Labour Supply of Aged Farmers in Japan

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Abstract: There is a rapid trend towards an ageing society in Japanese rural areas; aged farmers thus play an important part in agricultural production. The purpose of this paper is to analyse labour supply behaviour of aged farmers. After clarifying the main features of their labour supply, a labour supply function is estimated using data from the 1985 Survey of the Farm Household Economy.

Major findings are that: (1) aged farmers sometimes gain pleasure from working in agriculture, but their estimated wage and income affect whether they decide to be permanent or supplementary workers; (2) the participation rate in agriculture of aged females tends to increase if their husbands work in agriculture; (3) regional differences in probabilities of aged farmer employment can be explained by the income and wage effect and type of farming; and (4) pension payments for farmers have a negative effect on labour supply of the elderly; i.e., the participation rate in the agricultural labour force decreases about 7 percent because of pension payments.

Introduction

The ratio of aged persons to total family members has been increasing rapidly in Japan in recent years. According to the 1985 Census of Agriculture, the percentage of farm members over 65 increased by 17.3 percent in a 10-year period, and by a significantly greater percentage than the 10.3 percent of elderly among the general population. The percentage of aged persons who work in agriculture has nevertheless remained high. The result is that the employment rate for farmers over 65 has reached 29.1 percent, and the role that the aged play in agricultural production is becoming extremely important.

The main purpose of this paper is to estimate the labour supply function of aged farmers, to analyse the factors affecting the labour supply of aged farmers, and to clarify their quantitative relationships. Based on the estimated labour supply function, the causes of regional differences in the labour supply of aged farmers and in farm size are also examined.

The Special Nature of the Aged Farmer Workforce

The following three points may be singled out as being special features of the aged farmer workforce in Japan:

Work that Provides a Meaningful Existence

The percentage of aged farmers who work is fairly high when compared with employment of the aged in nonagricultural sectors. One reason for this is that there are many different kinds of agricultural work and diversity among family farms, allowing for flexibility in letting the aged work only when they are able to and so desire. For this reason, many aged persons work in agriculture to obtain a meaningful existence.

The point may be confirmed through estimation of the production function and shadow wage rate, using data from the 1985 Survey of the Farm Household Economy.[2] The results indicate that the shadow wage rate becomes significantly different due to the unique employment status of the aged. Accordingly, the shadow wage rate for farms in which the aged work in agriculture for a relatively long time is fairly low compared to the rate for farms without an aged labour force.

The low shadow wage rate in farms with aged members implies that labour is surplus on these farms. At the same time, it means that the elderly are able to decide their own work schedule, and is one proof of agriculture's reputation as meaningful or healthy employment.

The Aged as a Marginal Labour Force

There are regional disparities in the employment rate of aged members of farming families in Japan. For instance, the rate for males over 70 years old ranges from 76 percent in the Chugoku region to 36 percent in the Tohoku region, and for females over 70 years old from 34 percent in the Chugoku region to 8 percent in the Tohoku region. Such regional disparities exist because aged farmers are regarded as a marginal labour force. The marginal labour force operates in the boundary between the labour force and the nonworking sector, and whether it is employed or not depends on the financial state of individual households and also on employment status. Therefore, if the elderly are regarded as a marginal labour force, then the regional variance in their employment rates can be shown to be influenced by such economic factors as regional differences in agricultural structure, crop combinations, and incomes of other family members. The employment rate of aged farmers also varies widely depending on the size of the farm.

The decision on the amount of hours worked will in many cases not be explainable by economic analysis alone; it will be influenced by such noneconomic considerations as quality of life and health management. On the other hand, in the decision on whether or not to engage in agriculture as work, economic conditions are likely to have a substantial effect on participation of the aged in agriculture. This paper, therefore, is limited to the topic of whether aged farmers choose to work or not, and analyses of the factors that affect their work activities.

Isolation from the Labour Market

In general, it is difficult for aged persons to work in the nonagricultural sector in Japan. Many companies have age limits of 55 or 60 years of age, and there is not much demand for temporary employment of the elderly. Even so, quite a few males aged 60–70 work in the nonagricultural sector, but they are largely self-employed. It is therefore probably correct to assume that aged members of farming families are isolated from the labour market. In construction of labour supply models, this point is important. If farms are faced with a competitive labour market, then resource allocation may be set independently of consumption behaviour. Many current farm labour supply models are recursive; i.e., they fix the derived demand of labour from a balanced production sector, and based on this decide the allocation between self-employment and hired labour. However, if the aged members of farms are isolated from the labour market, it becomes difficult to apply a recursive model, and it is desirable to construct a model that takes into consideration both the production and consumption sectors.

Labour Supply Model for Aged Farmers

First, we must assume the consumption-leisure preference of aged farmers as (1):

(1) $U = U\,(H-L,\ C_1,\ \ldots\ C_i)$

subject to the restrictions facing the elderly:

(2) $\Sigma P_i C_i = \pi(q;\ L) + Y_o + Y_p$, and $L \leq H$

where H is available time of the elderly, L the agricultural working hours of the elderly, C_i the amount of consumption goods, P_i the price of consumption goods, π the profit function for farms, q the input price vector, Y_o assistance from other family members, and Y_p the pension. Since there is no labour market for the elderly, it is impossible to estimate their market wage

rate. The income from agriculture will therefore be calculated using a profit function such as (2).

The labour supply function of the elderly will be derived by maximizing (1) subject to (2). Since (2) is nonlinear, it is not easy to solve this problem. If linear homogeneity of the production function is assumed, then it is possible to solve it simply as described below.

If the production function is both linear and homogeneous, the profit function may be written as follows:

(3) $\pi(q; L) = L\pi(q)$

Equation (3) implies that the profit does not depend on hours of work.

W^* is defined as profit per hour of work or shadow wage rate. W^* can be derived from the farm production function:

(4) $W^* = \dfrac{L\pi(q)}{L} = \pi(q)$

subject to:

(2)′ $\Sigma P_i C_i = W^* L + Y$

where $Y = Y_o + Y_p$. From a solution of (1) subject to (2), the labour supply function can be derived.[3] Therefore:

(5) $L = \Omega(p, W^*, Y)$

is specified in hours of work, but this model can be converted to the logit model. Consider $W^{*\prime}$, such that $W^* = W^{*\prime}$ where $T = \Omega(p, W^{*\prime}, Y)$. T is the hours of work that the aged farmer would be fully engaged in agriculture. $W^{*\prime}$ indicates the boundary between permanent agricultural work and part-time work or unemployment, such that:

(6) $L \geq T$ if $W^* \geq W^{*\prime}$, and $L \leq T$ if $W^* \leq W^{*\prime}$

If R is defined as the probability of participation by the elderly in agriculture, then:

(7) $R = prob(W^* \geq W^{*\prime})$

Equation (7) is the probability density function, and p, W^*, and Y from (5) can be regarded as its parameters. Therefore,

(8) $R = \Phi(p, W^*, Y)$

Equation (8) is the labour supply function of aged farmers.

To estimate Equation (8), it can be approximated to a linear function of its independent variables. Then, the equation to be estimated assumes the following form:

(9) $R = \dfrac{1}{1 + e^{(a+bW^*+cY+dZ)}}$

where a, b, c, and d are parameters to be estimated and Z is a vector of constraints that arise from the characteristics of each farm, which are:

ME: Husband's employment status
KID: Number of children under 6 years old
Type-of-farm dummies: *vegetable*, *fruit*, and *dairy*

Table 1—Empirical Results of the Logit Analysis

Variable	Males		Females (1)		Females (2)	
	60–70	70+	60–70	70+	60–70	70+
Y	−0.1750E−4*** (−7.173)	−0.1108E−4*** (−4.420)	−0.8063E−5*** (−3.391)	−0.2649E−5* (−1.779)	−0.8924E−5*** (−3.477)	−0.7879E−6 (−0.833)
W^*	0.0193*** (5.209)	0.0106*** (4.009)	0.0039 (0.838)	0.0082*** (2.772)	0.0123** (2.385)	0.0056*** (2.881)
ME					0.4110*** (11.548)	0.0989*** (7.515)
KID					−0.0274 (−1.059)	−0.0227* (−1.816)
Type-of-farm dummies:						
Vegetable	0.1659*** (3.095)	0.0714 (1.596)	0.3843*** (8.149)	0.0804*** (3.200)	0.2727*** (5.393)	0.0479*** (2.775)
Fruit	0.0928*** (1.562)	0.0670 (1.363)	0.1872*** (3.810)	0.0464 (1.572)	0.0770 (1.439)	0.0334* (1.662)
Dairy	0.4782*** (5.534)	0.1123* (1.900)	0.2252*** (3.703)	0.1005*** (3.044)	0.1286** (1.971)	0.0663*** (2.985)
Intercepts	0.4845	−1.0307	−0.6778	−2.3738	−1.3695	−3.6294
Sample size	1,009	744	959	1,028	959	1,028

Note: The numbers in parentheses are *t*-statistics. ***Statistically significant at the 1-percent level. **Statistically significant at the 5-percent level. *Statistically significant at the 10-percent level.

Empirical Results

Estimation Results

The maximum likelihood estimation procedure is adopted to estimate Equation (9) using data from the 1985 Survey of the Farm Household Economy (Table 1). The logit coefficients are shown having been changed to partial derivatives at each average value. The coefficients indicate the change in the employment probability of the elderly associated with a one-unit change in the variable. They also indicate elasticities at average values (Table 2).

The sign condition of Y is negative, and it is satisfied for males and females. The sign of the wage coefficient cannot be determined theoretically; however, the estimation results indicate it to be significantly positive.

Wage elasticity has a relatively low value of less than 0.5, which becomes larger as age increases. The low wage elasticity is consistent with regional disparities in the participation rate of the elderly, which become larger in proportion to age. One can also calculate the elasticity of substitution from income and wage elasticities using Slutsky's equation. The estimated elasticities of substitution were all positive, satisfying the theoretical condition.

Table 2—Elasticities Evaluated at the Means

Sex and age	Income	Wage	Compensated Wage
Males:			
60–70	−0.403	0.266	0.522
70+	−0.730	0.339	0.505
Females:			
60–70	−0.466	0.161	0.239
70+	−0.246	0.423	0.433

The coefficient of *ME* indicates a strong relationship between the female elderly and their husbands; i.e., whether the husbands are consistently employed in agriculture or not strongly affects their wives' participation rate in agriculture. The coefficient of *KID* is not statistically significant, but the sign is negative as assumed.

For type-of-farm dummies, the coefficients of vegetable and dairy farming have high positive values, possibly because these types of farming need a large amount of labour input as well as cooperation among family members.

An Explanation of Differences of Participation Rates in Region and Farm Scale

The factors affecting regional disparity in the participation rate in agriculture of the elderly farmers were decomposed into the explanatory variables in Equation (9). The participation rate for 60–70 year-olds in Hokkaido is higher than the average for both male and female, which can be explained by the wage effect and differences in crop combinations. The high ratio of dairy farmers is one factor that raises the participation rate in agriculture.

In the Tohoku region, the high ratio of rice farmers lowers the participation rate. Since all coefficients of the variables for Hokuriku region males are negative, participation rates in agriculture are less than the national average. Due to the prevalence of part-time farming and also the extremely small scale of farming, other family members can receive a higher income in the nonagricultural sector. The participation rate in the Kinki region is also low due to the large incomes of other family members. All effects are positive for males in the Shikoku region, raising the participation rate. In the Kyushu region, low incomes of other family members raise the participation rate for males.

The factors that contribute to scale differences in participation rates of the elderly were also analysed. The results indicate that the low participation rate among small-scale farms is due to the wage effect, and the low participation rate among large-scale farms is due to the income effect.

The Effects of Pensions on the Participation Rate

Assumptions to compute the effects of pensions are as follows:

(a) The participation rate is affected only by the negative income effect due to pensions.

(b) The amount of the pension is ¥800,000 per year.

(c) The pension is only available to elderly couples.

Based on the above assumptions, a shift in the labour supply curve for 60–70 year-old males was calculated. It was found that pension payments depressed the participation rate of the elderly by approximately 7 percent.

Summary and Conclusions

There is a rapid trend towards an ageing society in Japanese rural areas, so that aged farmers play an important part in agricultural production. The purpose of this paper was to analyse the labour supply behaviour of aged farmers. After clarifying the main features of their labour supply, a labour supply function was estimated using data from the 1985 Survey of the Farm Household Economy.

Major findings are:

(1) Aged farmers sometimes gain pleasure from working in agriculture. However, their estimated wage and income affect whether they decide to be permanent or supplementary workers.

(2) The participation rate in agriculture of aged females tends to increase if their husbands work in agriculture.

(3) Regional differences in probabilities that an aged farmer works can be explained by the income and wage effect and type of farming.

(4) Pension payments for farmers have a negative effect on labour supply of the elderly; i.e., the participation rate in the agricultural labour force decreases about 7 percent because of pension payments.

Notes

[1]National Research Institute of Agricultural Economics, Japan.

[2]The functional form and estimation procedures are described in Egaitsu and Shigeno (1983).

[3]The procedure to derive the labour supply function is analogous to that used by Lopetz (1986).

References

Egaitsu, F., and Shigeno, R., "Rice Production Function and Equilibrium Level of Wage and Land Rent in Postwar Japan," *Journal of Rural Economics*, Vol. 54, 1983, pp. 167–174.

Lopetz, R.L., "Structural Models of the Farm Household that Allow for Independent Utility and Profit-Maximization Decisions," in Singh, Inderjit, Squire, L., and Strauss, J. (Eds.), *Agricultural Household Models*, Johns Hopkins University Press, Baltimore, Md., USA, 1986, Chap. 11, pp. 306–325.

Discussion Opening—*Shinnosuke Tama* (Hirosaki University)

In Japanese agriculture, the proportion of aged persons who work in agriculture is high and their role is becoming more important. This paper is useful not only in terms of the future of Japanese agriculture but as an analysis of trends in the country's aged society.

The paper identifies the labour of aged farmers as noneconomic activities (i.e., quality of life) and assumes that noneconomic factors influence only the decision on working hours, and that the decision on whether or not to engage in agriculture as work can be explained by economic factors. But the conception of farming as a meaningful existence also influences the decision of aged people to work or not, and economic factors also influence their decision on the amount of working hours. If it is necessary for mathematical modelling to distinguish the influence of noneconomic factors from that of economic ones, the paper should have made the distinction as a procedure for modelling.

Regional disparities of employment rates for aged farmers are related more to the reason why the proportion of aged farmers is so high in Japanese agriculture than to the economic conditions identified in the paper.

The explanation of why the proportion of aged farmers is so high lies in the *Ie* (family) system of Japan. The *Ie* system consists of three elements: family property, family business, and the family name itself. The highest priority in *Ie* is given to the sustained succession of all three elements by primogeniture. To guarantee this succession, a custom of retirement is retained in Japanese rural areas. In other words, the representative rights of *Ie* are bequeathed from a householder to one of his children, usually the oldest son, when the householder becomes a certain age, usually 60. Many farmers inherited from their fathers in this way, and they believe that passing on *Ie* to their sons is their *raison d'être*.

The high proportion of aged farmers means a low proportion of retirement from farming. There are many aged farmers who have a desire to retire from farming, but cannot retire because all their children have left home. Therefore, regional disparities have a strong relation to how many successors of farm households remain in each rural area. There are comparatively many successors in the Tohoku region because of the strong custom of primogeniture there, and few successors in the Chugoku region because of the weakness of that custom there. That implies that employment rates in agriculture of aged farmers are low in Tohoku and high in Chugoku.

The number of farm successors nevertheless depends on economic factors; e.g., farm scale and type of farming. But the behaviour of aged farmers is influenced by the spirit of *Ie*.

[Other discussion of this paper and the author's reply appear on page 21.]