No.388

Estimating the Shadow Value of Farmland in Japanese Agriculture, 1958-85

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(November 8, 1988)

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Ever since 1961 when the Agricultural Basic Act was established, achieving large-scale, more efficient farming has become a major concern in Japanese agriculture. In particular, this concern has been amplified in recent years due mainly to pressures by foreign countries for liberalizing Japanese markets of agricultural commodities. Consequently, it has been considered most essential to promote a transition from small- to large-scale farms. Along this line of thought, various policy measures have been introduced by the government: revisions of the Farmland Act in 1970 and 1980; launching of the Farmland Utilization Promotion Project in 1975; and establishment of the Farmland Utilization Promotion Act in 1980.

In spite of these efforts by the Japanese government, however, this transition has been making very slow progress. It has been considered that the major reason for this limited land movements has been a rapid increase in market prices of farmland.[1/] Tabata, Ishikawa, and others have pointed out that market prices of farmland have been much higher than the capitalized values of farmland which were estimated by the traditional residual-returns-to-land method.

However, as was already pointed out by Tsuchiya, critical defects lie in this traditional method. According to this method, which traces back to Ricardo, the average residual returns per unit of land are first estimated by subtracting the costs of all the factors of production other than land from gross farm income and dividing the residuals by the area of land. Then, the residual returns per unit of land are capitalized by an appropriate discount rate to yield the farmland value per unit of land.

Note that in this method all the factors of production are implicitly assumed to be in equilibrium. A most critical defect in this assumption lies in the manner of evaluating family labor to estimate labor costs.

It is a world-wide phenomenon that agricultural production is practiced mainly by family labor for which a market does not exist.[2/] In Japan, family labor has shared more than 95 % in total labor input in agricultural production. Under such a situation, the residual returns to land can be under- or over-estimated depending upon at what level unpaid family labor is evaluated.

However, the evaluation of family labor has often been arbitrarily made using the wage rate of either agricultural temporary-hired labor (e.g., Egaitsu and Shigeno, 1983) or nonagricultural employment (typically, the Survey Report on Costs of Rice Production published annually by the Ministry of Agriculture, Forestry, and Fisheries). If, for example, nonagricultural wage rates, which are in general higher than agricultural wage rate, are used, the residual returns to land will turn out to be relatively small, and hence the estimated land value capitalized by an appropriate discount rate will also turn out to be relatively small. Needless to say, the choice of the appropriate discount rate for capitalization has to be made very carefully, since it directly changes the magnitudes of estimated land values.

The major objective of this study is thus to introduce a more practical procedure for estimating farmland values which can avoid the above-mentioned shortcoming implied in the traditional residual returns method of the classical school. In order to achieve this objective, this study adopts the theory of income distribution of the neoclassical school, i.e., the marginal productivity principles. More specifically, unlike estimating the average productivity of farmland in the case of the traditional residual returns method, it estimates the marginal productivity (or shadow value) of farmland and investigates relationships between the market price and shadow value of farmland. The estimation is practiced using aggregate farm data composed of four different size classes for the 1958-85 period.

In order to carry out this estimation, the translog normalized restricted profit function is estimated in that family labor and land are treated as quasi-fixed inputs. The reasons for choosing the normalized restricted profit function of this form are as follows.

As shown in detail in the next section, introduction of the profit function of this specification makes it possible to compute directly the shadow values of both family labor and land. In this sense, the shortcoming of the traditional residual returns method can be bypassed.

In addition, the profit function approach is considered most convenient to investigate the effects of output price support programs on the shadow value of farmland, since, unlike the primal production function or dual cost function approach, it gives directly the impacts of changes in output price on various indicators including the shadow value of land.

Using the parameter estimates of the profit function, the shadow values of land are estimated for the average farms in different size classes as well as for the total average farm. Based on the results, the following subjects are investigated which are intimately associated with government agricultural policies.

First, using the estimates of the shadow values of land for different size classes, possibilities of land movements from small- to large-scale farms are examined.

Furthermore, since, as shown formally in the next section, the shadow value of land is a function of the prices of output and variable factor inputs, the quantities of quasi-fixed inputs, and technological change, the impacts of changes in these variables on the shadow value of land can easily be measured for the average farms in different size classes. Due to this property of the profit function approach, it is possible to investigate for different size classes the impacts of agricultural policies such as output price support programs, input subsidies, acreage allotment (or restriction) programs, and technological innovations on the shadow value of land.

In particular, an interesting and important subject in this context is to quantitatively investigate whether these impacts are neutral or systematically different among different size classes. As Gardner and Pope (p.297) have pointed out, investigations of the neutrality of these impacts among different size classes have important implications in size distribution. If, for example, a price support program yields higher rates of return to land in large farms than in small farms, movements of land from small to large farms will be promoted and vise versa. However, as they have pointed out, few studies, either theoretical or empirical, have been documented in the literature. Thus, the quantitative investigations of the neutrality of these impacts to be carried out in this study are expected to make a significant contribution to the literature.

A survey of the literature on farmland prices shows that, although there are a great number of studies which tried to explain market prices of farmland not only in Japan (e.g., Yori; Takebe; Miyazaki) but also in other countries (e.g., Chryst; Floyd; Herdt and Cochrane; Feldstein; Traill; Van Dijk, Smit, and Veerman; Alston; Burt; Featherstone and Baker; among others), there are surprisingly small number of studies which estimated the shadow values of farmland (e.g., Locken, Bills, and Boisvert; Egaitsu and

Shigeno 1983; Godo). Here, brief comments are offered only on the last two studies made for postwar Japanese agriculture.

Egaitsu and Shigeno (1983) estimated a particular Cobb-Douglas type production function for rice production for the 1951-79 period and estimated the shadow value of land using the parameter estimates. However, in the estimation of the shadow value of land based on the equilibrium conditions, they assumed that the shadow value of family labor equals the market wage rate of agricultural temporary-hired labor. This procedure may not be appropriate if, as mentioned earlier, the assumption on the evaluation of family labor is not valid.

Godo estimated the shadow values of land based on the parameter estimates of a quadratic restricted cost function also for rice production for 1970 and 1984. Although his procedure is rather appealing, he assumed a priori that the farm-firm minimizes the variable costs composed of intermediate inputs and labor. More specifically, he arbitrarily assumed that the price of family labor equals the wage rate of nonagricultural temporary-hired labor. If this assumption is not valid, the estimated shadow value of land may be biased. Furthermore, since output price does not enter the cost function framework, Godo failed to investigate the impacts of output price support programs on the shadow value of land.

The Analytical Framework

This section derives the shadow value equations for family labor and land using the framework of the normalized restricted profit function for which the translog form is specified. It also derives the measures of impacts of various policy instruments on the shadow value of land based on the estimated coefficients of the translog profit function.

The Normalized Restricted Profit Function

The production function for the farm-firm is assumed to be

$$(1) \qquad Q = F(X_M, X_I, X_O, Z_L, Z_B, t)$$

where Q is output; X_M, X_I, and X_O are machinery, intermediate inputs, and other inputs which are assumed to be variable factor inputs; Z_L and Z_B are family labor and land inputs which are assumed to be quasi-fixed factor inputs (hereafter, fixed factor inputs); and t is time which is assumed to allow for the effects of technological change.

It is assumed that the farm-firm maximizes restricted profits (gross revenue less variable costs) conditional on given stocks of fixed factor inputs. That is, the farm-firm is assumed to attain static equilibrium with respect only to the variable factor inputs $X_i (i = M, I, O)$ given the observed levels of the fixed factor inputs. In this sense, this study may be regarded to be treating a short-run behavior of the farm-firm in that the stocks of family labor and land are assumed to remain unchanged within the period of sample observation (one year).

Assuming further regular technologies, the normalized restricted profit function (hereafter, the profit function) can be derived as a dual transformation of the production function (1) (Diewert 1973; Lau 1976). are profit function is written as

(2) $\Pi = G(P_M, P_I, P_O, Z_L, Z_B, t)$

where Π is restricted profits normalized by output price (P); and P_M, P_I, and P_O are the prices of machinery, intermediate, and other inputs normalized by P.

A major reason for the treatment of family labor as a fixed factor input is as follows. As mentioned earlier, more than 95 % of labor is composed of family labor in postwar Japanese agriculture for which a market does not exist. Under such a situation, treating family labor as a variable factor input in the production function and hence in the profit function by arbitrarily assuming a priori that the price of family labor is equal to a market price, e.g., the wage rate of either agricultural temporary-hired labor or nonagricultural employment, may cause biased results in the parameter estimates of the profit function and hence in the estimates of the shadow value of land .

Instead, by treating family labor as a fixed factor input, the shadow value of family labor can be estimated together with that of land within the profit function framework of this study. And, it is an intriguing research subject to examine the level of the estimated shadow value of family labor compared with market wage rates, agricultural or nonagricultural.

Applying Hotelling's lemma yields the system of variable factor demand and output supply equations (Diewert 1974) as:

(3) $\partial\Pi(P_i, Z_j, t) / \partial P_i = -X_i(P_i, Z_j, t)$

(4) $\partial\Pi(P_i, Z_j, t) / \partial P_i = Q(P_I, Z_j, t)$

$i = M, I, O; \quad J = L, B.$

The shadow value of a fixed factor input can be obtained by differentiating the profit function (2) with respect to the quantity of that fixed factor input (Nadiri, P.452) as:

(5) $\partial\Pi(P_i, Z_j, t) / \partial Z_j = P_j^s(P_i, Z_j, t)$

$i = M, I, O; \quad j = L, B,$

where P_j^s is the shadow value of the j-th fixed factor input. Derivatives of the profit function (2) and the production function (1) with respect to the j-th fixed input are equivalent due to the dual transformation relationships between the two functions (Lau, 1978, p.146; Nadiri, p.452).

These equations give the imputed value of a marginal unit of fixed input j. As clearly seen in equations (3), (4), and (5), the output supply and variable factor demand equations and the shadow value equations are functions of the variable factor prices, the quantities of the fixed factor inputs, and technological change. Furthermore, since the variable factor prices are normalized by output price (P), these equations are also functions of output price.

The Translog Specification

For econometrical estimation, the following translog form is postulated for the profit function (1):

(6) $$\ell n\Pi = \alpha + \sum_{i=1}^{3} \alpha_i \ell nP_i + \sum_{j=1}^{2} \beta_j \ell nZ_j + \beta_t \ell nt$$
$$+ \frac{1}{2} \sum_{i=1}^{3}\sum_{k=1}^{3} \gamma_{ik} \ell nP_i \ell nP_k + \frac{1}{2} \sum_{j=1}^{2}\sum_{\ell=1}^{2} \delta_{j\ell} \ell nZ_j \ell nZ_\ell$$
$$+ \sum_{i=1}^{3}\sum_{j=1}^{2} \phi_{ij} \ell nP_i \ell nZ_j + \sum_{i=1}^{3} \varepsilon_{it} \ell nP_i \ell nt$$
$$+ \sum_{j=1}^{2} \mu_{jt} \ell nZ_j \ell nt + \frac{1}{2} \beta_{tt} (\ell nt)^2$$

where $\gamma_{ik} = \gamma_{ki}$ and $\delta_{j\ell} = \delta_{\ell j}$; $i = k = M, I, O$; and $j = \ell = L, B$.

In terms of the parameters of this translog profit function, the variable factor demand equations (3) are given as the profit share equations

(7) $$-R_i = -\frac{P_i X_i}{\Pi} = \frac{\partial \ell n\Pi}{\partial \ell nP_i}$$
$$= \alpha_i + \sum_{k=1}^{3} \gamma_{ik} \ell nP_k + \sum_{j=1}^{2} \phi_{ij} \ell nZ_j + \varepsilon_{it} \ell nt$$
$i = k = M, I, O$; $j = L, B$.

The output supply function is given as:

(8) $$Q = \Pi + \sum_{i=1}^{3} P_i X_i = \Pi(1 - \sum_{i=1}^{3} R_i)$$
$i = M, I, O$.

The shadow value equations (5) are expressed as:

(9) $$\frac{\partial \Pi}{\partial Z_j} = \frac{\Pi}{Z_j} (\beta_j + \sum_{\ell=1}^{2} \delta_{j\ell} \ell nZ_\ell + \sum_{i=1}^{3} \phi_{ij} \ell nP_i + \mu_{jt} \ell nt)$$
$i = M, I, O$; $j = \ell = L, B$.

Given the estimates of β_j, $\delta_{j\ell}$, ϕ_{ij}, and μ_{jt}, the shadow value of each fixed input can be estimated for each sample observation.

Impacts of Policy Instruments on the Shadow Value of Land

As seen in equation (9), the shadow values of the fixed factor inputs are functions of the variable factor prices normalized by output price, the quantities of the fixed inputs, and technological change. This means that the impacts of important agricultural policy instruments such as output price support programs, input subsidies, acreage allotment programs, and diffusion of technological innovations on the shadow values of family labor and land can be measured. The measurement is executed by differentiating the shadow value equation (9) with respect to the corresponding variables, i.e., P, P_i (i = M, I, O), Z_B, and t. However, as the primal interest in this study is to investigate the impacts of these policy means on the shadow value of farmland, the measurements are limited only to the impacts of these variables on the shadow value of land.

To begin with, the impacts of output price support programs on the shadow value of land can be investigated by measuring the impacts of changes in output price (P) on the shadow value of land (P_B^s) given in equation (9). This is carried out by differentiating P_B^s by P holding the other exogenous variables constant. Using the relationship $P_i = P'_i / P$ (i = M, I, O) where P'_i designate the nominal prices of the variable factor inputs, and applying Hotelling's lemma $\partial \Pi / \partial P = Q$, the impacts of changes in output price on the shadow value of land are obtained as

$$(10) \qquad \frac{\partial(\partial \Pi/\partial Z_B)}{\partial P} = -\frac{\Pi}{Z_B} \frac{1}{P} \left(\sum_{i=1}^{3} \phi_{iB}\right) \frac{Q}{Z_B} \frac{\partial \ell n \Pi}{\partial \ell n Z_B}$$

i = M, I, O,

where $\partial \ell n \Pi / \partial \ell n Z_B = (\partial \Pi / \partial Z_B)(Z_B / \Pi)$.[3/] Theoretically, these impacts are positive in sign for the following reason (Lau, 1978, pp. 147-149).

Suppose that output price is increased. To take full advantage of the increased output price, the profit-maximizing farm-firm will raise the output level (Q). Note here that due to the duality relationships, $\partial \Pi / \partial Z_B = \partial Q / \partial Z_B$ holds. Therefore, a rise in output price will lead to an increase in the shadow value of land, implying $\partial(\partial \Pi / \partial Z_B) / \partial P > 0$. That is, output price support programs are expected to have positive impacts on the shadow value of land.

Similarly, the impacts of input subsidy programs on the shadow value of land can be investigated by measuring the effects of changes in the prices of variable factor inputs on the shadow value of land as

$$(11) \qquad \frac{\partial(\partial \Pi/\partial Z_B)}{\partial P_i} = \frac{\Pi}{Z_B} \frac{\phi_{iB}}{P_i} - \frac{X_i}{Z_B} \frac{\partial \ell n \Pi}{\partial \ell n Z_B}$$

i = M, I, O.

In this case, the a priori theoretical determination of the sign cannot be made for the following reason.

As shown in Lau (1978, p.148), the impacts of an increase in the i-th variable factor price on the output level is not definite in sign. This implies in turn that, since $\partial \Pi / \partial Z_B = \partial Q / \partial Z_B$, the impacts of this increase in the i-th variable factor price on the shadow value of land, i.e., $\partial(\partial\Pi / \partial Z_B) / \partial P_i$, are not definite in sign. Thus, this is definitely an empirical matter.

The impacts of an acreage allotment program on the shadow value of land can be examined by estimating the effects of a change in the land area (Z_B) on the shadow value of land (P_B^S) as

$$(12) \qquad \frac{\partial(\partial\Pi/\partial Z_B)}{\partial Z_B} = \frac{\Pi}{Z_B^2} \left\{ \delta_{BB} - \frac{\partial \ell n \Pi}{\partial \ell n Z_B} + \left(\frac{\partial \ell n \Pi}{\partial \ell n Z_B}\right)^2 \right\}$$

where the relation $\partial\Pi/\partial Z_B = (\partial \ell n\Pi/\partial \ell n Z_B)(\Pi/Z_B)$ was used to simplify the expression. These impacts are expected to be positive for the following reason.

Since the profit function given in equation (2) is assumed to be continuous, non-decreasing, and concave in the fixed factor inputs, the second-order derivative of the profit function with respect to a fixed factor input becomes negative. This implies that $\partial(\partial\Pi/\partial Z_B)/\partial Z_B < 0$. That is, an increase in land area will decrease the shadow value of land. Interpreting conversely, this implies that the shadow value of land will increase if farmers are forced to reduce the planted area by an acreage allotment program.

Finally the impacts of technological change (advance) on the shadow value of land can be measured by

$$(13) \qquad \frac{\partial(\partial\Pi/\partial Z_B)}{\partial t} = \frac{\Pi}{Z_B} \left\{ \frac{\mu_{Bt}}{t} + \frac{\partial \ell n\Pi}{\partial t} \frac{\partial \ell n\Pi}{\partial \ell n Z_B} \right\}$$

where $\partial \ell n \Pi / \partial t$ may be designated as the rate of profit increase.[4/] The sign of this measure may in general be positive due to the following reason.[5/]

Suppose that a new technology has become available for farmers. To take full advantage of the new technology, the profit-maximizing farm-firm will in general increase output by changing factor proportions of the variable factor inputs, given the prices of output and the variable factor inputs and the quantities of the fixed factor inputs. Since $\partial \Pi / \partial Z_B = \partial Q / \partial Z_B$ due to the duality relationships, technological advance will increase the shadow value of land. This implies that $\partial(\partial \Pi / \partial Z_B)/\partial t > 0$.

The Empirical Application

The system of the four equations composed of the translog profit function (6) and the three variable factor profit share equations in (7) will be jointly fitted to date for four size classes pooled over the 28 years of the 1958-85 period. The parameter estimates of these equations will be used to estimate the shadow values of family labor and land and to derive the estimates of the impacts of various agricultural policy means on the shadow value of land.

Although it is assumed in this study that farms in different size classes have the same profit function and hence the same coefficients, as seen in equations (9) through (13) it is still possible to derive these estimates for the average farms in different size classes as well as for the total average farm. Due to this characteristic of the present model, comparisons of the shadow values of family labor and land can be made among different size classes.

In addition, owing to this characteristic, it is possible to examine whether or not the impacts of agricultural policies such as output price support programs, input subsidies, acreage allotment programs, and technological innovations diffusion programs on the shadow values of farmland are neutral among different size classes.

The Data

The data required to estimate the model are the restricted profit, the price of output, the prices and profit shares of the variable factors of production (machinery, intermediate inputs, and other inputs), and the quantities of the fixed factors of production (family labor and land). The major sources of data are the Survey Report on Farm Household Economy (FHE) and the Survey Report on Prices and Wages in Rural Villages (PWRV) published annually by the Ministry of Agriculture, Forestry, and Fisheries. In each year of the 1958-85 period one average farm was taken from each of the four size classes, 0.5-1.0 (I), 1.0-1.5 (II), 1.5-2.0 (III), and 2.0 hectares or over (IV), from all Japan excluding the Hokkaido district because of the different size classification. Thus, the sample size is 28 (years) x 4 (classes) = 112.

The restricted profit (Π') was obtained by subtracting the variable costs ($\sum_{i=1}^{3} P'_i X_i$, i = M, I, O) from gross revenue (PQ) where primes indicate nominal term expressions. The quantity and price indexes of output (Q and P) were computed by the Tørnqvist approximation method of the Divisia index. For this computation eleven different categories of crop and livestock products were distinguished. The base of all indexes is set at 1958 values taken from class I.

The quantity and nominal price indexes of intermediate inputs (X_I and P'_I) and other inputs (X_O and P'_O) were also constructed by the Tornqvist method. In these computations, the cost of intermediate inputs ($P'_I X_I$) was defined as the sum of the expenditures on fertilizer, feed, agri-chemicals, materials, clothes, and others; and the costs of other inputs ($P'_O X_O$) as the sum of the expenditures on animals, plants, and farm buildings and structures. The necessary data were taken from the FHE. In addition, the price date necessary for computing the Tornqvist indexes were obtained from the PWRV.

The quantity of machinery input (X_M) was defined as the number of machinery hours. The price of machinery input (P'_M) was obtained by dividing the sum of the expenditures on machinery, energy, and rentals ($P'_M X_M$) by the number of hours of machinery usage (X_M).

The quantity of family labor (Z_L) was defined as the total number of male-equivalent labor hours of operators and family workers. The number of male-equivalent labor hours by female workers was estimated by multiplying the number of female labor hours by the ratio of female daily wage rate to male daily wage rate of agricultural temporary-hired labor which can be obtained annually from the PWRV. The quantity of land (Z_B) was defined as the total planted area of paddy and upland fields.

The profit shares (R_M, R_I, and R_O) were obtained by dividing the expenditures, $P'_M X_M$, $P'_I X_I$, and $P'_O X_O$, by the restricted profit (Π').

Finally, the restricted profit (Π') and the prices of the three variable factor inputs (P'_M, P'_I, and P'_O) were normalized by output price (P). These normalized variables are denominated as Π, P_M, P_I, and P_O.

Statistical Method

The statistical estimation is based on assumption of an additive error with zero expectations due to errors in optimization and finite variance for each of the four equations of the system given in (6) and (7). A nonzero covariance of the errors of any two equations is permitted for the same farm. However, the covariances of different farms are assumed to be zero. Given this specification of errors, iterated Zellner's seemingly unrelated regression (IZSUR) method provides asymptotically efficient estimators.[6/] Thus, the system of the four equations composed of the translog profit function (6) and three profit share equations in (7) will be estimated jointly by IZSUR method. Moreover, the efficiency of estimation can be increased by imposing known restrictions on the coefficients in the system. Since profit-maximizing behavior of the farm-firm is maintained in this study, across-equations equality restrictions together with symmetry restrictions are imposed (Christensen, Jorgenson, and Lau).

Empirical Results

The translog profit function (6) and the three profit share equations (7) were estimated first by ordinary least squares method in order to check the goodness of fit. For the translog profit function and the profit share equations for machinery, intermediate inputs, and other inputs, the R^2's adjusted for degrees of freedom were 0.993, 0.862, 0.862, and 0.807 respectively, indicating a fairly good fit for the model.

Next, the system of the translog profit function (6) and the three profit share equations (7) were estimated by imposing the across-equations equality and symmetry restrictions. The result is presented in table 1. The regularity conditions of monotonicity and convexity were satisfied for each observation, indicating that the empirical results based on the parameter estimates will be economically meaningful. Thus, the set of estimates in table 1 is referred to as the final specification of the model and will be used for further analyses.[7/]

Shadow Value of Family Labor

Using the parameter estimates in table 1, the shadow value of family labor (P_L^S) was estimated for each year of the 1958-85 period using equation (9) in order to examine the validity of the Ricardian residual returns method for estimating the land value. The estimation was carried out for the average farms in the four different size classes as well as for the total average farm of these four size classes.[8/] The estimates for selected years are presented in table 2.

Furthermore, in order to compare the shadow value of family labor with market wage rates, the following market wage rates were obtained from the FHE for each size class. First, the wage rate of agricultural temporary-hired labor (W_A) was obtained by dividing the wage bill for temporary-hired labor by the number of male-equivalent labor hours of temporary-hired labor. In addition, three categories of nonagricultural employment can be distinguished in the FHE: temporary-hired wage labor, permanent wage labor, and permanent clerical labor. The wage rate for each category was estimated by dividing the wage bill by the corresponding male-equivalent labor hours. In this computation, the equivalence ratio used for converting female labor to male-equivalent labor was assumed to be 0.5 judging from the observation that the ratio of female to male wage rates in nonagricultural firms with more than 30 employees was almost consistently around 0.5 for the 1958-85 period.[9/] The three nonagricultural wage rates so obtained are designated as W_{N1}, W_{N2}, and W_{N3}. All of these agricultural and nonagricultural wage rates are expressed in yen per hour. The shadow value of family labor (P_L^S) and the four market wage rates (W_A, W_{N1}, W_{N2}, and W_{N3}) for the average farms of the four size classes and the total average farm are given diagrammatically in figures 1-1 through 1-5.

Table 2 shows that, as the farm size increases, the shadow value of family labor also increases. In particular, the shadow value of family labor of the average farm in the largest size class (2.0 hectares or larger) has been consistently more than 1.5 times greater than that in the smallest size class (0.5-1.0 hectares). This finding supports the results obtained by Egaitsu and Shigeno (1983, 1984) who found similar discrepancies in the shadow values of labor among different size classes in not only rice but also livestock production for the 1951-79 period. These results imply that larger-scale farms have achieved higher marginal productivities of family labor than smaller-scale farms. Or equivalently, these results imply that larger-scale farms have been assessing their family labor at higher values than have been smaller-scale farms.

Then, at what levels have farms been evaluating their family labor within each size class? A rough idea may be obtained by observing figures 1-1 through 1-4.

In size class I (figure 1-1), the shadow value of family labor (P_L^S) was clearly smaller than all of the three nonagricultural market wage rates

(W_{N1}, W_{N2}, and W_{N3}) for the whole 1958-85 period. However, it appears to have been almost equal to the wage rate of agricultural temporary-hired labor (W_A) until around 1976 but became smaller than W_A after that.[10/] Similarly, P_L^s in size class II was consistently smaller than W_{N1}, W_{N2}, and W_{N3} (figure 1-2). However, it also appears to have been almost equal to W_A until the late 1970s but became slightly smaller than W_A in the 1980s. Roughly speaking, these findings indicate that the price of family labor in these size classes may be approximated to the wage rate of agricultural temporary-hired labor, especially so until the late-1970s.

On the other hand, P_L^s in size class III was greater than W_A for the whole 1958-85 period (figure 1-3). Although it was clearly smaller than the wage rates of nonagricultural permanent wage and clerical labor (W_{N2} and W_{N3} , respectively), it was almost equal to and moved parallel with the wage rate of nonagricultural temporary-hired wage labor (W_{N1}) before 1980. In size class IV, P_L^s was greater than W_A and W_{N1} but smaller than W_{N3} (figure 1-4). However, it appears to have been almost equal to and moved parallel with W_{N2}. Judging from these observations, evaluations of family labor in these size classes must be made by the nonagricultural wage rates of either temporary-hired wage labor (for class III) or permanent wage labor (for class IV).

These findings obtained from table 2 and figures 1-1 through 1-4 strongly suggest that a uniform evaluation of family labor in different size classes at a certain market wage rate, agricultural or nonagricultural, may cause biases in the estimation of returns to land for different size classes. If, for example, the wage rate of nonagricultural permanent wage labor (W_{N2}) is used to evaluate family labor uniformly for different size classes in the estimation of residual returns to land by the

Ricardian method, the residual returns to land in smaller size classes will be under-estimated and hence the land values capitalized by an appropriate discount rate will also be under-estimated in these size classes.

On the other hand, if the same assumption was made in this study, i.e., if the farm-firm is assumed to be in static equilibrium with respect also to family labor whose price is assumed to be equal to W_{N2}, the shadow values of land in smaller size classes would turn out to be underestimated.

Note however that P_L^S of the total average farm appears to have been almost equal to and moved almost together with W_A for the whole 1958-85 period (figure 1-5). This must be due to the large shares of the numbers of farm households in smaller size classes in the total number of farm households. This result suggests that, in an aggregate analysis treating agriculture as a sector, for example, the price of family labor may be imputed by the wage rate of agricultural temporary-hired labor.

Shadow Value of Farmland

Using equation (9), the shadow values of land per 10 ares (P_B^S) were estimated for the average farms of the four size classes as well as for the total average farm for each year of the 1958-85 period. These values are expressed in nominal terms. The estimates for selected years are reported in table 3. At least two important findings emerge from this table.

First, the shadow value of land in the smallest size class (I) were smaller than those in larger size classes for the whole 1958-85 period. A more careful observation indicates that P_B^S in classes II, III, and IV were fairly comparable with each other until the mid-1970s. Indeed, P_B^S's in classes II and III appear to have been even slightly larger than the corresponding value in class IV for the 1958-75 period. After the mid-1970s, however, P_B^S in class IV became slightly larger than those in classes II and III.

Second, the shadow values of land grew very fast until the mid-1970s in all size classes. After that, however, they declined or became stagnant in classes I and II. However, though slowly, they grew in classes III and IV.

For the purpose of comparison, the estimates of the shadow values of farmland by Egaitsu and Shigeno (1983) were added for the corresponding years in table 3. Since their analysis was made for rice production for the 1951-79 period, their estimates can be regarded as the shadow values of paddy field. On the other hand, the land variable in this study is defined as the sum of paddy and upland fields. This indicates that the shadow values of land estimated in this study may be regarded as weighted average values of paddy and upland fields.

The estimates in this study to be compared with those by Egaitsu and Shigeno (1983) should be those for the total average farm, since their estimates are also for the total average farm of different size classes for all Japan excluding the Hokkaido district. A rough observation of the two series of estimates indicates that, although the methodologies and data used in the two studies are different,[11/] the estimates of the shadow values of land in both studies are fairly comparable with each other.

Next, let us compare the shadow values of land with the market price. For this purpose, the following standard procedure is employed. That is, the land values are first computed by capitalizing the shadow values by an appropriate discount rate and are then compared with market land price.[12/] This method is considered most convenient based on the assumption that if a farmer sold a piece of his farmland, he would deposit that amount of money in a bank. In Japan, bank interest rates on fixed deposits were consistently around 6 % for the period under question. Using this 6 % interest rate as a discount rate, the shadow values of land reported in table 3 were capitalized. The estimates are presented in table 4.

In addition, a market land price is reported in table 4. This is an weighted average of the national average prices of medium-quality paddy and upland fields used for farming purposes. This market price may be considered most appropriate since, as mentioned earlier, the shadow values of land estimated in this study can be regarded as weighted average values of paddy and upland fields used for farming purposes.

As was expected from the observation in table 3, the capitalized land values in size classes II, III, and IV were larger than those in the smallest size class I. However, the capitalized values in all size classes were much larger than the market farmland price before the mid-1970s. In size classes III and IV, in particular, this tendency continued after the mid-1970s also, although the discrepancies became very small in the 1980s.

This implies that, before the mid-1970s, utilization of land for farming purposes was more profitable than receiving interest earnings from making a bank deposit of the sale of land. Indeed, the relatively large capitalized land values even in the smallest size classes may be considered to have been an important factor which has limited land movements from small to large farms by selling and buying in spite of government's strong efforts for encouraging land movements by, for example, relaxing institutional restrictions.

However, the capitalized farmland values in size classes I and II turned out to be smaller than the market price after the mid-1970s and in the 1980s, respectively. This indicates that farming has not been a paying business for farmers in these size classes after the mid-1970s or in the 1980s. In other words, farmers in these size classes would have been better off if they had sold their lands and earned interests from making bank deposits of the sales of lands after the mid-1970s or in the 1980s.

This suggests that an important economic condition for land movements from smaller- to larger-scale farms has theoretically been ready after the mid-1970s or in the 1980s. This condition may further be reinforced by the earlier findings that the shadow values (marginal productivities) of family labor and land in larger-scale farms have been greater than those in smaller-scale farms, especially after the mid-1970s in the case of land, indicating that larger-scale farms are more "efficient" in the utilizations of both labor and land in farming.

However, in reality, land movements by selling and buying have been limited after the mid-1970s also, despite government's continuous efforts for promoting land movements. One of the most important reasons for this limited land movements by selling and buying may be that farmers have a strong preference to possess their lands as profitable assets. It is considered that farmers expect that they could sell their lands at much higher prices for either industrial utilizations such as building plants, highways, and railroads or residential purposes than for purely farming purposes.

Then, what about the possibilities of land movements by renting from smaller- to larger-scale farms? What economic conditions should at least be satisfied in order for smaller-scale farms to rent out their land to larger-scale farms? To simplify the following discussions, classes I (0.5-1.0 hectares) and IV (2.0 hectares or larger) are regarded as small- and large-scale farms, respectively. Since more than 70 % of farms are stratified into size classes with less than 1.0 hectares in Japanese agriculture, this investigation will have an important implication for the possibility of achieving more efficient, larger-scale farming.

Following Kako (1984), this study proposes the following two economic norms for small-scale farms to make a decision of renting out their lands to large-scale farms.13/

(14) $(P_B^s)^{IV} / (P_B^s)^I > 1$ ....Norm 1

(15) $(P_B^s)^{IV} / (\Pi)^I > 1$ ....Norm 2

where restricted profits (Π) are composed of incomes accruing to family labor, land, and entrepreneurship.14/

The first norm implies that if the rent paid by the large farm is greater than that requested by the small farm, then, the small farm will rent out its land to the large farm. This norm may be valid for small farms which can find better-paid off-farm jobs even if they give up farming.

The second norm implies that unless the rent paid by the large farm at least covers the foregone income accruing to labor and land of the small farm, the small farm will not rent out its land to the large farm. This in turn implies such a situation where the income level of the small farm will not decrease even if it rents out its land and converts the amount of labor time having been used for farming to non-labor activities. Thus, this norm may be valid for small farms which do not have well-paid off-farm job opportunities or have intentions of giving up farming.

Using equations (14) and (15), the two indicators for the two norms were estimated for the whole 1958-85 period. The estimates for selected years are reported in table 5. The following points are noteworthy.

First, it was found that the first indicator (for Norm I) was consistently slightly greater than unity until the mid-1970s. This implies that the first norm was barely valid for small farms with off-farm job opportunities for the period before 1975. Or, it may be said that small farms which even had access to off-farm jobs found their farming fairly profitable and comparable with large farms for this period. This in turn implies that the possibilities of land rentings from small to large farms were fairly small for this period.

On the other hand, the second indicator (for Norm II) was found to be considerably smaller than unity and it even had an over-time decreasing trend until the mid-1970s. This implies that small farms which found it difficult to obtain off-farm jobs or wanted to retire from farming would not have wanted to rent out their lands to large farms, since the latter farms were not able to offer enough rent covering both foregone labor income and land rent required by small farms.

These findings may have been a major cause for the slow land movements by rentings for the period before the mid-1970s (only about 6 to 7 % of the total area of paddy fields was rented in the 1970s), in spite of the fact that off-farm job opportunities were abundant for that period.

Next, situations seem to have changed after the mid-1970s. The estimates for the first norm turned out to be around 1.5 which were much larger than those in the previous years. This implies that if there exist abundant off-farm job opportunities, small farms would rent out their lands to large farms. On the other hand, the estimates for the second norm were still considerably less than unity, although they seem to have an over-time increasing trend after the mid-1970s. These results may indicate that economic conditions have been ready after the mid-1970s for small farms with off-farm job opportunities to rent out their lands to large farms, whereas small farms without off-farm job opportunities would have still been worse-off if they had rented out their lands to large farms.

In reality, however, it has become much more difficult for farmers to get off-farm jobs after the mid-1970s than before mainly because the Japanese economy has entered upon a stage of low or steady growth especially after the "oil crisis" occurred in 1973. Under such an economic situation, the second norm may be considered more appropriate to examine the possibilities of land movements by rentings from small to large farms. It may thus be said that small farms have been reluctant to rent out their lands to large farms due to the shortage of off-farm job opportunities after the mid-1970s, although they have not been as "efficient" as large farms in the utilization of lands as well as family labor. This in turn may have been a major reason why land renting have still been unpopular in recent years as compared with the previous years.

Presented thus far have been the economic factors which may explain why land movements by either selling and buying or rentings have been limited in postwar Japanese agriculture. What measures could then be conceived in order to promote land movements by either selling and buying or renting? Investigations in the next section will give a hint to this question.

Impacts of Policy Instruments on the Shadow Value of Farmland

Using equations (10), (11), (12), and (13), the impacts of changes in output price (P), input prices (P_M, P_I, P_0), and land area (Z_B) and of technological change (t) on the shadow values of land (P_B^S) were estimated for the average farm of each size class and the total average farm for each year of the 1958-85 period. Only the averages of these estimates for this period are presented in table 6.

In these estimations, all variables other than the time variable were expressed in index terms with the base being set at 1958 values. Thus, an estimate in the first five columns in table 6 should be interpreted as follows: e.g., a one point increase in the output price index (say, 100 to 101) will increase the index of the shadow value of land by 0.79 point on the average in size class I (i.e., 100 to 100.79). As for the effect of technological change, the estimate 0.0135 in class I, for example, should be interpreted as 1.35 % increase per year in the index of the shadow value of land since time variable is expressed as an integer with 1958 being one. Several important findings emerge from table 6.

First, as was expected theoretically in equation (10), the impacts of changes in output price turned out to be positive for all size classes. Moreover, the magnitudes of the impacts were found to be close to unity . This implies that an increase in output price will almost proportionally increase the shadow values of land. This in turn implies that output price support programs in postwar Japanese agriculture have played an important role in raising the shadow values and hence the capitalized values of farmland for all farms in different size classes.

However, it appears that the magnitudes of the impacts are not neutral among different size classes; they increase as the farm size gets larger. Or, it may at least be said that the magnitude of the impacts in class I (0.79) is smaller than those in classes II, III, and IV (0.95, 0.99, and 1.01, respectively). This indicates that, although price support programs in postwar Japanese agriculture have been practiced uniformly for farms with different sizes of land, larger-scale farms have taken more advantages of those programs in raising the shadow values of land. This in turn suggests that if an appropriate output price support program is employed where larger-scale, specialized farmers receive advantageous treatments over smaller-scale part-time farmers, then the discrepancies in the land shadow values between small and large farms will become larger than those corresponding to uniform price support programs and hence the possibilities of land movements by renting will be higher.

Second, the impacts of changes in the prices of all of the variable factor inputs turned out to be negative for all size classes, indicating that increases in the prices of these variable factor inputs will decrease the shadow values of land. Or, conversely, decreases in these prices will increase the land shadow values. In particular, that the absolute values of the impacts with respect to the prices of machinery and intermediate inputs are larger than unity indicates that decreases in the prices of these factor inputs will more than proportionally increase the shadow values of land. These results suggest that input subsidy programs have had strong effects in raising the shadow values of land in postwar Japanese agriculture.

Furthermore, as in the case of the impacts of output price changes, the impacts of changes in the prices especially of machinery and intermediate inputs in size classes II, III, and IV appear to be greater than those in the smallest size class I, while the impacts with respect to the price of other inputs appear to be almost scale neutral. This suggest that if an appropriate input subsidy program especially with regard to machinery and intermediate inputs which has effects of reducing the prices of these inputs is introduced advantageously for large farms, the shadow values of land in large farms will increase to a larger extent than those in small farms. This in turn will help promote land movements from small- to large-scale farms.

These findings based on the measures of the impacts of changes in output and input prices give empirical supports to the assertion by Egaitsu (1987), Hayami, and many others in that output price support programs and input subsidies which are practiced uniformly for small and large farms must be abandoned in order to develop more productive agriculture in Japan.

Note here that the degrees of impacts of decreases in the prices of machinery and intermediate inputs on the shadow values of land turned out to be greater than those of an increase in output price. This suggests that policies which have effects in reducing the prices of machinery and intermediate inputs are more effective than direct output price support programs in order to promote land movements from small- to large-scale farms.[15/]

Third, as was expected in equation (12), the impacts of an increase in land area were found to be negative for all size classes. Conversely, this implies that acreage restriction programs have an effect of increasing the shadow values of land. This result is consistent with the theoretical reasoning by Bullock, Nieuwoudt, and Pasour and empirical evidence obtained by themselves and Hasebe for U.S. and Japanese agriculture, respectively, in that application of an acreage restriction program has an effect of yielding "allotment rent", the concept similar to "quasi-rent" in Marshallian terminology, which may be regarded as an extra rent to be added to usual land rent.

However, it was found that the degrees of impacts of an average restriction program on the shadow values of land are different among different size classes; it appears that smaller-scale farms received more fruits in raising the land shadow values than larger-scale farms did. This suggests that acreage restriction programs practiced in Japan after 1969 uniformly for all rice-producing farms have contributed to raising the land shadow values of small-scale farms relatively greater than those of larger-scale farms. This seems to have had an effect of restricting land movements from smaller- to larger-scale farms.

Finally, the impacts of technological change on the shadow values of land were found to be positive for all size classes, indicating that the theoretical reasoning was valid. As having been clearly described by Christ, technological change, in general, will increase the shadow values of land under such a situation where output price is supported at a certain level, since, by taking full advantage of the new technology, the farm-firm can reduce production costs, increase output, and hence enjoy higher profits. The estimates of the impacts of technological advance on the shadow values of land in this study may be said to reflect exactly such a situation, considering the fact that the prices of more than 80 % of products have been supported in one way or another in postwar Japanese agriculture.

However, the impacts were found to be non-neutral among different size classes; technological change in smaller-scale farms had stronger impacts on the land shadow values than in larger-scale farms. In particular, the impacts in size class IV were found to be almost nil. This result is consistent with the finding by Kuroda (1988b) where the contribution of the technological change effect to the growth of labor productivity in smaller-scale farms was greater than that in larger-scale farms during the 1958-85 period.

A major reason for this may be that larger-scale farms might have reached or have been close to the frontier of the existing technologies, while smaller-scale farms have been catching up with larger-scale farms. Thus, in order to reverse this result or at least to level off the impacts of technological change on the shadow values of land among different size classes, economic conditions which encourage larger-scale farms to introduce new innovative technologies for higher-productive farming must be set in order.

Concluding Comments

This study has estimated the shadow values of land together with family labor for farms in different size classes in Japanese agriculture for the 1958-85 period using the framework of the traslog normalized profit function. Several important findings may be summarized as follows.

(1) The shadow values of family labor in larger-scale farms were found to be greater than those in smaller-scale farms. This indicates that imputations of the prices of family labor in different size classes uniformly by the wage rate of either agricultural or nonagricultural employment will cause biases in the shadow values of land estimated by either the Ricardian residual returns method or the shadow value method.

(2) The estimated shadow values of land in small farms were found to be fairly large compared with those in large farms. As a result, the capitalized land values in small farms turned out to be also fairly large compared with those in large farms and the market farmland price. These results may be considered to have been an important factor which restricted land movements in Japanese agriculture from small to large farms either by selling and buying or by renting during the last two decades.

(3) It was found that policy instruments such as output price support, input subsidy, and acreage allotment programs have significant impacts on raising the shadow values of land. Furthermore, these impacts were not scale neutral. In particular, the impacts of output price support and input subsidy programs especially for machinery and intermediate inputs in large farms were greater than those in small farms. This indicates that if a discriminatory instead of uniform price support and input subsidy programs, which are more advantageous for large, specialized farms than for small, part-time farms, are introduced, the discrepancies of the shadow values of land between small and large farms will become greater, which will help promote land movements.

A caveat needs to be mentioned at this point. This study has used aggregate farm data where all kinds of crop and livestock products were aggregated to a single composite output. Thus, the discussion of the possibilities of land movements had to be a little vague, since the estimated shadow values of land are regarded as weighted averages of paddy and upland fields which are influenced by changes in the composition of products. In reality, it has generally been agreed in recent years that a most urgent issue in Japanese agriculture is to raise the productivity of rice production by larger-scale, more efficient farming. For such a situation, therefore, application of the framework employed in this study specifically to rice production is strongly recommended.

Figure 1. Shadow Value of Family Labor and Market Wage Rates

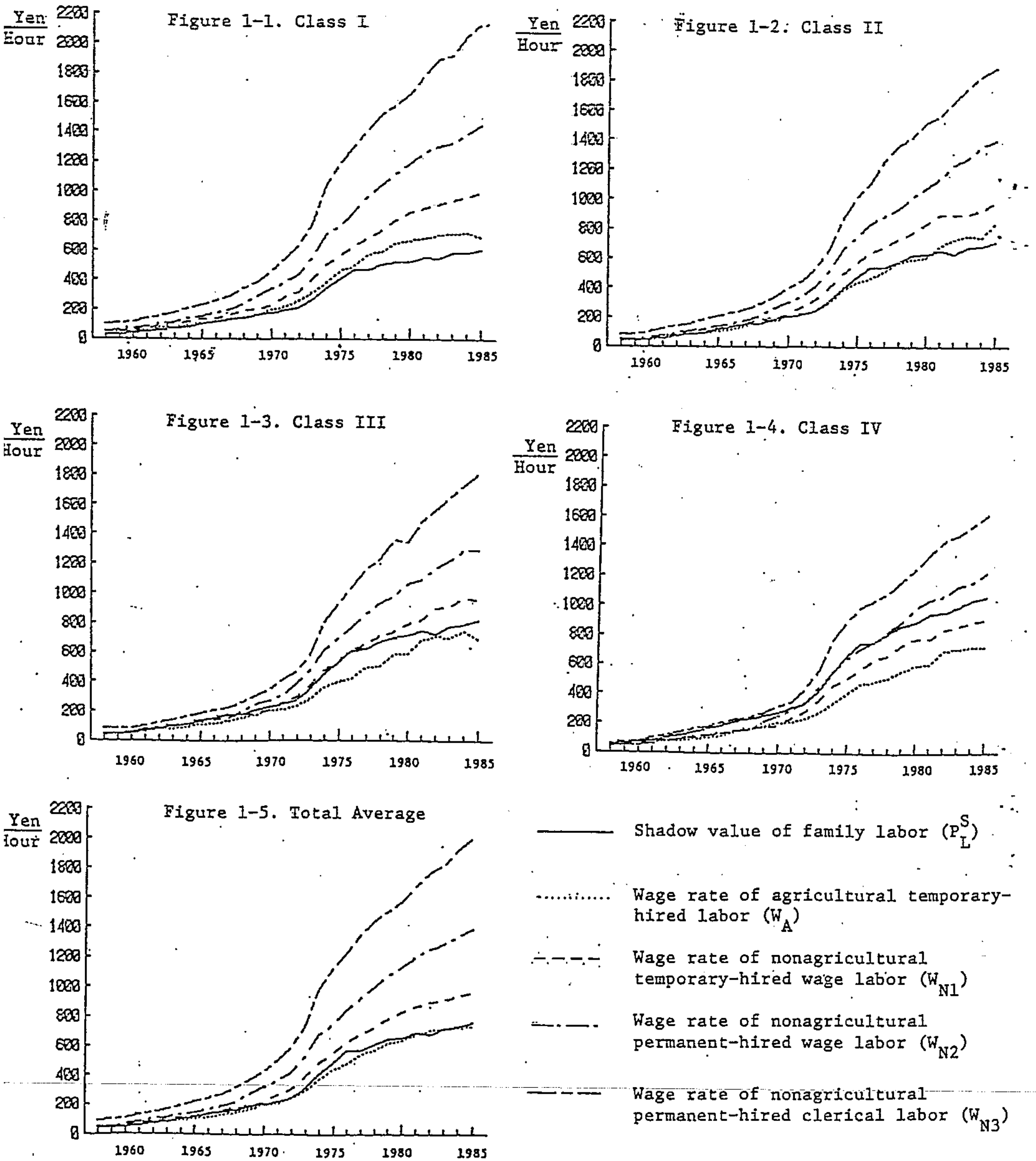

Table 1. Parameter Estimates of the Translog Restricted

Profit Function (1958-85)

α	5.201*	δ_{BB}	0.002
α_M	-0.152*	δ_{LB}	0.114
α_I	-0.244*	ϕ_{ML}	0.078**
α_O	-0.113*	ϕ_{MB}	0.018
β_L	0.672*	ϕ_{IL}	0.181*
β_B	0.753*	ϕ_{IB}	-0.018
β_t	-0.093**	ϕ_{OL}	0.041
γ_{MM}	-0.216*	ϕ_{OB}	0.015
γ_{II}	-0.295*	ε_{Mt}	-0.047*
γ_{OO}	-0.024**	ε_{It}	-0.097*
γ_{MI}	-0.093*	ε_{Ot}	-0.018*
γ_{MO}	-0.065*	μ_{Lt}	0.073
γ_{IO}	-0.042*	μ_{Bt}	-0.050
δ_{LL}	-0.180	β_{tt}	0.199*

Note: * and ** indicate that the coefficients are statistically significant at the 5 and 10 % levels, respectively.

Table 2. Shadow Values of Family Labor in Current Prices, P_L^S, Selected Years for 1958-85 (Unit: yen/hour)

	Class I	Class II	Class III	Class IV	Average
1958	32	38	45	58	39
1960	40	47	55	69	48
1965	101	115	133	164	118
1970	182	207	234	277	212
1975	414	472	530	661	492
1980	531	637	720	900	659
1985	612	714	820	1,064	767

Note: Equation (9) was used for the estimation.

Table 3. Shadow Values of Land in Current Prices, P_B^s, Selected Years for 1958-85

(Unit: 1,000 yen/10 ares)

	Class I	Class II	Class III	Class IV	Average	Estimates of Egaitsu & Shigeno
1958	18	19	20	20	19	13
1960	18	19	19	19	18	14
1965	25	29	30	28	27	20
1970	35	44	43	39	39	30
1975	63	76	75	67	68	71
1980	54	75	80	80	67	80[a]
1985	56	72	83	85	69	N.A.[b]

Notes: Equation (9) was used for the estimation.

a Figure for 1979.

b Not available.

Table 4. Capitalized Values and Market Price of Farmland in Current Prices, Selected Years for 1958-85

(unit: 1,000 yen/10 ares)

	Class I	Class II	Class III	Class IV	Average	Market land price
1958	302	323	333	333	314	131
1960	299	323	317	313	308	150
1965	424	483	494	462	451	166
1970	587	737	720	650	652	375
1975	1,054	1,267	1,242	1,120	1,134	799
1980	895	1,253	1,336	1,336	1,109	1,106
1985	940	1,198	1,385	1,419	1,142	1,395

Note: The shadow values given in table 4 were capitalized by a 6 % discount rate. The market land price is an weighted average of medium-quality paddy and upland fields sold for farming purposes. The source of data is the Survey Report on Prices of Sales and Purchases of Paddy and Upland Fields published annually by the National Council of Agriculture in Japan.

Table 5. Land Movement Possibilities

	$\frac{(P_B^s)^{IV}}{(P_B^s)^I}$	$\frac{(P_B^s)^{IV}}{(\Pi)^I}$
1958	1.10	0.82
1960	1.05	0.71
1965	1.09	0.66
1970	1.11	0.71
1975	1.06	0.51
1980	1.49	0.79
1985	1.51	0.82

Note: For the estimation of $(P_B^s)^{IV}/(P_B^s)^I$, the estimates in table 4 were used. As for restricted profits (Π) in size class I, the fitted values were used.

Table 6. Impacts of Exogenous Variables on the Shadow Value of Land, Averages for the 1958–85 Period

		Input Price				
	Output price (P)	Machinery (P_M)	Intermediate inputs (P_I)	Other inputs (P_O)	Land area (Z_B)	Technological change (t)
Class I	0.79 (0.06)	-1.33 (0.23)	-1.89 (0.54)	-0.75 (0.05)	-0.139 (0.054)	0.0135 (0.004)
Class II	0.95 (0.09)	-1.51 (0.29)	-2.10 (0.71)	-0.77 (0.08)	-0.078 (0.042)	0.0065 (0.0020)
Class III	0.99 (0.10)	-1.48 (0.28)	-2.12 (0.76)	-0.73 (0.10)	-0.049 (0.032)	0.0030 (0.0019)
Class IV	1.01 (0.11)	-1.43 (0.21)	-2.19 (0.70)	-0.69 (0.12)	-0.027 (0.014)	0.0002 (0.0003)
Average	0.87 (0.06)	-1.39 (0.23)	-1.99 (0.64)	-0.74 (0.06)	-0.077 (0.037)	0.0068 (0.0022)

Note: Equations (10), (11), (12), and (13) were used for the estimations.

Figures in parentheses are standard errors.

Footnotes

1/ "Farmland " and "land" are used interchangeably in this study.

2/ "Family labor" includes operator labor in this study.

3/ Note that these and the following impacts with respect to $P_i (i = M, I, O)$, Z_B, and t are all measured in real terms.

4/ This rate may be interpreted as a dual rate of technological progress. A similar concept in the translog cost function framework, $\partial \ell nC/\partial t$, is usually designated as the rate of cost diminution (e.g., Berndt and Wood).

5/ The reasoning will naturally be different for a longer run analysis of the effects of technological advance on farmland prices in a macroeconomic framework where output and input prices are all variable and no quasi-fixed factor inputs are assumed to exist (e.g., Chryst; Herdt and Cochrane; Smit and Veerman).

6/ Since all the regressors in the system are exogenous, the Zellner technique instead of three-stage least squares may be appropriate. However, Zellner's method is sensitive to which equation is excluded from the system. To avoid this problem the IZSUR procedure must be used (Oberhofer and Kmenta). Since this study excludes the output supply equation (or revenue share equation) from the original system the IZSUR method is considered most appropriate.

7/ Based on the parameter estimates, output supply and variable factor demand elasticities were computed using the formulas derived in Sidhu and Baanante for which some minor errors were corrected. The results were in principle economically meaningful. Since a detailed discussion is provided in Kuroda (1988 a), a repetition is avoided in order to save space.

8/ The estimates for the total average farm were obtained by substituting into equation (9) the weighted average values of Π, P_i (i = M, I, O), and Z_j (j = L, B) with the weights being the shares of the numbers of farm households of the four size classes in the total number of farm households of these four size classes. The same procedure was applied to the estimations of the following indicators for the total average farm.

9/ Egaitsu (1985, Table 4-2. p.53) used 0.8 as the equivalence ratio to convert female labor hours to male-equivalent labor hours to obtain not only agricultural but also nonagricultural wage rates, leading to an under-estimation of nonagricultural wage rates compared with those in this study.

10/ Ishida also pointed out that part-time small farms evaluate their own family labor lower than the wage rate of agricultural temporary-hired labor.

11/ A most important methodological difference is the following. Egaitsu and Shigeno (1983) estimated a peculiar Cobb-Douglas type production function with no a priori behavioral assumption. Then, they estimated the shadow values of land based on the equilibrium conditions. In this stage, they imputed family labor by the wage rate of agricultural temporary-hired labor for all different size classes. As clarified earlier, this study did not follow such procedures.

12/ Another procedure is to compute the rates of returns to land by dividing the shadow values of land by an appropriate market land price and then to compare there rates with appropriate market interest rates. Both procedures have a similar weakness since the choice of an appropriate discount rate or market land price has to be made arbitrarily.

13/ Here, small farms are assumed to carry out farming by family labor, capital, and land by their own.

14/ Shintani also used a very similar procedure

15/ In a different context, Barker and Hayami have documented an interesting finding which demonstrates a possibility that a subsidy applied to modern inputs such as fertilizer can be more beneficial than supporting product prices in order to attain self-sufficiency in food grains in many less developed countries.

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