Farm Production and Off-Farm Employment in Areas of Rapid Rural Industrialization

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Abstract: The interrelationship between off-farm employment and land use intensity among small farmers was examined. A farm survey of 3,333 farm households and secondary data from Korea were used for the empirical analysis. A simultaneous equations model that contained both qualitative and continuous dependent variables was used to estimate a joint determination of off-farm employment and land use intensity. A strong negative interrelationship was found between off-farm employment and land use intensity. The major result shows that government policies that pursue separate goals of off-farm employment and increased land utilization can be counterproductive if implemented concurrently. Also, some potential policy measures that can mitigate those policy conflicts are increased resources devoted to farmers' education and farm mechanization.

Introduction

Studies on off-farm employment of farm families have generally found that off-farm labour supply conforms to the neoclassical household model (e.g., Rogenzweig, 1980; Huffman, 1980; and Sumner, 1982). Nevertheless, those studies have not systematically considered the institutionalized fixed working hours and non-negligible labour market entry costs in the theoretical formulation for empirical studies. Consequently, the continuous labour supply assumption is widely adopted in the empirical model specification.

A comprehensive theoretical discussion on the lumpiness of work hours and high labour entry costs in off-farm labour supply was recently made by Bollman (1979). However, few researchers have attempted to find the interactions between off-farm employment and agricultural production (exceptions are Huffman and Lange, 1982; and Schaub, 1981). This paper, using Korean farm survey data, develops and simultaneously estimates a model of farm household decision behaviour in which off-farm employment and land use intensity are jointly determined.

Theoretical Consideration of Off-farm Employment Participation and Land Use Intensity

Throughout this study, we assume that a farm operator does not have complete flexibility in the choice of off-farm working hours because of limitations of off-farm job opportunities and/or inflexibility of working hours imposed by employers. Moreover, we further assume that entry costs to participate in off-farm labour markets (mainly commuting time) are substantial for off-farm employment. Under these situations, choices to the farm operator are between accepting the off-farm job with a substantial reduction of farm earnings and leisure or not accepting the off-farm job (for more details on these issues, see Bollman, 1979; Deaton and Muellbauer, 1980; and Chong, 1984). In other words, off-farm employment is preferable to full-time farming if the utility of off-farm work is higher than that of leisure.

The farm operator participates in off-farm work if it maximizes utility; i.e., participation occurs when:

\[ U_i [F(1-k)+M+Y, S] - D > U_0(F+Y, S) \]

where \( U_i (i = 0, I) \) represent the utilities of taking an off-farm job \( (U_i) \) and full-time farming \( (U_0) \), respectively; \( F \) is the amount of farm earnings; \( k \) is a fraction \( (0 < k < 1) \) representing the reduction rate of farm earnings due to off-farm work; \( M \) is the amount of off-farm earnings; \( Y \) represents leisure income; \( S \) denotes other observable attributes of the farm operator that might affect preferences (e.g., sex or age); and \( D \) represents the disutility arising from off-farm work participation.

Although the utility function in equation (1) is known to the farm operator with certainty, it contains some components that are unobservable and must be treated as stochastic. Those stochastic unobservable characteristics vary over the population. A specification of a distribution for the unobserved stochastic factors generates a distribution of choices in the population (Domencich and McFadden, 1975).

From the distribution of unobserved stochastic factors and determinants of \( F, M, \) and \( D \), the probit type off-farm work participation function is derived as:
(2) \[ DOFF^* = k_0 + k_1X_1 + k_2X_2 + k_3LUI + U \] and

(3) \[ DOFF = 1 \text{ if } DOFF^* > 0, \text{ otherwise } DOFF = 0, \]

where \( DOFF^* \) is a latent variable assumed to be normally distributed; \( X_1 \) is a vector of variables including farm input prices and level of fixed inputs; \( X_2 \) represents a set of variables representing off-farm labour market characteristics, leisure earnings, and personal characteristics; \( LUI \) represents land use intensity; and \( U \) is an error term.

On the land use intensity determination, Zandstra (1977) and Harwood and Price (1976) hypothesized its determinants as a set of physical environmental variables, \( Z_1 \), which include soil, climate, and water-related variables and a set of fixed variables, \( Z_2 \), which reflect land size, farm machinery, farm input and output prices, and human capital. In addition, land use intensity supposedly decreases as off-farm employment participation increases (Kada, 1980). A recent empirical study on land-use-related cropping system determinations was done by Paris and Price (1981).

Based on the previous theoretical and empirical works on land use intensity determination, the relationship between the land use intensity and sets of independent determinants was derived as:

(4) \[ LUI = b_0 + b_1Z_1 + b_2Z_2 + b_3DOFF^* + V, \]

where \( b_0, b_1, b_2, \) and \( b_3 \) are unknown parameters; and \( V \) is an unobservable error term.

As shown in equations (2) and (3), and (4), off-farm employment participation and land use intensity are determined jointly and are hypothesized to be negatively interrelated.

Data and Empirical Model

The data used for estimation is the Farm Household Economy Survey of 1982 conducted by the Republic of Korea’s Ministry of Agriculture and Fisheries (MAF). Out of an original sample of 3,375 farm households, 3,333 were used in the final analysis after removing missing values of sample farm households. In addition, secondary data on regional weather and topographical information compiled by the MAF were used.

The model to be estimated consists of a simultaneous equation model containing one continuous land use equation and a logistic function for off-farm employment participation. After some preliminary experimentation with functional forms for a two structural equation model, the following functions were chosen for empirical estimation,

(5) \[ \ln[DOFF/(1-DOFF)] = a_0 + a_1X_1 + a_2X_2 + a_3LUI + U_1 \] and

(6) \[ \lnLUI = b_0 + b_1Z_1 + b_2Z_2 + b_3DOFF + U_2, \]

where \( U_1 \) and \( U_2 \) are random disturbances.

The status of off-farm employment participation (DOFF) by a farm household is a zero-one dummy variable. A farm household is considered as an off-farm employment household if it reported more than 50 days of work off the farm by all family members during the year. A total of 619 farm households from the 3,333 total sample participated in off-farm employment activities. As a land use intensity measure, the land equivalent ratio (LER) was used. The LER is measured through the weighted sum of the average yields of the crop for the farm. As a whole, the LER is an index of two aspects—the productivity and cropping intensity in the use of the land base. The LER is hypothesized to be negatively correlated with off-farm employment because it is a physical efficiency factor directly related to increased farm income (Mosher and West, 1952). The status-of-off-farm-employment dummy variable was included to test its effect on land use intensity. Except for farm wage rate, most farm inputs and outputs prices were excluded in the estimation because of data limitations.

For estimating equations (5) and (6), the two-stage-least-squares estimation (2SLS) algorithm was applied. First the predicted values for the two structural equations (5) and (6) were estimated. Then the maximum likelihood logit estimation and ordinary least squares (OLS) were applied to estimate the reduced-form off-farm employment participation and land use intensity equations, respectively.
Next, to get unique and consistent estimations of the two structural equations, logit and OLS were applied directly to estimate equations (5) and (6) using the predicted values of the two endogenous variables estimated in the first stage.

**The Results**

Overall, all estimated regression coefficients were consistent with previous expectations in terms of their signs and statistical significance. Farm operator's education level, the availability of family labour and power tillers, favourable weather, and topographical conditions were all positively associated with cropping intensity. Conversely, operator's age, land size, ratio of rented area to total farm land, the ratio of livestock income to total farm income, and enterprise specialization in farming were all negatively associated with cropping intensity.

Operator's formal education was found significant at the 1 percent level, confirming the hypothesis that the better-educated farmers use information that leads to increased land use efficiency through the adoption of more intensive cropping patterns.

The power tiller dummy variable was found positively related to cropping intensity (at the 1 percent level of significance), implying that having a power tiller increases land use efficiency. That fits the hypothesis that a power tiller increases land productivity through increments of multiple cropping. Consequently, improved management and associated yield increases are likely.

The coefficient for land size was negative and significant at the 1 percent level, supporting the hypothesis that the smaller farms use land more intensively than the larger farms. The ratio of rented area to total land was found negative and significant at the 1 percent level, which supports the hypothesis that farmers cannot utilize rented land as efficiently as owned land, perhaps because of the uncertainty of tenure on those lands, and rented lands may have lower productivity.

In order to evaluate the relative importance of the explanatory variable for cropping intensity determination, elasticities of those variables were calculated at the mean values of each variable. Among the 17 independent variables, the number of adults in a household, precipitation, size of farm, the enterprise specialization index, and off-farm employment are important variables determining land utilization in Korea.

**Summary and Implications**

This study concerns the interrelationship between two important decisions—farm household labour use and land use intensity. Parameters from the two equation model were estimated using cross-sectional observations on individual Korean farms. A strong and negative interrelationship was found between off-farm employment and land use intensity. For example, a 10 percent increase in the off-farm employment will result in 1.5 percent reduction of the land utilization rate (intensity of land use). Land utilization is tied closely to food production; hence, food production will likely decrease at the same rates (assuming all other factors except land are constant in the aggregate agricultural production).

Government policies that pursue optimization of each function in isolation can be counterproductive if implemented at the same location. Some potential policy measures that can mitigate those policy conflicts are increased resources devoted to farmers' education and farm mechanization activities. Farmers' education, especially, has a strong and positive effect on both decisions. Farm mechanization has a strong and positive effect on cropping intensity and a positive effect on off-farm employment (although it is not significant). Increased farm mechanization can be expected to increase food production without reductions in off-farm employment. To minimize that conflict, rural industrialization and agricultural production policies should be coordinated. For example, the government can give priority to farm mechanization and educational supports in a region where those conflicts are expected.

**Notes**

1. Korea Rural Economics Institute, University of Missouri (Columbia), and International Rice Research Institute, respectively.
2. For details, see Chong (1984).
References


