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An Empirical Analysis of the Agricultural Labor Market in Postwar Japan

by

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1. Introduction

The growth of the Japanese economy during the postwar years has accompanied a sizable transfer of labor from agriculture to the nonagricultural sectors. According to Table 1, the total number of agricultural gainful workers declined from 13.3 millions in 1958 to 5.1 millions in 1980. The average annual rate of decrease was 4.7 percent. Looking separately at the numbers of male and female agricultural gainful workers, very similar movements can be observed between them. That is, the numbers of decrease in male and female agricultural gainful workers during the 1958-1980 period were 4.0 and 4.2 millions, respectively, implying that the annual rates of decrease were 4.6 and 4.7 percent, respectively, for this period.

These workers who gave up farmings moved to the nonagricultural sectors whose total number of employment increased from 28.5 millions in 1958 to 50 millions in 1980. The accumulated number of the outmigration, which can easily be estimated from Table 1, was 8.2 million workers for the period 1958-1980. This accounted for almost 39 percent of the increase in the nonagricultural employment which was 21.5 million workers for the same period. Application of the same calculation separately to male and female workers shows that the numbers of the outmigration of male and female agricultural workers accounted for 31 and 49 percent, respectively, of the increases in the male and female nonagricultural employment.[1)] Thus, agriculture has in this manner contributed to the growth of the nonagricultural sectors during the postwar years.

Table 1

Numbers of Agricultural and Nonagricultural Gainful Workers (1958-1980)

(1,000 persons)

	Agriculture (1)			Nonagriculture[1] (2)			Total[2] (3)=(1)+(2)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1958	6,460	6,830	13,290	18,440	10,090	28,540	24,900	16,920	41,820
1960	6,060	6,550	12,610	19,890	10,780	30,670	25,950	17,330	43,280
1965	4,430	5,370	9,800	23,590	13,250	36,840	28,020	18,620	46,640
1970	3,790	4,320	8,110	26,900	15,610	42,510	30,690	19,930	50,620
1975	2,760	3,130	5,890	29,750	16,300	46,050	32,510	19,430	51,940
1980	2,420	2,640	5,060	31,340	18,700	50,040	33,760	21,340	55,100
Annual Growth Rate[3] (%) 1958-'60	-3.2	-2.1	-2.6	3.8	3.3	3.6	2.1	1.2	1.7
1960-'65	-7.1	-4.2	-5.5	3.5	4.2	3.7	1.4	1.4	1.4
1965-'70	-2.7	-4.3	-3.5	2.6	3.1	2.8	1.9	1.3	1.6
1970-'75	-6.5	-6.4	-6.5	2.1	1.1	1.7	1.2	-0.3	0.7
1975-'80	-2.3	-2.9	-2.6	1.0	2.8	1.7	0.7	2.0	1.2
1958-'80	-4.6	-4.7	-4.7	2.4	2.8	2.5	1.4	0.9	1.2

Table 1 (continued)

Notes: 1) and 2) Excludes the numbers of gainful workers of forestry and fisheries.

3) For the estimation of growth rates, the following method was used.

$\ln y = a_0 + a_1 t$, where y is the number of gainful workers, t is time, and a_0 and a_1 are parameters to be estimated.

Source: Bureau of Statistics, Prime Minister's Office

Yearbook of Labor Statistics, various editions, Tokyo.

The objective of this study is to quantitatively describe the forces which have generated this sizable migration flow out of agriculture to the nonagricultural sectors during the postwar years. For this purpose, the structural demand and supply equations for the agricultural labor market are developed and estimated for the period 1958-1980. This is carried out separately for male and female workers and then a statistical test is applied in order to examine whether or not there exist differences in the structural demand and supply ralations between male and female agricultural employment.[2)]

Furthermore, based on the estimated elasticities of the demand and supply equations as well as the derived reduced-form elasticities, policy implications are discussed especially on the industrial adjustment of Japanese agriculture for the future.

The present study is constructed as follows. The structural demand and supply relations of the agricultural labor market are developed in section two. Section three discusses the specifications and the data sources of the variables used for the structural equations. The empirical results are interpreted in section four. Finally, section five discusses the policy implications on the basis of the empirical results.

2. The Model and Statistical Method

The model of the present study consists of structural demand and supply equations of agricultural employment. The structural model is developed separately for male and female agricultural employment in

order to investigate differences in the behavior of agricultural employment between the two categories of labor. However, the forms of the demand and supply equations are assumed to be identical between male and female employment.[3)]

The demand for agricultural labor is assumed to be a function of the money price of agricultural labor, the price level of farm products, and the price of farm machinery. On the other hand, the supply of agricultural labor is assumed to be a function of the money price of agricultural labor, alternative wage rates, the general price level of consumer goods, and job opportunities in the nonagricultural sectors.

These structural demand and supply equations may formally be written as follows.

Demand for labor:

(1) $L_i = f(W_{Ai}, P_A, P_M)$

Supply of labor:

(2) $L_i = g(W_{Ai}, W_{Ni}, P, U_i)$

where

L_i = the average level of annual farm employment, that is, the total number of agricultural gainful workers including operators, family workers, and hired workers;

W_{Ai} = the agricultural money wage rates in yen per day for casual hired labor;

W_{Ni} = the nonagricultural money wage rates in yen per day for an average employee in a firm with five or more employees;

P_A = the index of prices recieved by farmers;

P_M = the index of prices of farm machinery inputs;

P = the consumer price index;

U_i = unemployment rate; and

i = M, F for male and female labor.

The quantity and price of labor (L_i and W_{Ai}) are treated as endogenous and all other variables are assumed to be exogenous.

It should be noted at this point that in developing the structural demand and supply relations of the agricultural labor market as above, it is assumed that there exists a competitive labor market in the agricultural sector. This assumption has the following theoretical implication.

In reality, the postwar Japanese agriculture is composed mainly of family farms. This means that the farm household acts as the demander for own labor for agricultural production on one hand, and at the same time as the supplier of own labor for agricultural production on the other hand. However, this separation of the farm household as a producer and at the same time as a consumer cannot be made without an assumption of the existence of a competitive labor market in agriculture (Sasaki and Maruyama, 1966 and Jorgenson and Lau, 1969). With this assumption, one may derive a market labor demand function as well as a market labor supply function which are considered to be aggregates of the labor demand and supply functions of individual farm households.

Now for the statistical estimation, both the demand and the supply equations are assumed to be loglinear in the observed variables. This implies that the coefficient of each variable gives directly the

elasticity with respect to that variable.

In addition, a linear trend variable is introduced in both the demand and the supply equations. It is expected that the trend variable picks up the effects of omitted variables that are highly correlated with time. On the demand side, it may pick up the effects of such factors as the changing quality of the labor force, improvements in production technologies, and institutional changes. On the supply side, it may pick up the effects of changes in tastes and preferences for employment in specific industries, increased level of schooling, improvements in communication and transportation, and institutional changes.

The stochastic demand and supply equations are thus written as:

$$(3) \qquad D: \quad \ln L = a_0 + a_1 \ln W_A + a_2 \ln P_A + a_3 \ln P_M + a_4 T + v_1$$

$$(4) \qquad S: \quad \ln L = b_0 + b_1 \ln W_A + b_2 \ln W_N + b_3 \ln P + b_4 \ln U + b_5 T + v_2$$

where T is the trend variable, a_j's (j=0,...,4) and b_j's (j=0,...,5) are the parameters to be estimated, v_1 and v_2 are the disturbance terms. Note that subscript i (=M, F) for male and female employment is dropped from these and the following equations in order to avoid complexity of notations and possible misunderstanding of the structural relations.

It is assumed for each disturbance term an additive error with zero expectation and non-zero finite variance. However, since the dependent variables of the two equations are assumed to be mutually interdependent, the covariances of the two disturbance terms are assumed to be non-zero.

Thus far, it has been assumed that both the demand for and the supply of labor are adjusted perfectly within a specific period of time, in the present case within one year, in accordance with changes in the explanatory variables. In this sense, the system of the demand and supply equations is static.

However, this assumption may not be relevant in the actual world. Farmers may take more than one year to fully adjust the demand for and the supply of labor to changes in, say, the agricultural wage rates. The following Nerlovian type adjustment functions are thus postulated for both the demand for and the supply of labor.

$$(5) \qquad D: \ln L_t - \ln L_{t-1} = \gamma_1(\ln L_t^* - \ln L_{t-1})$$

$$(6) \qquad S: \ln L_t - \ln L_{t-1} = \gamma_2(\ln L_t^* - \ln L_{t-1})$$

where $0 \leqq \gamma_1, \gamma_2 \leqq 1$, L_t^* is the expected level of agricultural employment in period t, and γ_1 and γ_2 are the coefficients of adjustment of the demand for and the supply of agricultural labor, respectively.

By assuming L_i in equations (3) and (4) to be the expected level of agricultural employment in period t and combining equations (3) and (5) and equations (4) and (6), respectively, one may obtain the following dynamic structural demand and supply equations where all the variables are statistically observable.

$$(7) \qquad D: \ln L_t = \gamma_1 a_0 + \gamma_1 a_1 \ln W_{At} + \gamma_1 a_2 \ln P_{At} + \gamma_1 a_3 \ln P_{Mt}$$
$$+ (1-\gamma_1) \ln L_{t-1} + \gamma_1 a_4 T + \gamma_1 v_{1t}$$

$$(8) \quad S: \ln L_t = \gamma_2 b_0 + \gamma_2 b_1 \ln W_{At} + \gamma_2 b_2 \ln W_{Nt} + \gamma_2 b_3 \ln P_t + \gamma_2 b_4 \ln U_t + (1-\gamma_2) \ln L_{t-1} + \gamma_2 b_5 T + \gamma_2 v_{2t}$$

where the subscript t stands for time. The one-year lagged dependent variable is assumed to be exogenous in this system of the structural demand and supply equations. Furthermore, the assumptions about the disturbance terms made for those in the static structural demand and supply equations are still valid in the dynamic system, since both error terms are multiplied only by constants and hence they do not change the original properties.

As mentioned earlier, since the quantity of labor and the agricultural wage rates are assumed to be endogenously determined subject to the indicated exogenous variables, a simultaneous-equations method is necessary for estimating the structural equations in order to avoid inconsistency bias. Two-stage least squares (2SLS) method is therefore applied.

The structural equations given in (7) and (8) are estimated for the period 1958-1980 in the following forms.

$$(9) \quad D: \ln L_t = A_0 + A_1 \ln W_{At} + A_2 \ln P_{At} + A_3 \ln P_{Mt} + A_4 \ln L_{t-1} + A_5 T + V_{1t}$$

$$(10) \quad S: \ln L_t = B_0 + B_1 \ln W_{At} + B_2 \ln W_{Nt} + B_3 \ln P_t + B_4 \ln U_t + B_5 \ln L_{t-1} + B_6 T + V_{2t}$$

where, for example, $A_1 = \gamma_1 a_1$, $A_2 = \gamma_1 a_2$, and so on.

By estimating these two equations simultaneously, one may obtain the short run and long run elasticities of the demand for and the supply of agricultural labor together with the adjustment coefficients. The coefficients A_j's (j = 1,2,3) and B_j's (j = 1,2,3,4) are regarded as the short run elasticities in the sense that they are weighted by the adjustment coefficients γ_1 and γ_2, respectively. These adjustment coefficients can be obtained from the estimates of A_4 (= $1-\gamma_1$) and B_5 (=$1-\gamma_2$), respectively. By making use of these adjustment coefficients, the long run elasticities a_j's (j = 1,2,3) and b_j's (j = 1,2,3,4) can easily be obtained like $a_1 = A_1/\gamma_1$, for example. Similarly, the short run and long run coefficients of the linear trend variable can easily be obtained for both the demand and the supply equations.

The a priori theoretical restrictions on the coefficients are $A_1 < 0$, $A_2 > 0$, $A_3 > 0$, and $A_4 > 0$ in the demand function, and $B_1 > 0$, $B_2 < 0$, $B_3 > 0$, $B_4 > 0$, and $B_5 > 0$ in the supply function. However, the signs of the coefficients of the trend variable in both equations could not be determined a priori.

Finally, the complete structural demand and supply relations given in equations (9) and (10) are estimated separately for male and female agricultural employment for the 1958-1980 period. Then, based on the estimates, a statistical test is carried out in order to examine differences in the structural demand and supply relations between male and female agricultural employment.

3. The Data

Agricultural employment

The total numbers of male and female agricultural gainful workers were obtained from Annual Report on the Labour Force Survey published by the Bureau of Statistics, the Prime Minister's Office. These total numbers are annual averages expressed in 1,000 persons which are composed of operators, family workers, and hired workers.[4] No adjustment was made for seasonality of agricultural production and differences in the quality of labor in each category of male and female agricultural workers simply because of lack of information.

Agricultural wage rates

Since operators and family workers are unpaid workers, one has to impute wage rates to their labor. For this purpose, it is assumed that there is no quality difference among operator, family, and hired labor. Then, one may impute the price of hired labor to operator and family labor. Two series of agricultural wage rates are available for this purpose. One is for annual-contract hired labor and the other is for casual or daily hired labor. The former, however, is not available after 1967 because annual contract hired labor has been almost nil since then. The daily agricultural wage rates of casual hired labor were therefore employed, although they may overestimate the marginal productivity of operator and family labor since casual labor is employed mainly during peak seasons of agricultural production[5].

The data were taken from Survey Report on Prices and Wages in Farm Villages published annually by the Ministry of Agriculture, Forestry,

and Fisheries from which male and female wage rates are available separately. They are expressed in yen per day in current prices.

Alternative (nonagricultural) wages

As the Japanese economy grew, many agricultural workers have migrated not only to the secondary sector but also to the tertiary sector. Furthermore, these agricultural migrants are not always engaged in jobs which require only unskilled labor. Part of them have been engaged in clerical works in regional govenment offices and agricultural cooperatives as well as private companies in urban areas. These works often require fairly high standards of skills. Therefore, the alternative wages should reflect wages of not only unskilled but also skilled labor in the nonagricultural sectors.

Thus, the wage rate per average worker in an average firm with five or more employees was assumed to be a best proxy for alternative wage rates. The data were taken separately for average male and female workers from the Yearbook of Labor Statistics published by the Statistical Bureau of the Prime Minister's Office. These wage rates are however reported in terms of average monthly wage earnings. Fortunately, the Yearbook reports the average numbers of work days per month for male and female workers seperately. Then, the average monthly wage earnings were divided by the average numbers of work days in order to obtain the average daily wage earnings. These daily wage earnings were assumed to be the alternative wage rates which are expressed in yen.[6)]

Unemployment rate

Unemployment rate was chosen as a best proxy for job opportunities

in the nonagricultural sectors. There are some other proxies such as the growth rate of nonagricultural products and vacancy rate. Although these variables were tried in the estimation of the structural demand and supply equations, they did not give statistically significant and economically meaningful results for both cases of male and female agricultural employment.

The data were obtained from the Yearbook of Labor Statistics published by the Statistical Bureau of the Prime Minister's Office. This Yearbook gives separately male and female unemployment rates together with average unemployment rate. These unemployment rates are annual averages and are expressed in terms of percent.

Price indices of agricultural output and machinery inputs and the consumer price index

The price indices of agricultural output and machinery inputs are available in the Survey Report on Prices and Wages in Farm Villages published by the Ministry of Agriculture, Forestry, and Fisheries. The CPI was taken from the Yearbook of Consumer Price Indices published by the Bureau of Statistics of the Prime Minister's Office. These price indices are expressed in 1975 prices.

4. Empirical Results

4.1 Estimates of the Structural Demand and Supply Equations

The structural demand and supply equations given in equations (9) and (10) were estimated by 2SLS separately for male and female employment for the period 1958-1980. However, statistically significant

coefficients could not be obtained for the machinery price variable in the demand equations in both male and female structural relations. This may have been caused by the multicolinearity between the agricultural wage rates and the machinery price index. Then, two other proxy variables were tried in order to examine the effect of a rapid mechanization of agricultural production during the period under question. They are the stock of machinery capital and machinery hours per one hectar per average farm firm.[7] However, none of them gave a statistically significant result. Thus, the variable which was expected to capture the effects of farm mechanization as an important technological change in postwar Japanese agriculture had to be dropped from the demand equations.

In addition, since the trend variable did not give a statistically significant coefficient in both demand equations, it was also omitted from the estimation. Furthermore, the coefficient of the trend variable in the male labor supply equation was not statistically significant at the conventional level. However, this variable was not dropped from the estimation, since some of the coefficients of the other variables became statistically insignificant by doing so.

The estimates of the structural demand and supply equations for the male and female agricultural employment are presented in Table 2. The fit of the estimation of each equation is very good as indicated by the coefficient of determination adjusted for the degree of freedom. Furthermore, almost all the estimated coefficients are statistically significant at either the 5 or 10 percent level and the signs of them

are consistent with the a priori theoretical expectations.

As is observed in Table 2, the estimated coefficients of the structural demand and supply equations look very similar between the male and female agricultural employment. In order to investigate whether or not there exist differences in the structure between the male and female structural demand and supply relations, a covariance analysis was then applied. The test was carried out separately for the demand and supply equations.

In the case of the demand equations, the computed $F_{(4,34)}$ and $F_{(1,38)}$ were 0.85 and 1.77 for the test of the equality of the slope coefficients and for the test of the equality of the intercepts, respectively. The critical F-statistics for the corresponding degrees of freedom are 2.65 and 4.10, respectively, at the 95 percent level of statistical significance. Thus, one could not reject both null hypotheses, implying that the demand equations for male and female labor are identical.

On the other hand, the test statistics for the equality of the slope coefficients and for the equality of the intercepts in the supply equations were respectively $F_{(6,30)} = 1.08$ and $F_{(1,36)} = 2.89$. Since the critical F-values with the corresponding degrees of freedom are 2.42 and 4.13, these null hypotheses could not be rejected. This implies that the behavior of the labor supply for agricultural production is identical between male and female workers.

In summary, the structural demand and supply relations of the male and female agricultural employment were found to be identical.

Table 2

Estimates of the Structural Demand and Supply Equations :

Male and Female

	Male		Female	
	Demand	Supply	Demand	Supply
Const.	3.570**	9.008*	1.325	6.628*
	(1.661)	(2.998)	(0.608)	(2.258)
ln W_{Ai}	-0.289*	0.139**	-0.236*	0.295*
	(-2.813)	(1.570)	(-2.137)	(2.605)
ln W_{Ni}		-0.570**		-0.439*
		(-1.685)		(-2.693)
ln P_A	0.351**		0.358*	
	(1.656)		(2.018)	
ln P		0.295*		0.197*
		(2.125)		(3.002)
ln U_i		0.114**		0.055*
		(1.529)		(1.847)
ln L_{i-1}	0.679*	0.360**	0.892*	0.389**
	(3.360)	(1.592)	(4.885)	(1.429)
T		-0.022		-0.021*
		(-1.140)		(-2.912)
SSR	0.020	0.019	0.009	0.004
$\bar{R}^2$	0.987	0.987	0.996	0.997

Table 2 (continued)

Note: 1) The equations were estimated by 2SLS method.

2) The period for the estimation is 1958-1980.

3) i = M, F

4) $\bar{R}^2$ stands for the coefficient of determination adjusted for the degrees of freedom.

5) SSR indicates the sum of squared residuals.

6) Figures in parentheses are computed t-ratios.

7) * and ** indicate that the coefficients are statistically significant at the five and ten percent levels, respectively. A one-tail test was applied for all the coefficients except for the ones of the intercept and the trend variable for which a two-tail test was applied.

This indicates that it is possible to aggregate male and female labor and estimate the aggregated structural demand and supply equations for the agricultural labor market.

Thus, the male-equivalent total number of agricultural gainful workers was estimated by adding the total number of female workers weighted by 0.8 to that of male workers.[8] Then, the structural demand and supply equations for the "total" agricultural employment were estimated by 2SLS. In this case, the male wage rates were used for both the agricultural and nonagricultural wage rates and the male unemployment rate was employed. Furthermore, as in the cases of the separate estimations of the male and female structural demand and supply equations, the machinery price index and the trend variable were omitted in the estimation of the demand equation, since, in this case, too, these variables did not give statistically significant coefficients. The estimates of the structural demand and supply equations for the total agricultural employment are reported in Table 3.

The fit of both the demand and the supply equations is very good as indicated by the coefficients of determination adjusted for the degrees of freedom. Moreover, all the estimated coefficients are statistically significant at either 5 or 10 percent level except for that of the trend variable in the supply equation. This variable was not dropped in the estimation because the estimated coefficients of the other variable became statistically less significant by doing so. These estimates are the final specification of the structural demand and supply equations in the present study and will be further analyzed.

Table 3

Estimates of the Structural Demand and Supply Equations :

Total Labor Force

	Demand	Supply
Const.	2.716 (1.163)	5.036** (1.887)
ln W_A	-0.254* (-2.596)	0.180** (1.447)
ln W_N		-0.346* (-2.275)
ln P_A	0.341* (2.092)	
ln P		0.201* (1.937)
ln U		0.095* (1.888)
ln L_{-1}	0.775* (3.910)	0.627* (3.012)
T		-0.014 (-1.297)
SSR	0.013	0.010
$\bar{R}^2$	0.992	0.993

Table 3 (continued)

Note: 1) The equations were estimated by 2SLS method.

2) The period for the estimation is 1958-1980.

3) SSR indicates the sum of squared residuals.

4) $\bar{R}^2$ stands for the coefficient of determination adjusted for the degrees of freedom.

5) Figures in parentheses are computed t-ratios.

6) * and ** indicate that the coefficients are statistically significant at the 5 and 10 percent levels, respectively. A one-tail test was applied for all the coefficients except for the ones of the intercept and the trend variable for which a two-tail test was applied.

4.2 The Short Run and Long Run Demand and Supply Elasticities

Based on the estimates given in Table 3, which represent the short run elasticities, the elasticities of adjustment and the long run elasticities were calculated for both the demand and the supply equations. The short-run and long-run elasticities of the demand for and the supply of agricultural labor together with the elasticities of adjustment are presented in Table 4.

Demand Elasticities

First, the elasticity of adjustment of the demand for agricultural labor is 0.23. This indicates that the discrepancy between the expected and actual levels of demand for labor for agricultural production is adjusted by only 23 percent within a year. This rather slow adjustment may have come from the fact that it takes fairly a long time for farmers to change the organization of agricultural production in accordance with changes in the demand for agricultural products.

The short-run elasticity of the demand for agricultural labor with respect to the agricultural wage rates is -0.25, indicating that the demand curve is inelastic. However, the long-run elasticity is -1.1, indicating that a one percent increase in the agricultural wage rates will result in a decrease in the demand for labor by 1.1 percent. This implies that farmers respond in the long run fairly sensitively in the demand for labor for agricultural production to changes in the agricultural wage rates.

The elasticity of the demand for labor with respect to the agricultural output price is 0.34 in the short run, while it is 1.5 in the

long run. This indicates that farmers are fairly sensitive in the demand for labor to changes in the output pirce in the long run, although they are not in the short run.

Supply Elasticities

The elasticity of adjustment is 0.37, indicating that the discrepancy between the expected and actual supply of labor for agricultural production is adjusted by 37 percent within one year. This fairly slow adjustment may have been caused by such facts that the proportion of elderly workers in the total agricultural labor force has become larger during the postwar years and that farmers in general tend to stick to traditional customs. These factors may have had the effects of retarding the farmers' responses in the supply of labor for agricultural production to changes in the economic environment.

The elasticities of labor supply with respect to the agricultural wage rates are 0.18 in the short run and 0.48 in the long run, indicating that the supply of labor by farmers for agricultural production is inelastic not only in the short run but also in the long run. On the other hand, the supply elasticities with respect to the nonagricultural wage rates are -0.35 in the short run and -0.93 in the long run. This implies that a one percent increase in the nonagricultural wage rates will reduce the farmers' supply of labor for agricultural production by only 0.35 percent in the short run but it will reduce the labor supply by almost one percent in the long run.

As is clear from these elasticities, farmers are more responsive in the supply of labor for agricultural production to changes in the

nonagricultural wage rates than to changes in the agricultural wage rates. This implies that if the agricultural and nonagricultural wage rates rise by the same proportion, the supply of labor for agricultural production will decline, other things being held constant.

The elasticities of labor supply with respect to the consumer price index are 0.20 in the short run and 0.54 in the long run. Although these figures indicate that farmers are not that sensitive to changes in the CPI in the supply of labor for agricultural production, the positive signs show that farmers will increase the supply of labor for agricultural production if the price level of consumer goods rises because a rise in the CPI implies a reduction in the real income of farmers.

Finally, the elasticities of the supply of labor with respect to the unemployment rate are 0.1 and 0.26 in the short run and in the long run, respectively. These rather low elasticities may have come from the fact that job opportunities abounded and almost full employment was attained during the period under question and hence the unemployment rate did not fluctuate that much. The positive elasticities though small, however, implies that farmers will increase the supply of labor for agricultural production, if job opportunities in the nonagricultural sectors become limited. In other words, shortage of job opportunities in the nonagricultural sectors works as a suppressing factor for migration of labor from agriculture to the nonagricultural sectors.

Table 4

Short-Run and Long-Run Demand and Supply Elasticities

		$\ln W_A$	$\ln W_N$	$\ln P_A$	$\ln P$	$\ln U$	Elast. of Adjustment
Demand	SR	-0.254		0.341			0.225
	LR	-1.129		1.516			
Supply	SR	0.180	-0.346		0.201	0.095	0.373
	LR	0.483	-0.928		0.539	0.255	

Note: The elasticities were derived from the estimates in Table 3.

4.3 Comparison with other Studies

Quantitative analyses of both the demand for and the supply of agricultural labor are very few in Japan. In particular, there is no empirical study of the structural demand and supply relations of the agricultural labor market as far as the author knows.[9)]

However, Kuroda and Yotopoulos [1978 and 1980] report estimates of the demand and supply functions of agricultural labor at the micro level for 1965. Based on the theoretical framework of the subjective equilibrium of the agricultural household, they estimated simultaneously the profit and factor demand functions (including the labor demand function) on the production side. On the other hand, they estimated simultaneously the labor supply functions to both on-farm and off-farm work together with the demand functions for agricultural and nonagricultural commodities on the consumption side.

According to their estimation, the elasticities of the demand for labor with respect to the agricultural wage rates and the output price are respectively -1.5 and 2.0 (Kuroda and Yotopoulos, 1978, Table 4-2, p.123). Since their model is static, these elasticities may be regarded as long-run elasticities. Though slightly larger, they are comparable very well with the long-run elasticities, -1.1 and 1.5, respectively, in the present study.

On the other hand, the elasticities of the supply of labor to on-farm work with respect to the agricultural wage rates, the nonagricultural wage rates, and the price level of purchased consumer goods are 0.4, -2.0, and 0.3, respectively (Kuroda and Yotopoulos,

1980, Table 4-3, p.9). Since their model is static, they may again be regarded as long-run ones. These estimates of elasticities are also very well comparable with the corresponding elasticities in the present study, 0.5, -0.9, and 0.5, respectively, except for the elasticity with respect to the nonagricultural wage rates. Although the elasticity with respect to the nonagricultural wage rates in KY paper is in the absolute term twice as large as the one in the present study, the tendency that farmers are more sensitive in the supply of labor for agricultural production to changes in the nonagricultural wage rates than to changes in the agricultural wage rates remains unchanged.

4.4 Reduced-Form Elasticities

In order to look at the net effects of a change in the exogenous variables, the reduced-form elasticities were estimated by making use of both the short-run and the long-run elasticities of the structural demand and supply equations presented in Table 4. The estimates of the short-run and the long-run reduced-form elasticities are reported in Table 5.

First, according to Table 5, the elasticities of the agricultural wage rates with respect to the farm output price are 0.8 and 0.9 in the short run and in the long run, respectively. This implies that an increase in the prices received by farmers will increase the agricultural wage rates fairly elastically both in the short run and in the long run. On the other hand, the elasticities of the agricultural employment with respect to the output price are 0.14 in the short run and 0.35 in the

long run. This indicates that if the farm output price is raised by ten percent, the agricultural employment will increase by 1.4 percent in the short run and by 3.5 percent in the long run, respectively.

As such, the agricultural employment seems insensitive to a change in the output price. However, the absolute number of a change in the agricultural employment would be substantial, especially in the long run, for a change in the output price. This can be shown by the following hypothetical calculation. Suppose 10 million workers are employed in agriculture at a certain period of time. If the output price is raised by ten percent during that period, the numbers of agricultural employment will be 10,140 thousands in the short run and 10,350 thousands in the long run, ceteris paribus. That is, a ten percent increase in the farm output price will result in an increase in the agricultural employment by 140 thousand workers in the short run and 350 thousands in the long run, which are, by all means substantial.

Second, the short-run and long-run elasticities of the agricultural wage rates with respect to the nonagricultural wage rates are 0.8 and 0.6, respectively. The values of these elasticities are very close to those with respect to the farm output price, although the long-run elasticity with respect to the farm output price is slightly larger than that with respect to the nonagricultural wage rates. This implies that an increase in the nonagricultural wage rates will have almost an equal effect as an increase in the farm output price in increasing the agricultural wage rates and hence farmers' labor incomes both in the short run and in the long run.

On the other hand, the elasticities of the agricultural employment with respect to the nonagricultural wage rates are -0.20 in the short run and -0.65 in the long run. This indicates that a ten percent increase in the nonagricultural wage rates will reduce the agricultural employment by 2 percent in the short run and by 6.5 percent in the long run which are substantial in terms of the absolute numbers of decreases in the agricultural employment.

Furthermore, the absolute values of these elasticities are larger than those with respect to the farm output price not only in the short run but also in the long run. This implies that if the farm output price and the nonagricultural wage rates are raised by the same proportion, the agricultural employment will decline not only in the short run but also in the long run, ceteris paribus.

Third, the elasticities of the agricultural wage rates with respect to the CPI are -0.46 in the short run and -0.33 in the long run. This indicates that an increase in the CPI will decrease the agricultural wage rates by more or less the same proportion both in the short run and in the long-run. On the other hand, the short-run and the long-run elasticities of the agricultural employment with respect to the CPI, 0.12 and 0.38, respectively, are almost equal to the corresponding elasticities with respect to the farm output prices. This implies that an increase in the CPI will have almost the idential effects as an increase in the farm output price in increasing the agricultural employment not only in the short run but also in the long run.

Finally, the elasticities of the agricultural wage rates with

Table 5

Reduced-Form Elasticities

		$\ln P_A$	$\ln W_N$	$\ln P$	$\ln U$
$\ln L_A$	SR	0.141	-0.202	0.118	0.056
	LR	0.346	-0.650	0.378	0.179
$\ln W_A$	SR	0.786	0.797	-0.463	-0.219
	LR	0.940	0.576	-0.334	-0.158

Note: The reduced-form elasticities were computed based on the elasticities reported in Table 4.

respect to unemployment rate both in the short run and in the long run are about -0.2. That is, an increase in unemployment rate will reduce the agricultural wage rates. On the other hand, the positive elasticities of the agricultural employment with respect to unemployment rate, though small both in the short run and in the long run, imply that a decrease in job opportunities in the nonagricultural sectors will increase the agricultural employment.

5. Policy Implications

At this point, let us evaluate on the basis of the present study economic policies which may give important impacts on the levels of the agricultural employment and wage rates. The discussion is centered around agricultural price support programs and fiscal and monetary policies.

Price support programs, those of which the major one has been the rice price support program in postwar Japanese agriculture, are in general operated to raise farm product prices above the equilibrium levels. This implies that price support programs will have an effect of shifting to the right the demand curve for agricultural output, which in turn will shift the demand curve for agricultural labor to the right.

As shown in the reduced-form elasticities, the impact of price support programs on the increase in the agricultural employment will be substantial in terms of the number of agricultural gainful workers,

especially in the long run. On the other hand, the impact of them on the increase in the agricultural wage rates will also be substantial both in the short run and in the long run.

In short, price support programs which set agricultural output prices over equilibrium levels will increase substantially both the agricultural wages and the agricultural employment. In other words, price support programs will suppress migration of labor from agriculture to the nonagricultural sectors significantly, although they will increase the agricultural wage rates and hence the farmers' labor incomes.

On the other hand, fiscal and monetary policies serve mainly for the nonagricultural sectors to raise the nonagricultural wage rates and to lower the level of unemployment. This increase in the nonagricultural wage rates will in turn have a strong effect in shifting the supply curve of agricultural labor to the left.

The impact of an increase in the nonagricultural wage rates on the increase in the agricultural wage rates, judging from the reduced-form elasticities, will be as almost equally substantial as that of an increase in the agricultural output prices both in the short run and in the long run. On the other hand, the impact of this increase in the nonagricultural wage rates on the decrease in the agricultural employment will also be substantial in terms of the number of agricultural gainful workers, especially in the long run.

Based on these economic implications, a concluding remark may now be derived. It has been an old problem that Japanese agriculture needs

a structural change in the organization of production. That is, the small scale farming system should be reorganized in order to enjoy scale economies for more efficient agricultural production. Labor adjustment in agriculture is therefore essential for such a structural change in agricultural production in the future.

For this end, it will be necessary to transfer more agricultural labor force to the nonagricultural sectors. In this context, therefore, agricultural price support programs which raise farm prices over equilibrium levels may not be relevant, since they will retard the outmigration of farmers to the nonagricultural sectors, although they will increase farmers' labor incomes. Instead, promotion of fiscal and monetary policies which would operate to increase job opportunities and nonagricultural wage rates with a moderate inflation may be more relevant, since they will promote the outmigration of farm labor to the nonagricultural sectors, but at the same time they will increase the returns to those who remain in agriculture.

Footnotes

1) The total number of net migration including the number of newly-graduates of farm households who obtained jobs in the nonagricultural sectors was 11 million workers during the 1958-1980 period. This implies that agriculture contributed by more than fifty percent to the increase in the employment in the nonagricultural sectors during this period. Similar calculation applied separately for the male and female cases shows that 46 and 64 percent of the increases in the male and female nonagricultural employment were accounted for by the outmigration of male and female workers from agriculture, respectively. The data of the net migration was obtained from the Survey Report on Changes in Employment of Farm Households published by the Ministry of Agriculture, Forestry, and Fisheries.

2) This implicitly assumes that there exist two agricultural labor markets, one for male employment and the other for female employment. This may not be a realistic assumption since in the real world the demand for female labor, for example, may affect not only the demand for but also the supply of male labor and vise versa. Therefore, it is most ideal to develop and estimate simultaneously the structural relations with four interdependent demand and supply equations. This would imply that the demand for male labor, for example, is a function of male and female agricultural and nonagricultural wage rates together with the other exogenous variables not only in that demand equation but also in the demand and supply equations of female labor.

Several alternative four-equation simultaneous structural relations were developed along this line and were estimated. However, none of them was successful in obtaining meaningful results mainly because of the multicolinearity, especially among wage variables.

3) See footnote 2) in section one for the problem of developing and estimating four-equation simultaneous structural models.

4) Although it is not possible to estimate the proportion of workers in each category in the total numbers of male and female agricultural workers from this source, about 97 percent of labor input in terms of hours was formed by operator and family labor during the 1958-1980 period. The source of the data for this estimation is Survey Report on Farm Household Economy published annually by the Ministry of Agriculture, Forestry and Fisheries.

5) It has been an old question in Japan to choose which agricultural wage rate for the imputation of operator and family labor. No unambiguous answer has been offered to this question.

Minami [1973] has argued that the wage rate of annual-contract hired labor should be imputed to family labor, since annual-contract workers usually live with the family members in the same houses or on the same lots and work together with the family members on farms. Thus, the performance by annual-contract hired labor and family labor may be considered almost identical on an average through a year.

If this view is accepted as correct (indeed, the author is inclined toward this view at the present state of the art), the imputation of family labor by the wage rate of casual hired labor will be an

overestimation of the marginal productivity of operator and family labor. This can be shown by making use of Minami's [1973] estimates of the daily wage rates of annual-contract and casual hired labor (Appendix Table A-3, p.300). The ratio of the former to the latter was around 0.7 on an average for the period 1958-1966.

6) Since the structural model in the present study is developed to explain annual agricultural employment, the annual-income concept may be more desirable. Thus, the annual wage earnings per agricultural worker were also estimated for the 1958-1980 period by multiplying the daily wage rate by the number of work days per year which was estimated from the Survey Report on the Farm Household Economy published by the Ministry of Agriculture, Forestry, and Fisheries. On the other hand, the annual wage earnings per nonagricultural worker were estimated simply by multiplying the average monthly wage earnings by twelve months. These calculations were carried out separately for male and female wage earnings.

However, the estimated results of the structural demand and supply equations using the annual wage earnings were similar to but slightly poorer in the fit and the t-ratios of the estimated coefficients than those with the daily wage rates both in the cases of male and female employment. This is the main reason why the daily wage rates were chosen in the present study.

7) These data are available in the Survey Report on the Farm Household Economy published by the Ministry of Agriculture, Forestry, and Fisheries.

8) The coefficient 0.8 was obtained as follows. The ratio of the female wage rate to that of male wage rate was computed for each year of the 1958-1980 period. Then, the simple average of this ratio for this period was computed, which yielded 0.8.

9) There is however a fairly large number of empirical studies in this field for U.S. agriculture. See, for example, Schuh [1962], Tyrchniewicz and Schuh [1966, 1969], and Gardner [1972] to name only a few.

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