\mathbf{E}^d\exp(u)$, where $\mathbf{P}_\mathbf{V}$ is the price of $\mathbf{V}$ and P is the price of rice. The optimum rental rate, $P_{A(WTP)}$, willingly paid by individual farmers, is taken to maximize R for a given A, so that the optimal rate is defined as $P_{A(WTP)} = P(\partial Q/\partial A)$. This relation indicates that the shadow price of the farmland corresponds to the marginal productivity of that farmland. By substituting $\mathbf{V}$ into $\mathbf{P}_\mathbf{V}$ in the first-order condition, $P_{A(WTP)}$ is given by

[1] There is a possibility that farmers accepted the proposed rate in spite of the high value in the question without any consideration, because they thought questions from a semi-public organization like JIID should be answered positively. However, unlike the hypothetical question on environmental protection, questions about renting are quite common for them, so this probability should be low. All farmers who accepted a high rate were therefore assumed to be rational.

$$(1)\quad \ln[P_{A(WTP)}] = a' + b'\ln(A) + c'\ln(\mathbf{P}_v) + d'\ln(E) + e\ln(P) + \varepsilon = f(\mathbf{X}) + \varepsilon.$$

Here,

$$a' = \frac{1}{1-c}\ln(a) + \ln(b) + \frac{c}{1-c}\ln(c),$$

$$b' = -\frac{1-b-c}{1-c}, \qquad c' = -\frac{c}{1-c},$$

$$d' = \frac{d}{1-c}, \qquad e = \frac{1}{1-c}, \quad \text{and}$$

$$\varepsilon = \frac{u}{1-c}.$$

Equation (1) shows that the rental rate can be decomposed into two parts, a systematic element $f(\mathbf{X})$, which relates to management resources, and a stochastic element ε, which represents technological differences between farmers. Unlike the other prices, $\mathbf{P}_V$, the optimal rental rate $P_{A(WTP)}$ is different for each farmer, because farmland area is a given factor for farmers.

The parameters in Equation (1) cannot be estimated directly because of the small variability in the real data for the rental rate. To specify this formula from CV data, Equation (1) must be modified to a stochastic choice type function. It is reasonable to suppose that supply-side farmers will agree with renting if the proposed rate (B^s) is greater than $P^s_{A(WTP)}$ in Equation (1). Given that the distribution of technological differences shown by ε is independent, identically distributed (i.i.d.) with a zero mean, the acceptance probability of the supply-side π^s is

$$(2)\quad \pi^s = \Pr(I^s = 1) = \Pr[B^s > P^s_{A(WTP)}] = \Pr\left[\frac{\ln(B^s) - f(\mathbf{X}^s)}{\sigma^s} > \frac{\varepsilon^s}{\sigma^s}\right] = G\left[\frac{\gamma^s\ln(B^s) - \mathbf{X}^s\boldsymbol{\beta}^s}{1 + \mathbf{Z}^s_R\boldsymbol{\delta}^s}\right]$$

where γ, $\boldsymbol{\beta}$, and $\boldsymbol{\delta}$ are parameters and G is the cumulative density function. The suffix i denoting the ith farmer is dropped in this equation and henceforth. If the ith farmer agrees with renting, then $I^s = 1$; otherwise $I^s = 0$. Here σ is the standard deviation of ε and is taken to be defined by $\sigma = \bar{\sigma}(1 + \mathbf{Z}_R\boldsymbol{\delta})$, with the bench mark value $\bar{\sigma}$ and regional heteroscedasticity term $\mathbf{Z}_R\boldsymbol{\delta}$. The parameter $\boldsymbol{\delta}$ is statistically significant if the jth region is different from other regions in the standard deviation of the data.

Demand-side farmers will accept the proposed rental rate (B^d) if B^d is lower than $P^d_{A(WTP)}$ in Equation (1). The demand-side acceptance probability π^d is

$$(3)\quad \pi^d = \Pr(I^d = 1) = \Pr[B^d \leq P^d_{A(WTP)}] = \Pr\left[\frac{\ln(B^d) - f(\mathbf{X}^d)}{\sigma^d} \leq \frac{\varepsilon^d}{\sigma^d}\right] = 1 - G\left[\frac{\gamma^d\ln(B^d) - \mathbf{X}^d\boldsymbol{\beta}^d}{1 + \mathbf{Z}^d_R\boldsymbol{\delta}^d}\right].$$

The presence of ER farmers reduces the acceptance probability defined by Equations (2) and (3). Because researchers do not know in advance whether the farmer belongs to the ER group, the proportion in that group is treated as a stochastic variable. Upon describing this uncertainty by the cumulative density function H, the probability of classification into the ER group is defined as $\pi_{ER} = \Pr(I_{ER} = 1) = H[\mathbf{Z}_{ER}\boldsymbol{\theta}]$. Here, the parameter $\boldsymbol{\theta}$ shows the degree of emotional factors, and the variables $\mathbf{Z}_{ER}$ are fixed factors relating to the emotional attitude of farmers. As a result, farmers are classified into three groups: the non-ER group that accepts the rate proposed in the questionnaire, the non-ER group that rejects the proposed rate, and the ER group that refuses renting with any profit. The log likelihood function is

$$\ln(L) = \sum^{\text{Samples}} \{(1 - I_{ER})(I)\ln[(1 - \pi_{ER})\pi] + (1 - I_{ER})(1 - I) \times \ln[(1 - \pi_{ER})(1 - \pi)] + I_{ER}\ln(\pi_{ER})\},$$

for both the S-D sides. If the functions G and H are taken as the logistic distribution, the probabilities π and π_{ER} in this equation are

$$(4) \quad \pi^s = \frac{\exp\left(\dfrac{\gamma^s \ln(B^s) - \mathbf{X}^s\boldsymbol{\beta}^s}{1 + \mathbf{Z}_R^s\boldsymbol{\delta}^s}\right)}{1 + \exp\left(\dfrac{\gamma^s \ln(B^s) - \mathbf{X}^s\boldsymbol{\beta}^s}{1 + \mathbf{Z}_R^s\boldsymbol{\delta}^s}\right)},$$

$$\pi^d = 1 - \frac{\exp\left(\dfrac{\gamma^d \ln(B^d) - \mathbf{X}^d\boldsymbol{\beta}^d}{1 + \mathbf{Z}_R^d\boldsymbol{\delta}^d}\right)}{1 + \exp\left(\dfrac{\gamma^d \ln(B^d) - \mathbf{X}^d\boldsymbol{\beta}^d}{1 + \mathbf{Z}_R^d\boldsymbol{\delta}^d}\right)},$$

$$\pi_{ER}^s = \frac{\exp(\mathbf{Z}_{ER}^s\boldsymbol{\theta}^s)}{1 + \exp(\mathbf{Z}_{ER}^s\boldsymbol{\theta}^s)},$$

$$\pi_{ER}^d = \frac{\exp(\mathbf{Z}_{ER}^d\boldsymbol{\theta}^d)}{1 + \exp(\mathbf{Z}_{ER}^d\boldsymbol{\theta}^d)}.$$

The signs of the coefficients are considered as follows. For rational farmers, the acceptance probability is such that $\partial\pi^s/\partial B^s > 0$ and $\partial\pi^d/\partial B^d < 0$. Now, $\partial\pi^s/\partial P = [\partial\pi^s/\partial f(\mathbf{X})][\partial f(\mathbf{X})/\partial P]$ is negative because the first differential on the right-hand side of the equation is negative, due in turn to the negative sign in front of $f(\mathbf{X})$ in the function $G(\cdot)$, and the second differential is positive because $e > 0$ in Equation (1). In addition, $\partial\pi^d/\partial P > 0$ because $\partial\pi^d/\partial f(\mathbf{X}) > 0$ in Equation (3). Similarly, the negative sign of c' implies that $\partial\pi^s/\partial\mathbf{P}_V > 0$ and $\partial\pi^d/\partial\mathbf{P}_V < 0$. The signs of $\partial\pi/\partial A = [\partial\pi/\partial f(\mathbf{X})][\partial f(\mathbf{X})/\partial A]$ in both the S-D sides cannot be determined in advance, because the sign of $\partial f(\mathbf{X})/\partial A$ is related not only to the parameter (b') of diminishing returns but also to the total factor productivity (a') in Equation (1). If the total factor productivity changes in proportion to A, the effect of diminishing returns may be overwhelmed (i.e., $\partial f(\mathbf{X})/\partial A > 0$), and the sign of $\partial\pi/\partial A$ most likely corresponds to the signs of $\partial\pi/\partial f(\mathbf{X})$. In the estimation process, the negative signs of $\mathbf{X}\boldsymbol{\beta}$ in Equation (4) were set as positive and denoted by the estimated sign of $\boldsymbol{\beta}$ to show the effect of explanatory variables more directly.

Next, the theoretical equilibrium is embodied by the S-D functions for renting that replicate mutual transactions and reveal the influences of primary factors in the simulation. The acceptance probabilities in Equations (2) and (3) correspond to the proportion of farmers who accept the proposed rental rate for a single farm parcel of dA. Almost all parcels of farmland are the same size in Japan, so the acceptance probability corresponds to the percentage of farmland parcels rented, and consequently corresponds to the percentage of farmland areas rented in a single transaction.

The theoretical equilibrium of the S-D sides is defined at the intersection of the S-D functions. At this point, the equilibrium rental rate (B^*) and area rented ($N^* \times dA$) are such that $N^* \times dA = \Pr(B^* > P^s_{A(WTP)}) \times N^s \times dA = \Pr(B^* \leq P^d_{A(WTP)}) \times n \times N^d \times dA$. Upon considering the different farmland areas of S-D farmers, the equilibrium condition is

$$\begin{aligned} N^* \times dA &= \sum_{k=1}^{K} \Pr[B^* > P^s_{A(WTP)}]_k \times N^s_k \times dA \\ &= \sum_{l}^{L} \Pr[B^* \leq P^d_{A(WTP)}]_l \times n \times N^d_l \times dA. \end{aligned}$$

Here, N^* shows the number of farmland parcels rented within a site. The quantities $N^s = \Sigma_k N^s_k$ and $N^d = \Sigma_l N^d_l$ are, respectively, the total number of farmers (corresponding to the total number of farmland parcels) supplied and demanded by the S-D sides. Suffixes k and l show the kth and lth group of farmers whose management scales are similar on each S-D side. The rate n is constant for each site assuming that transactions at one site are divided into "n-auctions"; demand-side farmers (large-scale farmers) can bid on every auction, but supply-side farmers (small-scale farmers) can bid only once because of the small area of farmland in their possession (Figure 1). If the ratio n is stable for each site as the result of the fixed number of participants, and corresponds to N^s/N^d, and if $N^s_k = \phi_k N^s$ and $N^d_l = \phi_l N^d$ (here ϕ is the rate for the kth or lth division out of the total),[2] then the agreement level for renting is

[2] According to the data on sites, the rate, n, is approximately 8, so that typically one demand-side farmer rented from eight small-scale farmers. This rate differs between sites in the project, but appears to be stable for many years since there is little entry or exit of farmers. The rate n therefore scarcely affects equilibrium values, even in actual transactions. Actual rental transactions may be too small to ensure market equilibrium, but Rustichini, Satterthwaite, and Williams showed that indeterminacy or inefficiency caused by trader bargaining behavior in a small market vanishes rapidly under a uniform price double auction, provided that there are at least six traders per side.

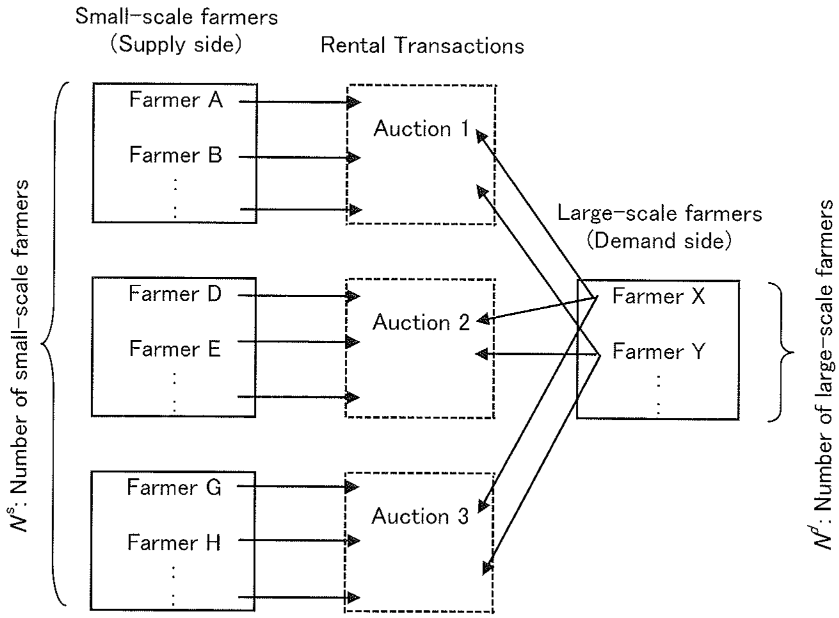

Figure 1. Theoretical Market Structure of Farmland Rental Transactions

$$(5)\qquad N^*/N^s = \sum_{k=1}^{K} \phi_k\{G[\gamma^s \ln(B^*) - \bar{\mathbf{X}}_1^s\boldsymbol{\beta}_1^s - \overline{A_k^s}\beta_A^s]\}$$
$$= \sum_{l=1}^{L} \phi_l\{1 - G[\gamma^d \ln(B^*) - \bar{\mathbf{X}}_1^d\boldsymbol{\beta}_1^d - \overline{A_l^d}\beta_A^d]\}.$$

Here, $\bar{\mathbf{X}}_1\boldsymbol{\beta}_1$ shows the effect of explanatory variables other than farmland for an average farmer. The quantity $\bar{A}$ denotes the average farmland area within the kth or lth division, so that $\bar{A}\beta_A$ shows the average effect of farmland. Also, N^* corresponds to the number of farm parcels accepted to rent in a single imaginary transaction, but does not represent all contracts nor the aggregate derived demand for farmland. However, if the need for additional paddy fields is high, the actual rental rate and area rented will be high and proportional to the agreement level as the target variable of the model.

Data

To obtain the variances in price indexes, a total of 117 survey sites were selected throughout Japan, and the CV questionnaires were administered by the Japan Institute of Irrigation and Drainage (JIID) with the assistance of MAFF in December 1999 (JIID 2000). Hokkaido and Okinawa were excluded, because they have different management styles and rice varieties from other regions. All survey sites were located in paddy field zones consolidated by the Land Improvement Projects before the survey. Conditions of soil and irrigation were almost the same for all fields.

Table 1 shows the results of the surveys. Questionnaire sheets were provided to all farmers in each site, so that the data gathered here corresponded closely to the actual situations of rice production farmers. The ER group accounted for 30% of small-scale farmers (supply side), but only 4% of large-scale farmers (demand side). The χ^2 values were calculated on the supply side (13.0) and the demand side (5.8) to clarify the relation between the size of the ER group and the proposed rental rate.[3] These χ^2 values show that

[3] χ^2 values were calculated as

$$\sum_{i=1}^{5}\sum_{j=1}^{2}\frac{(TN_{ij} - AN_{ij})^2}{AN_{ij}},$$

where i and j show the proposed rates and resistances. Here AN is the actual number of farmers classified into

Table 1. Questionnaire Results

	Small-scale (Supply)	Large-scale (Demand)
Number of project sites	82	117
Distributed questionnaire	7459	764
Collection rate (%)	80.6	85.0
Effective responses	3331 (100)	412 (100)
Rate of effective response (%)	55.4	63.4
ER group	981 (29.5)	18 (4.4)
Non-ER group	2350 (70.5)	394 (95.6)

Note: Farmers in the ER group hated renting, whatever the rental rate. At 35 research sites (difference between 117 and 82), the questionnaire was executed only for the demander to increase the data.

the ER group remained consistent despite different proposed rates [the critical value of $\chi^2(\alpha = 0.01)$ is 13.3).

Table 2 shows candidates for the explanatory variables in Equation (4). The prices of agricultural machinery, fertilizers, and pesticides were not included, because they were almost uniform nationwide. Geographical conditions in suburban areas show the influences of urbanization. Hilly and mountainous areas are less favorable for agricultural production because of the long distances to the main markets and haphazard location of fields in the mountainous terrain. These geographical classifications are based on the Agricultural Census and are indicated by binomial variables.

Estimates of the S-D Functions

Table 3 shows the estimates of the S-D functions in Equation (4). Three functions were estimated for both S-D sides: a log-linear type with all variables involved (models 1 and 4), a log linear type with only significant variables (models 2 and 5) as compared to t-statistics of more than 1.0, and a linear type with all variables as an approximation of the logarithmic function (models 3 and 6). All parameters in the table had the signs expected theoretically. Only a few differences were seen in the performances of the log-linear and linear models in regard to the log-likelihood value, the fraction of correct predictions, and the number of significant parameters.[4] The following features are found in Table 3.

First, the estimated coefficients of the proposed rate B, which correspond to the inverse value of the standard deviation of ε, reveal significant technological differences between farmers. The elasticity values of farmer response to the rental rate, $(\partial\pi/\partial B)(B/\pi)$, were 0.64 for the supply and -0.89 for the demand side at the point of indifference ($\pi = 0.5$), at which the expectation of ε in each S-D function is zero. Similar absolute values of the S-D side elasticity imply a homogeneous distribution of technological differences and a homogeneous response tendency of farmers both in renting out and renting from others, but their responses were inelastic.

Second, most coefficients of the regional heteroscedasticity, except for Tokai and Kyushu, had insignificant values on the supply side. The significant coefficients for Tokai and Kyushu indicate that the standard deviation of

the ith and jth category, and TN is the theoretical number calculated from

$$TN_{ij} = \left(\sum_j AN_{ij}\right) \times \left(\sum_i AN_{ij} \Big/ \sum_{ij} AN_{ij}\right)$$

(Hidano).

[4] A bootstrap simulation was performed to determine reliability in the stochastic choice S-D responses. Rental rates at the indifferent points were calculated using 1,000 sets of bootstrap sampling. The error range of the supply response function with respect to the rental rate was $\pm 10\%$ $[P^s_{A(\alpha=0.95)}/P^s_{A(\alpha=0.05)} = 1.21]$ at 90% reliability in the actual case, and for the demand response function it was $\pm 20\%$ $([P^d_{A(\alpha=0.95)}/P^d_{A(\alpha=0.05)} = 1.40]$. The reliability of the demand response function was therefore lower than the supply side.

Table 2. Possible Explanatory Variables for S-D Functions in Rental Transactions

Explanatory Variables		Unit	Supply Mean	Supply SD	Demand Mean	Demand SD
Price of rice (by prefectures)	P	1,000 yen/60 kg	16.29	1.11	16.38	1.18
Wage (by prefectures)	P_L	1,000 yen/hr	1.61	0.21	1.54	0.16
Attribute (by farmers)						
Management area of paddy	A	ha	1.28	2.23	6.31	5.86
On steep hillside (over 1%)	I	1 or 0	0.36	0.48	0.18	0.39
Age (under 50)	*Age*	1 or 0	0.19	0.40	0.47	0.50
Certificated farmers by gov.	*Certif*	1 or 0	0.22	0.41	0.50	0.50
Geographical classification (by towns) following the Agricultural Census grouping						
Suburban area	*SUA*	1 or 0	0.16	0.37	0.09	0.28
Hilly and mountainous area	*HMA*	1 or 0	0.37	0.48	0.45	0.50
Other area (except for the above areas)						
Regional dummy (by prefectures) following the Agricultural Census grouping						
West Japan	*West*	1 or 0	Tokai, Kinki, and Chyu-Shikoku (except for the below regions)			
Tohoku (including 6 prefectures)						
Kanto (including 6 prefectures)	Z_{Kanto}	1 or 0	0.23	0.42	0.25	0.43
Hokuriku (including 4 prefectures)	$Z_{Hokuriku}$	1 or 0	0.06	0.24	0.05	0.22
Toukai (3 prefectures)	Z_{Tokai}	1 or 0	0.07	0.25	0.01	0.09
Kinki (3 prefectures)	Z_{Kinki}	1 or 0	0.09	0.29	0.04	0.19
Chyu-Shikoku (6 prefectures)	$Z_{ChuShikoku}$	1 or 0	0.19	0.39	0.08	0.27
Kyushu (4 prefectures)	Z_{Kyushu}	1 or 0	0.21	0.41	0.04	0.20

Note: "I" is the tangent of the mean geographical slope between the top and bottom points at the research site.
Source: P and P_L were introduced from Cost Research of Rice Production (MAFF) after matching to the prefectures in the research areas.

ε was higher in these regions, with a greater diversity of individual reactions to renting. In the demand functions, all coefficients of the regional heteroscedasticity were insignificant, although D_{Tokai}, D_{Kinki}, and $D_{\text{ChuShikoku}}$ were scarcely used in the estimation because samples were insufficient and the estimation process did not converge.

Third, the cross elasticity, $(\partial B/\partial \mathbf{X})(\mathbf{X}/B) = (\partial\pi/\partial B)^{-1}(\partial\pi/\partial\mathbf{X})(\mathbf{X}/B)$, was calculated at $\pi = 0.5$ to reveal the effects of economical variables on the rental rate (Table 4). The cross elasticity value of the rental rate with respect to the rice price was the highest of the economic variables, showing a great influence of the rice price on FRT. The cross elasticity values with respect to farmland, which correspond to the rental rate inverse elasticity of farmland, were positive on both S-D sides, showing a tendency for the total factor productivity to increase with management scale. In general, this elasticity value is negative as a result of the diminishing returns in rice production, but the tendency for diminishing returns was overwhelmed by the increase in the total factor productivity. Also, inclined land (I) had a negative effect, and a younger age of farmers (*Age*) had a negative effect on the rental rate.

Fourth, in regard to emotional factors, all constant coefficients were significant and negative in Table 3, showing inflexible emotional reluctance for renting in both S-D sides. Different signs in the cross elasticity values with respect to the ER group (the bottom row in Table 4) imply that the effects of the ER group on the rental rate were offset between the S-D sides. The absolute value of the cross elasticity was greater on the supply side than the demand side, so the existence of the ER group gradually increased the rental rate. As explanatory variables for the ER probability π^{ER}, the coefficients of suburban areas and hilly and mountainous areas were significant on both S-D sides in Table 3. The positive coefficient indicates an increase in the ER probability, with shifts in both S-D curves toward the left side, when the explanatory variables increase. The effect of ER is therefore strong in suburban areas and weak in hilly and mountainous areas on the supply side. It is lower in suburban areas than in flat farming areas, and lowest in hilly and mountainous areas on the demand side. The existence of certified farmers (*Certif*) reduced the proportion in the ER group, as expected.

Simulation Results

Figure 2 shows the S-D curves calculated from models 2 and 5 of Table 3. Curves S0 and D0 include the ER group, and S1 and D1 exclude the ER group (i.e., no emotional reluctance for renting). All curves were plotted by calculating the weighted average of the acceptance probabilities according to Equation (5). Table 5 shows the simulation results by region for renting.

In the case of whole country on average, the equilibrium point "A," where the S-D curves intersect each other and satisfy Equation (5), shows that 35% of the paddy fields owned by supply-side farmers were theoretically rented at a rental rate of 188,000 yen/ha/year. Table 5 also indicates that the simulated rental rates were lower and simulated rental agreement levels were higher than the actual values in most regions. The simulated values represent the theoretical equilibrium conditions even with emotional reluctance, there must be economic inefficiencies in the actual FRT. Economic inefficiencies were calculated as the triangle bounded by the S-D curves and the vertical line at the actual rental agreement level. Because the total surplus of the S-D side farmers was 117,000 yen/ha/year, so that economic inefficiencies, equivalent to 3,100 yen/ha/year, accounted for 3% of the total surplus in actual situations. Economic inefficiencies stem probably from socio-institutional factors to be discussed later.

Detailed investigation of the regional ranking in Table 5 shows that the simulated and actual rankings of rental rates were almost identical. High rental rates were seen in the eastern part of Japan (Tohoku, Kanto, and Hokuriku), and low rental rates in the western part (Kinki, Chu-Shikoku, and Kyushu). The ranking of rental agreement levels is similar between the simulation and the actual values, provided that Tokai and Chu-Shikoku are excluded. The model estimated here therefore successfully explains the differences in the rental rate and rental agreement level between regions. The exceptional results in Tokai and Chu-Shikoku are due to a lack of actual data to be compared with the simulation results in Table 5. In general, the proportions of areas rented in these regions were larger than in Tohoku, Kanto, and Kyushu (MAFF), showing an indication of the progress of renting as seen in the simulations. Overall, the model replicated the regional differences well.

The ideal situation with no emotional reluctance of farmers was simulated by setting $\pi^{ER} = 0$ in the model. The "ideal" equilibrium rental rate decreased by 17%, and the rental agreement level increased by 24%, relative to the value simulated with the ER group included. These changes show the strong negative impact of emotional factors on FRT in Japan. The economic surplus of the ideal situation without emotional reluctance was 134,000 yen/ha/year, greater by 15% than with emotional reluctance.

The effects of economic factors were simulated in the light of recent deregulation in the agricultural sector. A 10% reduction in the rice price reduced the rental rate by 47%, and the rental agreement level by 7%. A 10% increase in wages also reduced the rental rate by 17% and the rental agreement level by 5%. In regard to geographical location, the rental rate was 20% greater in suburban areas and 17% less in hilly and mountainous areas than in flat farming areas. This is because farmers in suburban areas maintained their farmland with the expectation of extra profit from land developers, whereas farmers in hilly and mountainous areas allowed a low rental rate because of the low marginal productivity of rice (Shogenji).

Table 3. Estimations of the S-D Functions in Equation (4) Assuming a Logistic Distribution Function

	Supply (Small-scale Farmers)			Demand (Large-scale Farmers)		
	Log Linear		Linear	Log Linear		Linear
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Farmers' reaction to the rental rate (relating to technological gaps)						
ln (B^s) B^s	1.553	1.405	6.82E-05	−1.489	−1.505	−7.96E-05
	(9.8**)	(20.4)**	(10.6**)	(−7.0**)	(−9.1**)	(−6.9**)
Regional heteroscedasticity factors (Z_R)						
Z_{Kanto}	0.017	—	0.080	−0.217	—	−0.093
	(0.1)		(0.6)	(−1.1)		(−0.4)
$Z_{Hokuriku}$	0.194	—	0.466	1.683	—	4.610
	(0.9)		(1.6)	(0.8)		(0.6)
Z_{Tokai}	0.759	0.629	0.943	—	—	—
	(1.8*)	(1.7*)	(1.8*)			
Z_{Kinki}	0.363	—	0.370	—	—	—
	(1.4)		(1.5)			
$Z_{ChuShikoku}$	0.156	—	0.103	—	—	—
	(1.0)		(0.7)			
Z_{kyushu}	0.383	0.250	0.535	0.275	—	0.515
	(1.8*)	(1.6)	(2.4**)	(0.3)		(0.4)
Economic factors (X)						
Constant	−3.851	−3.495	1.259	−11.087	−5.652	−4.866
	(−1.4)	(−1.5)	(1.3)	(−1.4)	(−0.9)	(−1.6)
$\ln(P)$, P	−4.623	−4.177	−0.316	9.188	7.267	0.605
	(−4.4**)	(−4.8**)	(−4.6**)	(3.0**)	(3.1**)	(2.9**)
$\ln(P_L)$, P_L	1.667	1.435	0.915	−3.669	−3.825	−2.289
	(2.7**)	(2.7**)	(2.3**)	(−2.1**)	(−2.5**)	(−1.9*)
$\ln(A)$, A	−0.283	−0.270	−0.043	0.975	0.966	0.079
	(−4.0**)	(−4.4**)	(−1.5)	(3.7**)	(4.0**)	(2.2**)
l	0.524	0.487	0.593	0.133	—	−0.011
	(3.8**)	(4.1**)	(4.1**)	(0.3)		(0.0)
Age	−0.085	—	−0.142	−0.523	−0.452	−0.573
	(−0.6)		(−0.9)	(−1.8*)	(−1.7*)	(−1.8*)

Table 3. Continued

	Supply (Small-scale Farmers)			Demand (Large-scale Farmers)		
	Log Linear		Linear	Log Linear		Linear
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
HMA	0.542	0.537	0.485	−0.589	−0.398	−0.499
	(3.7**)	(4.4**)	(3.3**)	(−1.6)	(−1.3)	(−1.3)
West	0.636	0.526	0.618	−0.402	—	−0.380
	(4.0**)	(4.1**)	(3.8**)	(−0.8)		(−0.7)
Emotional factors (Z_{ER})						
Constant	−0.859	−0.865	−0.859	−0.911	−0.911	−0.911
	(−14.3**)	(−15.6**)	(−14.3**)	(−4.4**)	(−4.4**)	(−4.4**)
SUA	0.269	0.270	0.269	−1.888	−1.888	−1.888
	(2.5**)	(2.5**)	(2.5**)	(−1.8*)	(−1.8*)	(−1.8*)
HMA	−0.148	−0.146	−0.148	−3.148	−3.148	−3.148
	(−1.7*)	(−1.7*)	(−1.7*)	(−4.2**)	(−4.2**)	(−4.2**)
Certif	−0.026	—	−0.026	−1.206	−1.206	−1.206
	(−0.3)		(−0.3)	(−2.9**)	(−2.9**)	(−2.9**)
No. of data	3,331	3,331	3,331	412	412	412
Log-likelihood	−3,246	−3,249	−3,248	−288	−290	−284
χ^2 (0-slopes)	1,382**	1,378**	1,380**	506**	502**	515**
McFadden R^2	0.18	0.18	0.18	0.47	0.46	0.48
Correct prediction	0.67	0.67	0.70	0.75	0.75	0.75

* $P < 0.1$.
** $P < 0.05$.

Table 4. Cross-elasticity of the Rental Rate With Respect to Other Factors

	Small-scale (Supply)	Large-scale (Demand)
P_A vs. P	3.28	5.84
P_A vs. P_L	−0.93	−2.15
P_A vs. A	0.18	0.63
P_A vs. I	−0.12	—
P_A vs. Age	—	−0.14
P_A vs. SUA	0.03	0.01
P_A vs. HMA	−0.18	−0.03
P_A vs. π_{ER}	1.72	−0.69

Note: Cross-elasticity with respect to variables **X** is calculated from $(\delta B/\delta \mathbf{X})(\mathbf{X}/B) = (\delta\pi/\delta B)^{-1} (\delta\pi/\delta \mathbf{X})(\mathbf{X}/B)$.

Summary and Conclusions

This work has focused on farmland rental transactions, taking into account socio-institutional and emotional factors as well as economic factors. The rental rate and rental agreement level were analyzed using the supply and demand functions for theoretical transactions. A stochastic choice model was derived from production theory by considering regional heteroscedasticity and the emotional reluctance of farmers, and was estimated using cross-sectional data from differing sites to introduce price indexes into the model. Contingent valuation data were used to overcome the problem of low variability in the actual rental rates prevailing in restrictive Japanese farmland rental transactions. The results are summarized as follows.

First, in regard to socio-institutional factors, the simulation results of theoretical S-D equilibrium revealed the existence of economic inefficiencies in actual farmland rental transactions. About 3% of economic surplus was lost as a result of economic inefficiencies, probably due to government regulations and maladjustment of farmers in transactions; this is reflected in the transaction costs of farmers. These inefficiencies can be seen as socio-institutional factors, which raise the rental rate and lower the rental agreement level in actual transactions. Second, the emotional reluctance of farmers over renting also reduced economic surplus by 15% in farmland rental transactions. This reduction in profit was caused by a gradual increase in the rental rate offset through the ups and downs in demand and

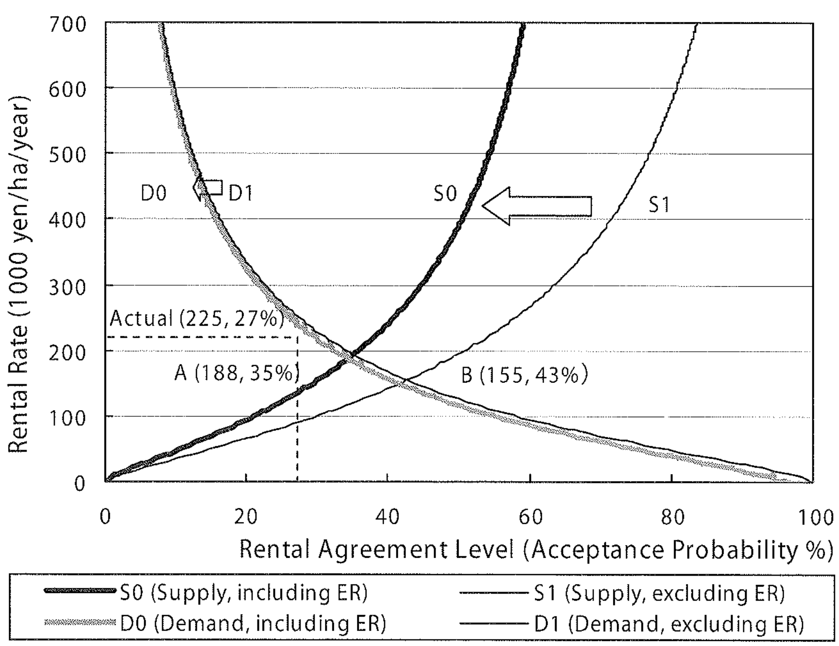

Figure 2. Supply and Demand Curves in Farmland Rental Transactions (by functions 2 and 5)

Table 5. Simulation Results at Equilibria of the S-D Functions by Region

	Rental Rate 1,000 yen/ha/year)					Rental Agreement Level (%)				
		Sim 1	Sim 2	Different			Sim 1	Sim 2	Different	
	Actual	inc. ER	ex. ER			Actual	inc. ER	ex. ER		
Region	A	B	C	B/A	C/A	D	E	F	E/D	F/D
Tohoku	288	228	189	0.79	0.66	31.2	31.8	38.7	1.02	1.24
Kanto	220	198	175	0.90	0.79	22.2	28.8	37.0	1.29	1.66
Hokuriku	258	257	221	1.00	0.86	40.7	33.4	41.0	0.82	1.01
Tokai	210	202	199	0.96	0.95	10.7	38.3	54.0	3.56	5.02
Kinki	170	125	103	0.73	0.61	43.1	33.6	43.3	0.78	1.00
Chu-Shikoku	190	123	100	0.65	0.53	18.4	37.5	45.0	2.04	2.45
Kyushu	238	169	140	0.71	0.59	20.6	31.2	39.0	1.51	1.89
Whole	225	188	155	0.84	0.69	26.7	34.6	42.8	1.30	1.60

Note: Simulation 1 includes (inc.) the ER group, and simulation 2 excludes (ex.) it (no emotional resistance). All simulation values were calculated by substituting the regional mean values into explanatory variables, except for farmland, and taking the weighted average according to the classification of management area noted in Figure 2. Source: The actual rental agreement level was calculated from the data of JIID (2001), and the situations of the survey sites in this data (including 150 survey sites that were different from the data used for estimating the model) were almost the same as the data used to estimate the model.

supply effects, and by large decreases in the rental agreement level multiplied by both effects. Third, farmland rental transactions were affected by changes in rice price, wages, and geographical location of farmlands. A fall in rice price and an increase in wages as well as farmland location (flat vs. hilly and mountainous areas) reduced the rental rate and affected the profit of farmers.

Based on these empirical results, it is concluded that the stochastic choice model involving the emotional reluctance of farmers and regional heteroscedasticity is a useful tool for analyzing restricted markets such as farmland transactions, and it can be used in policy evaluation. This model suggests that deregulation is needed in farmland transactions to reduce social transaction costs for farmers and to ease their emotional reluctance. Accordingly, the operation of local agricultural committees that contribute to the adjustment of the S-D side should be improved, and newcomers such as incorporated companies should be introduced into rice production to break the emotional reluctance barrier of existing farmers. Furthermore, the present method can be applied to other subjects, such as evaluation of water pricing and treatment of cross-sectional pooling data for contingent valuation analysis.

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