Have the Agricultural Public Investments Improved Rice Productivity through Farmland Usage Reallocation?: An Empirical Study on Japanese Paddy-field Rental Transactions

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Abstract

This paper aims to analyze the effects of paddy-field consolidation projects by using the stochastic model. Empirical results showed that the degree of effects, realized as a rise in rental rate and rental-area, vary in each region and that several factors influencing the project effects can be evaluated quantitatively.

Key words: Paddy-field Consolidation Projects, Rental Rate, Rental Area, Stochastic Choice Model, Supply and Demand Function for Renting

JEL Classification codes: C25, D44, Q12, Q15, Q38, R58

Introduction

Improving rice productivity is a critical issue in Japanese rice production because the average management scale of each farmer is about 1 hectare (ha) and still little progress has been made in this improvement for many years. To overcome this situation, focus on agricultural policy is now stimulating Paddy-field Rental Transactions (PRTs) along with public investment as seen by Paddy-field Consolidation (PC) Projects (Fig. 1). In Japan, more than 15% of the agricultural budget has been spent on PC projects. Consequently, 60% of the total paddy-fields have been consolidated from small paddy-fields of irregular-shape to efficient fields endowed with standardized large parcels of farmland (over 0.3 ha), irrigation and drainage canals and brunch roads.

Ideally, the effects of PC projects are realized in two aspects. The first effect is improvement of agricultural productivity by modernization of agriculture with large agricultural machinery, high flexibility of water management and betterment of less fertile soil. In other words, this effect is revealed by a high rental rate as a shadow price of farmland through the process of increasing farmland quality. The second effect is realized as the scale merit in rice production by accelerating intensive farmland use by efficient large scale farmers. Since the PC projects break old farmland ownership and establish new ownership or usage rights, implementation of the projects stimulate PRTs even though many paddy-fields belong to small-scale farmers. To substantiate these two effects, researchers need to demonstrate not only an ascent in the rental rate related to the improvement of productivity, but also an increase in the scale of management by efficient farmers through PRTs.

Previous studies suggested difficulty in farmland reallocation among farmers by the aggregate production function approach providing low elasticity of farmland with regard to the rental rate (Godo, 1993 and Ito, 1993). Hedonic price analyses tried to find the causative factors on farmland values by considering of soil characteristics (Elad, et al., 1994), urbanization (Plantinga and Miller, 2001) and site characteristics (Xu and Barkley, 1993 and Boisvert, et al., 1997). Those studies could not analyze the PRTs which consist of mutual dealings of farmers, so the response model of individual farmers estimated from micro-data should be used. However, estimating the production function or hedonic price function from micro-data might have not succeeded due to the affects of the differences of individual farmers that were hardly measured as tangible variables. It is also impossible to specify why farmland is so inelastic in agricultural production by those methods, though those methods provide interesting fact findings about the farmland situations. Additionally, analyzing market situations with mixture data of SD, which is common in those methods[1], causes the identification problem especially regarding to the restricted market like Japanese farmland situations that the local governments have controlled the rental rates in order to protect the farmland possession right of farmers. A lack of data is also recognized in the statistics on farmland situation affected by PC projects and this becomes a bottleneck for empirical studies. Even the Survey of Rice Production Cost (Ministry of Agriculture, Forestry and Fishery; MAFF), which was used in many of the previous analyses, includes no information on consolidation field areas.

The purpose of this study is to evaluate the project effects by modeling both supply and demand (S-D) sides of farmland renting from micro-data. To overcome low variability of the actual rental rate data, the contingent valuation (CV) method is employed to estimate the S-D functions in PRTs and ideal equilibriums of S-D are discussed by simulating the effects of PC projects (Kunimitsu, 2003) regarding to policy issues in Japan.

< Fig. 1. A paddy-field consolidation project. >

Survey Design and Data Sources

To obtain variable farmer reactions to the different rental rate, the CV questionnaire survey was designed for individual farmers whose paddy-fields were consolidated by PC projects two years before the survey. The question asked to the supply side farmers was as follows.

> "If you had a chance to rent one parcel of paddy field (*dA*) to another farmer, would you accept the rental rate B^s yen/ha/year?"

Demand side farmers were asked the following question.

> "If you had a chance to hire one parcel of paddy field (*dA*) from another farmer, would you pay the rental rate B_1^d yen/ha/year? Assume that you could use other agricultural machinery in addition to 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."

Regarding Japanese rice production, demand side farmers are far less than supply side farmers although their rental areas from other farmers are larger and their needs of renting are greater than supply side. Hence, the estimation error of the demand function will become larger due to a smaller amount of data. To improve statistical efficiency, a double bounded question was employed (Hanemann et. al., 1991). A second question that depended on the response to the first question was as follows.

> "If you accept the above situation, are you going to pay higher rental rate (B_{2H}^d yen/ha/year) for the rental field?" or, "If you reject the above situation, can you pay less rental rate (B_{2L}^d yen/ha/year) for the rental field?"

In these questions, one parcel of paddy-field for rent (*dA*) was assumed to be 0.3 ha for Consolidated Fields (CF) and 0.1 ha for Non-consolidated Fields (NF). These areas are common in Japanese paddy-fields.

A simple "yes-no" responses to above questions were asked to S-D farmers to realize the actual PRTs. Five rental rates for B were prepared, i.e. 50, 100, 200, 400, and 700 thousand yen/ha/year, and each value was proposed to each group of farmers that were classified randomly as the same number. Questions for both the S-D sides were asked about both NF, wherein a paddy-field was under bad conditions before the PC project, and CF, wherein a paddy field was under good conditions after the project. Thus, four kinds of data were collected, i.e. (supply or demand side) × (NF or CF).

The cross-sectional data were composed from the survey of farmers conducted by Japan Institute of Irrigation and Drainage (JIID) with the assistance of MAFF in December 1999 (JIID, 2000). A total of 118 research sites were selected from throughout Japan except for Hokkaido and Okinawa where the management style and rice varieties are different from those of the other regions. The average project area was over 100 ha of paddy-fields, and most of the project sites were located in the flat plain areas. The questionnaires were distributed to farmers who owned paddy-fields in the project sites. Average management scale of the farmers corresponded to the average figure for mainland Japan according to the Agricultural Census (MAFF). The results of the survey are shown in Table 2.

<Table 1 Questionnaire Results>

Empirical model

The empirical model employed here consists of i) the S-D functions that show decision making of farmers for renting based on individual differences of production conditions and ii) the simulation of the S-D equilibrium as ideal rental agreements. Stochastic functions were used in previous agricultural production analyses in order to introduce individual differences of farmers into an equation (Kumbhakar, 1994 and Chambers and Quiggin, 2002). These analyses needed a convergence process, which sometimes failed, in the estimation of function to identify those differences that are not obtained in actual data. In this study, the S-D function for renting was directly estimated to secure the estimation of farmer responses to PRTs after deriving those functions from the stochastic production function and by modifying them to the stochastic choice type model.

Each farmer is assumed to produce rice (Q) according to the Cobb-Douglas production function, such that $Q = aA^b\mathbf{V}^c\mathbf{E}^d\exp(u)$, $(b+c<1)$, with pre-fixed farmland (A), other input factors ($\mathbf{V}$) and social and geographical influences ($\mathbf{E}$). Here, bold character shows the vector, and a, b, c and d are parameters which relate to the rice production structure. Variable u is the stochastic element which represents technological gaps among farmers, relating to differences in skills, knowledge and experiences of individual farmers, inherited farmland quality and amount of information from consumers. The existence of the technological gaps makes farmers decide differently even if they have the same management conditions. Given that farmers try to maximize the profit $R = PQ - \mathbf{P}_\mathrm{V}\mathbf{V}$ under the technical constraints of the production function, the first order condition with regard to $\mathbf{V}$ is $\mathbf{P}_\mathrm{V} = P(\partial Q/\partial\mathbf{V})$ $= PacA^b\mathbf{V}^{c-1}\mathbf{E}^d\exp(u)$, where $\mathbf{P}_\mathrm{V}$ is the price of $\mathbf{V}$ and P is the price of rice.

Since A is restricted for farmers, the optimum rental rate $P_{A(WTP)}$ is different among farmers according to their management conditions. The optimum rental rate $P_{A(WTP)}$, e.g. willingly paid by individual farmers, is assumed to be decided by the marginal productivity of farmland as $P_{A(WTP)} = P(\partial Q/\partial A)$, that is,

$$\ln(P_A) = a' + b'\ln(A) + c'\ln(\mathbf{P}_\mathrm{V}) + d'\ln(E) + e\ln(P) + \varepsilon = f(\mathbf{X}) + \varepsilon \quad (1).$$

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

$e = \frac{1}{1-c}$, $\varepsilon = \frac{u}{1-c}$. Consequently, the rental rate can be decomposed into two parts: a systematic element which is a linear index of the variable matrix $\mathbf{X}$, and a stochastic element ε which represents intangible influences on the rental rate but is different from the observation error.

When a farmer cultivates farmland A_0 initially and rents one parcel of additional farmland dA, the farmland area after renting is $A = A_0 \pm dA$ (dA is negative for the supply side and positive for the demand side).

Since ε in Eq. (1) is not error term, this function is hardly estimated with market data because of the lack of data variability and the S-D separability. To specify this equation from the CV questionnaire data, Eq. (1) should be modified to stochastic choice type function. It is reasonable to presume that the supply side farmer would agree with the rental rate (B^s) proposed in the questionnaire, if the proposed value was higher than $P^s_{A(WTP)}$ in Eq. (1). Given that the distribution of technological gaps shown by ε is i.i.d. with zero means, the probabilities of acceptance are defined by using the cumulative density function G as follows:

Probability of supply side acceptance, π^s;

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

Here and subsequently, the superscripts "*s*" and "*d*" show the S-D side, respectively. A symbol σ shows the standard deviation of ε, and γ and **β** are parameters.

The demand side farmers would accept the proposed rental rate (B^d for first bit, B^d_{2H} and B^d_{2L} for second bit), if the rate is lower than $P^d_{A(WTP)}$ in Eq. (1). The demand function can be defined as a stochastic type in the same way as the supply side as follows.

Probability of 'yes' in both answers, π^d_{yy};

$$\Pr(B^d_{2H} \le P^d_{A(WTP)}) = \Pr\left[\frac{\ln(B^d_{2H}) - f(\mathbf{X}^d)}{\sigma^d} \le \frac{\varepsilon^d}{\sigma^d}\right] = 1 - G[\gamma^d \ln(B^d_{2H}) - \mathbf{X}^d \boldsymbol{\beta}^d)];$$

Probability of 'no' followed by 'yes,' π^d_{yn};

$$\Pr(B^d_1 \le P^d_{A(WTP)} \le B^d_{2H}) = G[\gamma^d \ln(B^d_{2H}) - \mathbf{X}^d \boldsymbol{\beta}^d] - G[\gamma^d \ln(B^d_1) - \mathbf{X}^d \boldsymbol{\beta}^d];$$

Probability of 'yes' followed by 'no,' π^d_{ny};

$$\Pr(B_{2L}^d \le P_{A(WTP)}^d \le B_1^d) = G[\gamma^d \ln(B_1^d) - \mathbf{X}^d \boldsymbol{\beta}^d] - G[\gamma^d \ln(B_{2L}^d) - \mathbf{X}^d \boldsymbol{\beta}^d];$$

Probability of 'no' in both answers, $\pi^d{}_{nn}$;

$$\Pr(P_{A(WTP)}^d \le B_{2L}^d) = G[\gamma^d \ln(B_{2L}^d) - \mathbf{X}^d \boldsymbol{\beta}^d] \qquad (3).$$

Parameters can be estimated by the maximum likelihood estimation method with the log sum of the likelihood composed by response models as above. Expected signs of coefficients are as follows. The rational farmers lead the acceptance probability to $\partial \pi^s / \partial B^s > 0$ and $\partial \pi^d / \partial B^d < 0$. $\partial \pi^s / \partial P = \{\partial \pi^s / \partial G(\cdot)\}\{\partial G(\cdot)/\partial P\}$ is less than 0, because the first differential on right hand of the equation is positive. The second differential is negative due to the negative sign in the function $G(\cdot)$ and e>0 in Eq. (1). Also, $\partial \pi^d / \partial P > 0$ due to $\partial \pi^d / \partial G(\cdot) < 0$ in Eq. (3). Similarly, the negative sign of *c'* brings about $\partial \pi^s / \partial \mathbf{P}_\mathrm{V} > 0$ and $\partial \pi^d / \partial \mathbf{P}_\mathrm{V} < 0$. The signs of $\partial \pi / \partial A$ in both the S-D sides cannot be determined in advance, because these signs are related not only to the parameter *b'* of diminishing returns but also the total factor productivity *a'*. If the total factor productivity changes in proportion to *A*, the affect of diminishing returns may be overwhelmed and the sign of $\partial \pi / \partial A$ may become the same as $\partial P_A / \partial A$, but the signs of $\partial \pi / \partial A$ may be opposite of $\partial \pi / \partial \mathbf{P}_\mathrm{V}$.

Equation (2) and (3) are the survival functions regarding to the proposed rental rates for one farm parcel of *dA* (ha), so the acceptance probability corresponds to the number rate of farmers who accept the proposed rental rate in PRTs. Since all parcels of farmland are assumed to be the same area and a standard shape, acceptance probability would correspond to the number rate of farmland parcels, consequently area rate of rented farmland. The ideal equilibrium of the S-D sides is defined at the intersection of the S-D functions[2)]. At this point, the equilibrium rental rate (B^*) and rental area ($N^* \times dA$) are decided as, $N^* \times dA = \Pr(B^* > P_{A(WTP)}^d) \times N^s \times dA \quad = \Pr(B^* \le P_{A(WTP)}^d) \quad \times n \times N^d \times dA$. Here, N^* shows the number of rented parcels of farmland within a project site. N^s and N^d are the total numbers of farmland parcel participated in bidding for the S-D sides, respectively. In detail, transactions at one project site are assumed to be divided into '*n*' parts of bidding, and large-scale farmers can participate in every bidding, but small scale farmers can participate only once in one of the bidding opportunities due to the small farmland area for bidding. In practice, *n* is assumed to correspond to the ratio (N^s / N^d)[3], then,

$$N^* / N^s = \mathrm{G}[\gamma^s \ln(B^*) - \overline{\mathbf{X}}^s \boldsymbol{\beta}^s] = 1 - G[\gamma^d \ln(B^*) - \overline{\mathbf{X}}^d \boldsymbol{\beta}^d] \quad (4).$$

$\Pr(B^* > P^d_{A(WTP)})$ and $\Pr(B^* \le P^d_{A(WTP)})$ are substituted by stochastic function using the average value of explanatory variables $\overline{\mathbf{X}}$, supposing that all related farmers in each sides would be distributed consistently.

Estimation Results of S-D Functions

Table 2 shows the candidates for the explanatory variables of Eqs. (2) and (3). The prices of agricultural machinery, fertilizers, and pesticides were not included as candidates, because these prices correspond to nationwide market prices and have little variability among farmers (unified by the constant of the equation).

Tables 3 and 4 show estimation results of the S-D functions in both the NF and CF, respectively. Insignificant variables were excluded as compared to t-statistic at 15% level. Coefficients of the proposed rental rate in both tables are significant as compared to t-statistic and show the correct signs based on the theoretical framework. Comparing the coefficients in NF and CF shows that the CF have greater value in both the S-D sides. Clearly, both S-D farmers reacted to the rental rates more sharply after the PC projects. These changes are shown more concretely by the rental rate elasticity to acceptance probability at the indifferent points where acceptance probabilities correspond to 0.5. The values of elasticity in the NF were 0.34 (supply) and -0.39 (demand); those values in the CF were 0.44 (supply) and -0.63 (demand). Thus, both elasticity values in the CF were higher than in the NF, but all values were less than 1.0 indicating inelasticity. An inelastic structure in farmland derived demand was also shown by previous studies that estimated the trans-log cost function of aggregated agricultural production[4)].

As for the estimated coefficients of rice price and wages, the positive coefficient shifts both S-D functions toward the right in the price-quantity graph, showing lower and higher affects on acceptance probabilities on the S-D sides, respectively. Thus, the higher price in rice and lower wages tend to encourage both S-D farmers to easily accept a high rental rate in spite of different signs in coefficients of the estimated equations. The farmland area A has a negative affect on the supply and a positive affect on demand. As discussed in the former section, the coefficient of this variable can take positive and negative signs, but should take opposite signs between S-D. Therefore, the estimation results do not contradict the theoretical framework.

Estimated coefficients of geographical classification show that farmers on the supply side in urban areas tended to rent their paddy-fields at a high rental rate. This is because the rental rate was raised by strong intention for the land use conversion of farmers (Shogenji; 1998). However, the situation was the reverse in LFAs, showing the low rental rate and easy renting from other farmers.

<Table 2　Candidates of Variables for Estimation in Eqs. (3) and (4)>

<Table 3. Estimation of the Supply Functions.>

<Table 4.　Estimation of the Demand Functions.>

Simulation

Figure 2 shows the S-D curves derived from Eq. (2) and (3) in the NF (S0, D0) and in the CF (S1, D1). Points A and B show the ideal equilibrium of PRTs for the NF and CF, respectively. Comparing point A to B indicates that the rental rate increased by four times and rental area increased by 40% because of the PC projects. Point C shows the supply-side effect in which the demand function was stable while the supply function shifted after the projects. Comparing point C to A demonstrates that the rental rate increased by 50% and rental area decreased by 27% because of the projects. This is because farmers restarted cultivating their own paddy-fields with increased incentive when conditions of their paddy-fields were bettered by the projects (JIID, 2000). Furthermore, the burden for the PC project costs made it impossible to rent their paddy-fields to others with low rental rate (Tanada, 1993). On the contrary, comparing point A to D showing the demand effect only suggests that both the rental rate and rental area increased by 190% and 70%, respectively. This is because large-scale farmers could attain efficient production with a high rental rate and larger rental area after the projects. Consequently, the rental rate highly increased with synergism of S-D effects and the rental area was improved moderately because of the PC projects with greater increase in the demand effect than decrease in the supply effect, in spite of S-D effects offsetting each other.

Table 6, calculated form the mean value of the explanatory variables in each region, reveals that the simulated rental rates correspond to the actual values and the orders of simulated values and actual values are almost the same. Most of the simulated rental areas are almost the same as the actual values, indicating considerable applicability of this model, except for the Tokai region[5)]. It is clear that rental rates increased drastically in all regions after the projects, especially in Tohoku, Kanto and Hokuriku, but, rental areas increased moderately in all regions. The increases in the rental areas of Tokai, Kinki, Chyu-Sikoku and Hokuriku were remarkable as compared to other regions. Therefore, the eastern part of Japan including Tohoku, Kanto and Hokuriku tends to attain high project effects that appear in the rental rate rather than the rental area, but the western part of Japan tends to attain high project effects in the rental area.

Table 6 also shows that the simulated rental rates of all regions were lower than the actual values, especially in NF. Five out of seven regions attained a higher rental area by the simulation that shows ideal transactions. A transaction cost in the rental market may be caused by miss-adjustment between farmers and regulation by the government. However, from the gaps between the simulated values and actual values, the transaction cost seems to not be serious in the CF but serious in the NF. Therefore, it can be concluded that the PC projects reduced the transaction cost in the rental market.

Table 7 shows the influences of low rice price, high wages and geographical situation on the project effects. The low price of rice and high wages brought about low rental rates and low rental areas in both NF and CF, but the decreases in these indexes were remarkable in the CF. As a result, the effects of the PC projects shown by the differences in rental rate become lower than the whole country (status quo) in comparison of average situations, especially in the case of decrease in rice price. As for geographical situations, the project effects on the rental rate in SUAs were higher, but the project effects on the rental area in SUAs were lower. Conversely, the effects in LFAs appeared through the rise in the rental area rather than the rental rate.

<Figure 2. Changes in supply and demand by the PC projects in PRTs. >

<Table 5. Regional effects of the PC projects (at equilibrium).>

<Table 6. Influence of outside factors on effects of PC projects.>

Conclusions and Future Subjects

Applying the stochastic choice model to the regulated market including PRTs is useful for analyzing the capitalization mechanisms of PC projects and for evaluating causative factors.

One of the remarkable results is that the PC project effects appears as a marked increase in the rental rate and a moderate increase in the rental area, in spite of the negative effect at supply side overwhelmed by the positive effect of the demand side farmers. In addition, the PC projects can ease the transaction costs, which came from miss-adjustment between farmers and affected the rental transactions severely, by making paddy-fields usage more flexible. Second, regional differences in agricultural and social situations bring about regional differences in the project effects. Namely, the project effects in the eastern part of Japan tend to appear as high rental rates because both S-D farmers have a strong will to continue their cultivation and outer situations such as the rice price and monoculture of rice suit their will. On the other hand, the project effects in the western part of Japan appear as large rental areas because the small average farmland area and many varieties of crops make it easy for farmers to rent their paddy-fields to other farmers. Third, a decrease in rice price negatively influences in the project effects. This may be a dilemma, that is, the PC projects are needed to improve rice productivity, but the decrease of rice price derived from high rice productivity brings about negative effects on the PC projects. Additionally, a change in the project site to LFAs makes the project effect appear higher in the rental area than the rental rate. This indicates the PC projects can be useful for protecting against farmland abandonment caused by a lack of rental demanders in LFAs.

Finally, there is a need for further investigation to apply other kinds of distribution functions to the model, to improve questionnaire items and to test uniformity of the market structure. Furthermore, this model may be applicable to analysis of the price of water, which has not been evaluated empirically, but constitutes an important factor in agricultural production.

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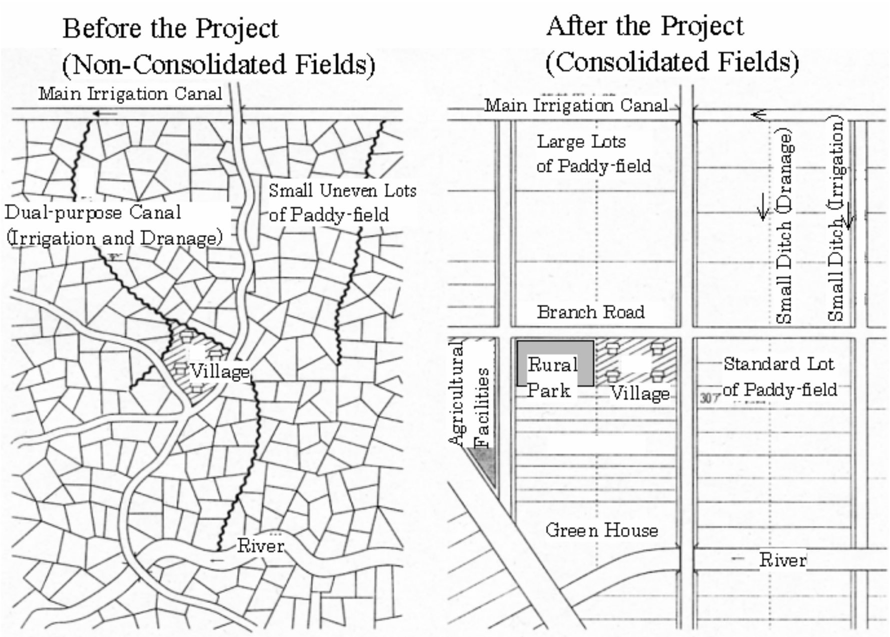

Figure 1. A Paddy-field Consolidation Project.

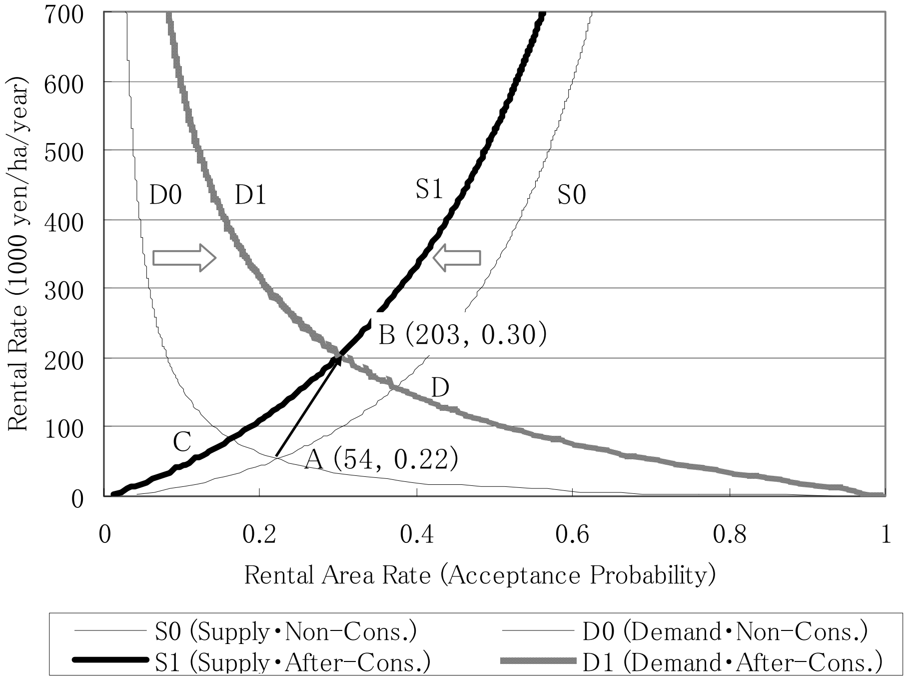

Figure 2. Changes in supply and demand by the PC projects in PRTs.

Table 1. Questionnaire results.

	Supply side (Small scale)		Demand Side (Large scale)	
Distributed Questionnaire (household)	7,920		925	
Collection Rate (%)	78.0%		75.4%	
Effective Responses (household)	3,651	(46.1%)	426	(100.0%)
Effective Responses (%; to Effec. Res.)	60.0%		61.1%	
Effec. Res. for non-consolidated fields	3,335	(42.1%)	409	(96.0%)

Note: Farmers who answered only for consolidated fields were excluded for non-consolidated simulations.

Table 2. Candidates of variables for estimation in equation (4) and (5).

Explanatory Valiables		Unit	Supply (Small-Farmers) Mean	Demand (Large-Farmers) Mean	Data Source
Price of Rice (by pref.)	*P*	¥1000/60Kg	16.29	16.38	*SRPC*
Wage (by pref.)	P_L	¥1000/hr	1.61	1.54	*SRPC*
Attribute (by farmer)					
Management Scale	A_0	ha	1.30	6.40	*JIID*
Enlarg. of A (≧20%)	*Agress*	1 or 0	–	0.35	*JIID*
Steepness (> 1%)	*Steep*	1 or 0	0.36	0.19	*JIID*
Age (<50)	*Age*	1 or 0	0.20	0.47	*JIID*
Geographical Classification (by town)					
Suburban Area	*SUA*	1 or 0	0.16	0.10	*AC*
Less Favored Area	*LFA*	1 or 0	0.37	0.44	*AC*
Flat Farming Area		Except for the above regions			
Regional Dummy (by prefecture)					
Hokuriku (4 pref.)	*Hokuriku*	1 or 0	0.06	0.05	*AC*
Tokai (3 pref.)	*Tokai*	1 or 0	0.07	0.01	*AC*
Kinki (3 pref.)	*Kinki*	1 or 0	0.09	0.04	*AC*
Chyu-Sikoku (8 pref.)	*Chyu-Sikoku*	1 or 0	0.19	0.08	*AC*
Others (19 pref.)		Except for the above regions			

Data: SRPC ; Survey of Rice Production Cost by MAFF, AC ; Agricultural Census by MAFF, JIID; Research of JIID

Note:1. "Agress" becomes 1 in the case of a farmer who enlarges his or her farmland to more than 20% after consolidation, or 0 in otherwise.

2. "Other Regions" consist of Tohoku (6 pref.), Kanto (7 Pref.) and Kyushu (6 pref.).

Table 3. Estimation of the supply functions.

Variables	Non-Consolidated Case Est.Coeff.	(t-statistics)	Consolidated Case Est.Coeff.	(t-statistics)
Constant	-4.561	(-2.4 **)	-3.635	(-1.9 *)
ln(*B*)	0.689	(16.6 **)	0.883	(19.9 **)
ln(*P*)	-1.278	(-1.9 *)	-2.481	(-3.5 **)
ln(P_L)	1.163	(3.4 **)	1.048	(2.5 **)
ln(A_0-*dA*)	-		-0.090	(-2.0 **)
Steep	0.598	(7.3 **)	0.408	(4.7 **)
SUA	-0.232	(-2.0 **)	-0.264	(-2.1 **)
LFA	0.343	(3.9 **)	0.320	(3.3 **)
Hokuriku	0.684	(3.6 **)	0.687	(3.7 **)
Tokai	0.912	(6.0 **)	1.184	(7.5 **)
Kinki	-		0.362	(2.1 **)
Chyu-Sikoku	-		0.383	(3.4 **)
No. of Data	3,335		3,651	
LogLiklifood	-2,046		-1,984	
Fract. of Correct Pred.	0.660		0.715	

Note: Significant at 5% level("**"), at 1% level("*").

Table 4. Estimation of the demand functions.

Variables	Non-Consolidated Case Est.Coeff.	(t-statistics)	Consolidated Case Est.Coeff.	(t-statistics)
Constant	-4.284	-0.7)	-12.783	(-3.1 **)
ln(*B*)	-0.885	-6.8 **)	-1.287	(-14.5 **)
ln(*P*)	4.628	1.9 *)	8.937	(5.9 **)
ln(P_L)	-7.105	-3.9 **)	-3.772	(-3.5 **)
ln(*A*+*dA*)	0.670	2.6 **)	0.825	(4.4 **)
Agress	0.502	1.8 *)	0.692	(2.9 **)
Age	-0.396	-1.5)	-0.468	(-2.3 **)
LFA	-0.790	-2.6 **)	-	
No. of Data	414		426	
LogLiklifood	-276		-457	
Fract. of Correct Pred.	0.460		0.519	

Note: Significant at 5% level("**"), at 10% level("*").

Table 6. Regional effects of the PC projects (at equilibrium).

(¥1000/ha/year)

Regions	Estimated Rental Rate			Estimated Rental Area (Rate)			Actual Value		
							Rental Rate		Rental Area (after Cons.)
	Non-Cons.	After Cons.	After-Non	Non-Cons.	After Cons.	After-Non	Non-Cons.	After Cons.	
Tohoku	81	261	180	0.22	0.27	0.05	195	288	0.31
Kanto	49	212	163	0.19	0.25	0.06	188	220	0.22
Hokuriku	41	251	210	0.28	0.41	0.13	169	258	0.41
Tokai	44	169	125	0.33	0.47	0.14	137	210	0.11
Kinnki	23	157	134	0.14	0.30	0.16	97	170	0.43
Chyu-Sikoku	33	142	109	0.20	0.33	0.13	102	190	0.18
Kyusyu	69	191	122	0.20	0.25	0.05	146	238	0.21
Whole	54	204	150	0.22	0.30	0.08	148	225	0.27

Note: 1. Actual values came from previous research data (JIID 2000).
2. The estimation values are calculated by using the average values of explanatory variables in each region.

Table 7. Influence of outside factors on effects of PC projects.

(1000 yen/ha/year, Rate)

Outside Factors	Rental Rate			Rental Area (Rate)		
	Non-Cons.	After Cons.	After-Non	Non-Cons.	After Cons.	After-Non
Declease in Rice Price (-5%)	44	156	112	0.21	0.28	0.07
Increase in Wages (+5%)	42	183	141	0.20	0.29	0.09
Suburban Areas	82	239	157	0.21	0.26	0.05
Less Favored Areas	35	182	147	0.21	0.33	0.12
Whole (correspond to the status quo.)	54	204	150	0.22	0.30	0.08

<Foot Note>

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1 The hedonic model has the reduced form of supply and demand (S-D) functions and each factor of S-D cannot be specified by this method as explained by Brown and Rosen (1982).

2 The actual rental market may be too small to ensure market equilibrium, but Rustichini, et al. (1994) showed that the indeterminacy or inefficiency caused by trader bargaining behavior in a small market vanishes rapidly under a uniform price double auction with more than six or three traders per side.

3 According to the data on site, the rate n is approximately eight on the average, that is, one demand side farmer rented from eight small scale farmers. This rate differs in sites of the project, but appears stable for many years. Therefore, n rarely affects the equilibrium values even in the actual transactions.

4 The elasticity in this paper is different from conventional production function, but the following features were found if this point was ignored for the comparison. That is, the elasticity for factor demand of paddy-field estimated by Ito (1993) during the period 1988-90 was 0.06-0.69 for the small-scale farmers and 0.72-0.84 for the large-scale farmers. These values are similar to the estimation values calculated above for 1999. Godo (1993) also showed that the elasticity value of large-scale farmers was larger than that of small-scale farmers.

5 Many cooperative groups for agricultural production were established in the Tokai region, and their management area exceeds the project site. Also, their large cultivation area makes the number of data lower than other regions. Therefore, the actual rate of the rental agreement level in Table 6 should be considered with some limitations.