INTERDEPENDENCE BETWEEN OFF-FARM EMPLOYMENT AND LAND-USE INTENSITY AMONG SMALL FARMS IN KOREA

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Many studies have been made on off-farm employment by farm families. These studies generally have found that off-farm labor supply conforms to the neoclassical household model (for example, Rogenzweig, 1980; Huffman, 1980; Sumner, 1982). Nevertheless these studies have not systematically considered the institutionalized fixed working hours and non-negligible labor market entry costs in the theoretical formulation for empirical studies. Consequently, the continuous labor supply assumption is widely adopted in the empirical model specification. Recently a comprehensive theoretical discussion on the lumpiness of work hours and high labor entry cost in off-farm labor supply was made by Bollman (1979). Under this situation, the reservation wage theory of labor force participation may no longer necessarily hold true because an important nonconvexity is created in a model of labor force participation (Hausman, 1980; Keeley, 1981). In addition, few attempts have been made to find the interactions between off-farm employment and agricultural production (exceptions are Huffmand and Lange, 1982; Schaub, 1980). This paper considers these issues with Korean farm survey data.

The present paper develops and simultaneously estimates a model of farm household decision behaviors in which off-farm employment and land-use intensity are jointly determined. In the first section, a relatively simple model of off-farm employment participation, and a land-use intensity function are introduced. The results of emprirical analysis using two-stage least square (2SLS) analogue method are included in the second section. Finally, implications and conclusions of the study are made.

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

Suppose that the farm operator pocesses a twice differentiable utility function:

$$U = U(L, Y) \quad (1)$$

where L = leisure time; Y = disposable income.

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It is also assumed that the farm operator faces two constraints, budget and time constraints:

$$Y = F + IM + Yo \tag{2}$$
$$T = L + ITm + Ta\ (1 - Ik) \tag{3}$$
$$F = Ta(1 - Ik)Wa \tag{4}$$
$$M = TmWm \tag{5}$$

where F = farm earnings; I = a status variable specified as $I = 1$ if the farm operator participates in off-farm work and $I = 0$ if not: Y0 = nonwork income; T = available time; Tm = time allocated for off-farm work; k is a fraction $(0 < k < 1)$ representing the reduction rate of farm work due to off-farm work; Ta = time allocated for farm work; Wa = average farm earning per unit of farm work time; Wm = market wage rate facing to the farm operator.

The conditions for off-farm employment participation can be developed through maximizing (1) subject to (2) and (3) by choosing Ta, Tm, Y and I. Since I is binary, the easiest way to find the solution is to maximize (1) with respect to Ta, Tm and Y holding I constant, and then determine the utility maximizing value of I (participation or not).

From equation (1)-(5), the Lagrangian expression can be obtained as

$$l = U(L,\ Y) + \lambda_1[Ta(1 - Ik)Wa + ITmWm + Yo - Y] + \lambda_2[L + ITm + Ta(1 - sk) - T) \tag{6}$$

where λ_1 and λ_2 are Lagrange multipliers.

From (6), the first-order conditions for utility maximization are derived:

$$l_L = U_L + \lambda_2 = 0 \tag{7a}$$
$$l_Y = U_Y - \lambda_1 = 0 \tag{7b}$$
$$l_{Ta} = \lambda_1(1 - Ik)Wa + \lambda_2(1 - Ik) = 0 \tag{7c}$$
$$l_{Tm} = \lambda_1 IWm + \lambda_2 I = 0 \tag{7d}$$

The optimal allocations of operator's time can be derived from (7a)-(7d):

$$U_L/U_Y = Wa = Wm = \lambda_2/\lambda_1 \tag{8}$$

Since the operator's wage rate for off-farm work, Wm, is assumed to be independent of Tm, the marginal value of the operator's time allocated to leisure must be equal to the operator's off-farm wage rate and to the average farm wage rate (not marginal wage rate) in his own farm work.

To the farm operator, the allocation of his time to farm production (Ta) is a quantity demanded for and supplied of the operator's time to his farm. Consequently the demand for leisure time is derived as a function of all of the exogenous variables in the model (assuming T is constant):

$$L = L(I, IWm, (1 - Ik)Wa, Yo) \tag{9}$$

The choice of I, in turn, depends upon whether maximum utility is greater under $I = 1$ or $I = 0$. This decision can be expressed with the aid of the indirect utility function. Define $L^*(I)$ as the chosen utility maximizing value of L from equation (1) and $Y^*(I)$ as the corresponding amounts of disposable income calculated from the budget constraint (2). Then the indirect utility function is the value of utility obtainable from substituting L^* and Y^* into the direct utility function

$$\begin{aligned} V &= U\,(L^*(I), Y^*) \\ &= U\,(L^*(I), F^* + IM^* + Yo) \\ &= V(I, IWm, (1 - Ik)Wa, Yo + ITmWm \end{aligned} \tag{10}$$

Define I^* as the utility difference between $I = 1$ and $I = 0$. Then the off-farm employment participation is a function of I^*:

$$I^* = V(1, Wm, (1 - k)Wa, Yo + TmWm) - V(O, Wa, Yo) \tag{11}$$

The farm operator participates if $I^* > 0$ and not otherwise.

To estimate the probability function for off-farm employment it is necessary to specify the functional form of V. Assuming the functional form of V is specified as a function of the log of income, and of the linear in other variables (e.g., $V(Y, S) = a + b \ln Y + cS, b > 0$). Then the utility difference I^* can be expressed as

$$\begin{aligned} I^* &= (a_1 - a_0) + bWm + c(\text{-}k)Wa + d \ln (Yo + TmWm) \\ &\quad - d \ln Yo \\ &= a + bWm - c'Wa + d(TmWm/Yo) \\ &\quad (\because \ln (1 + TmWm/Yo) \cong (TmWm/Yo)) \\ &\quad (b > 0, c > 0, d > 0 \;\; c' > 0) \end{aligned} \tag{12}$$

Equation (12) provides many meaningful information. For example, an additional increase in off-farm wage rate (Wm) increases the value of I^*; hence, an increase in the odds of off-farm employment participation. The marginal increase in average farm income (Wa) decreases the value of I^*. Also, the marginal increase in nonwork income (Yo) decreases the value of I^*, hence, a decrease in the probability of off-farm work. Moreover, an exogenous increase in off-farm work time (Tm), that is assumed to be inflexible and is different depending on types of industries, will increase the probability of off-farm work participation.

Even though equation (12) provide information on off-farm employment participation, some additional assumptions are necessary for incorporating the land-use intensity index in the model. Note that the average farm wage rate for operator's time allocated in his farm (Wa) is determined by the amount of farm earnings (F) under a given amount of farm work.

Assume that the farm earnings (F) is a function of a set of exogenous variables including farm inputs and outputs prices and level of fixed inputs (Xo) and an index which represents a cropping systems intensity and/or represents the (physical) efficiency of land use (CSI). The positive effect of CSI on F has been pointed out by Mosher and West (1952), and Lee et al. (1975). Then the operator's average farm wage rate (Wa) can be expressed as

$$Wa = Wa(F) = Wa(Xo, \ CSI) \qquad (13)$$
$$(\partial Wa/\partial CSI > 0)$$

In many studies, the importance of management and family labor as a major increasing factor of land-use intensity has been pointed out (Harwood and Price, 1976; Wang, 1975). As assumed in (3), the farm labor after taking an off-farm job ($Ta(1 - k)$) is less than that of full-time farming (Ta).

This issue has been pointed out in most previous theoretical and empirical studies (for example, Huffman, 1980; Sumner, 1982; Huffman and Lange, 1982). In other words, the CSI changes depending on the value of I. From these additional assumptions, following equation is derived:

$$\begin{aligned} CSI &= CSI\,(Ta(1 - Ik), Z_o) \\ &= CSI\,(I, Z_1) \qquad (14) \\ (\partial CSI/\partial I &> 0) \end{aligned}$$

where Z_0 = a vector of other cropping intensity determinats variables; Z_1 = a vector of variables including Z_0 and other variables determining Ta.

Combining equation (12), (13), and (14), the structural equation system of this study can be summarized as:

$$I^* = a + bWm - c'Wa\,(Xo, CSI) + d(TmWm/Yo) \qquad (15)$$
$$\begin{aligned} I &= 1 \text{ if } I^* > 0 \qquad (16) \\ &= 0 \text{ if } I^* < 0 \end{aligned}$$
$$CSI = CSI\,(I^*, Z_1) \qquad (17)$$

Although the three equation system (15)–(17) provide a general theoretical framework for the off-farm employment participation and land use intensity determination process, it is still imperfect. Some difficulties with these equations are: (1) the market wage rate (Wm) is not observable if a farm operator does not participate in off-farm work; (b) X_0, which are determinants of Wa, are not fully specified; (c) also the determinants of CSI is not fully expressed; (d) the entry cost for off-farm labor market (mainly commuting cost) is not incorporated in the basic model.

There are virtually two ways to include Wm in the off-farm employment participation function: (a) use a least squares forecasts of market wage (Wm) for nonlabor market participants in the participation equation, and (b) use a reduced form participation function in which the determinants of the market wage function are included directly in the participation function. The first approach can arise a biased estimation because of smaple selection problems. This may occur because farm operators with higher market wages are more likely to work off the farm and a significant correlation exists between the stochastic disturbance of the least squares wage equation and the participation equation (for more details on this issue, see Keeley, 1981; Hausman, 1980). Moreover, the explanatory power of the market wage equation (R-square) is generally low in empirical estimation (it ranges from 0.1 to 0.4 in most studies). To avoid these problems above, a reduced form participation function is considered in the study.

For the commuting cost, it is handled in market wage rate (*Wm*) because it reduces the net wage received by the farm operator. Since data on commuting cost were not available, the commuting distance was included as a proxy in the empirical statistical model. Variables related to *Wm* and *CSI* are specified in the statistical estimation base on previous empirical studies.

Data and Empirical Model

The data used for estimation is "the Farm Household Economy Survey of 1982" conducted by the Ministry of Agriculture and Fisheries (MAF) of Korean Government. Out of 3,375 original sample of farm households, 3,333 farm households were used in the final analysis after removing missing value of sample farm households. In addition, secondly date 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 experimentations with functional forms for a two structural equation model, the following functions were chosen for empirical estimation,

$$\ln\,(DOFF/1 - DOFF) = ao + a_1X_1 + a_2 \ln X_2 + a_3 \ln LUI + u_1 \quad (18)$$

$$\ln LUI = bo + b_1Z_1 + b_2 \ln Z_2 + b_3DOFF + u_2 \quad (19)$$

where *DOFF* and *LUI* represent off-farm employment participation status and land use intensity, respectively; X_1, X_2, Z_1, and Z_2 are explanatory variables; and, u_1 and u_2 are random disturbances.

Table 1 contains a summary statistics and its definition for the variables used in the empirical analysis.

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.[1] A total of 619

TABLE 1 MEANS AND STANDARD DEVIATIONS OF SURVEY VARIABLES 3,333 KOREAN FARM HOUSEHOLDS, 1982

Variable	Whole sample (N = 3333)		Off-farm work farm (N = 619)	
	Mean	S.D.	Mean	S.D.
Off-farm employment participation (DOFF = 1 if participate)	0.19	0.39	—	—
Land Equivalent Ratio (LER)	1.33	0.82	1.32	0.98
Operator's age (AGE)	50	11	49	10
Operator's sex (DSEX = 1 if male)	0.86	0.34	0.75	0.43
Operator's years of schooling	8.9	4.6	9.3	4.3
Number of (Education) in the family adult man-equiv. (NADULT)	2.3	0.9	2.5	1.0
Number of children aged less than 6 (CHILDREN)	0.4	0.7	0.4	0.7
Non-work income measured in 1,000 Korean won (NONWORK INCOME)	844	929	777	852
Power tiller dummy (DTILLER = 1 if holding power tiller)	0.22	0.41	0.17	0.38
Dummy variables for location industrial park area (DINDUSTRY)	0.08	0.26	0.14	0.35
Rural city area (DRURAL CITY)	0.18	0.39	0.19	0.39
Urban area (DURBAN)	0.06	0.24	0.09	0.29
Mining area (DMINING)	0.05	0.23	0.05	0.23
Fishery and others (DOTHERS)	0.09	0.28	0.09	0129
Commuting distances measured in km (DISTANCE)	14.0	8.1	11.9	8.6
Annual ave. precipitation measured in Korean won (PRECIPITATE)	1,303	233	1,293	231
Ave. lowest temeprature in January	-7.0	4.4	-7.4	4.5
Land size measured in ha (LAND)	0.99	0.65	0.81	0.57
Ratio of rented land to total land (RATIO REMTED)	0.23	0.32	0.23	0.32
Ratio of paddy land to total land (RATIO PADDY)	0.64	0.31	0.63	0.32
Ratio of livestock income to total income (RAID LIVESTOCK)	0.21	0.23	0.21	0.22
Dummy for topographical variables				
Mountainous area (DMOUNTAIN)	0.06	0.23	0.04	0.20
Semi-mountainous area (SEMIMTIN)	0.22	0.42	0.18	0.38
Semi-plain area (DSEMIPLAIN)	0.29	0.46	0.31	0.46
Daily agricultural wage rate measured in Korean won (WACTE)	6,253	989	6,409	1.024

Note: 1. standard deviation

TABLE 2 DISTRIBUTION OF OFF-FARM WORKS (WORKER AND HOUSEHOLD) BY JOB PERMANENCE, 619 KOREAN FARM HOUSEHOLDS, 1982

	Off-Farm Workers[a]		Off-Farm Work Household[b]	
Job permanence	No.	%	No.	%
Permanent	455	68	415	67
Temporary	219	32	204	33
Total	674	100	619	100

Note: [a]. Including farm operator and other family members of 619 off-farm work participation households.
[b] A farm household is classified as a permanent off-farm work household if it has one or more family members who are working under permanent job status, otherwise it is classified as a temporary off-farm work households.

farm households from 3,333 total sample participated in off-farm employment activities. About 67 percent of off-farm employed households participated in off-farm work under permanent job status (Table 2). Major occupations of permanent off-farm employment were local government officials, clerical workers in private business, whereas temporary off-farm workers were mainly employed in factories, service industries or jobs related to physical works such as construction works. Job permanence influences the amount of time engaged in off-farm work. If a worker is employed under a permanent job status, the time (hours and days) flexibility is limited. Consequently, at least in the short-run, the effective choice may be one of working a standard day (or week) or not working at all.

As a land-use intensity measure, the land equivalent ratio (LER) were used. The LER is measured through the weighted sum of the average yields of the crop for the farm.[2] This index indicates how particular farm performs in the use of its land base compared to the performance of an average farm or an experimental level (Case, et al., 1960; Ranola, et al., 1983; Price, 1984). As a whole, the LER is an index of two aspects—the productivity and cropping intensity in the use of land base. Since this index combines yields expressed in different units, such as bushels or tons, it is useful to measure the cropping intensity of inter- or mixed cropping as well as sequential cropping (Price, 1984).

Independent variables in the participation equation (DOFF) could be characteristcs of the farm household, commuting costs and attributes of farm and off-farm earnings. Variables relating to farm household are operator's age, sex, years of education, and number of adults and children in the household. Commuting distance was used as a proxy for commuting costs. For the structure of rural labor markets, qualitative variables representing types of off-farm jobs were included. Related to farm earnings, size of land, land-equivalent ratio (LER), ratio of rented farm land, farm mechanization and the enterprise specialization in farming were included The LER represents the degree of land-use intensity, and is hypothesized to be negatively correlated with off-farm employment because it is an efficiency factor (physical) directly related to increase farm income (Mosher and West, 1952).

The ratio of rented farm land to owned land was hypothesized to increase the likelihood of family members' off-farm employment because it is negatively related to farm earnings. A power tiller dummy variable was used as a farm mechanization variable. The effect of having a power tiller is unclear since it has two different roles in farming. First, it could be labor saving and free labor for alternative employment. Second, however, is that if it enhanced farm earnings, the desire or need for off-farm work could be diminished. The degree of enterprise specialization in farming is measured as the sum of squares of the share of gross revenue of each individual farm enterprise in a year. This variable is used as a proxy for riskiness of farm income; hence, a positive relationship with off-farm employment is expected, possibly to avoid or "insure" for income risk in farming (Sumner, 1982). Finally, negative effect of nonwork income on off-farm employment participation was hypothesized because of its "income effect" on income-labor supply choice (leisure is assumed to be a normal good).

In the land-use intensity function, the major explanatory variables are physical environmental variables (climate, land slope, ratio of paddy land to total land), human capital and the level of fixed farm inputs (operator's age, sex, level of education, land size, number of adult and status of farm mechanization) and variables related to farm organization (ratio of gross livestock income to total farm income, degree of tennancy and enterprise specialization). The status of off-farm employment (dummy) was included to test its effect on land-use intensity. Except farm wage rate, most farm inputs and outputs prices were excluded in the estimation because of data limitations.

For estimating equations (18) and (19), the two-stage least square estimation (2SLS) analogue was applied. Maddala and Lee (1976) have discussed estimation procedures and identification problems for this estimation. The estimation procedures of 2SLS analogue are as follows: In the first stage, predicted values for two structural equations (18) and (19) are estimated. The maximum likelihood logit estimation (logit) and ordinary least squares (OLS) are applied to estimate the reduced form off-farm employment participation and land-use intensity equations, respecitively. In the second stage, to get the unique and consistent estimation of two structural equations, logit and OLS are applied directly to estimate equations (18) and (19) with use of predicted values of two endogenous variables estimated in the first stage. For comparison between the single equation estimators and those of simultaneous estimation, the results of OLS and logit estimation for the land-use intensity and off-farm employment participation equations were included.

The Results

Table 3 shows the results of the estimated equation for the odds of participating in off-farm work. The coefficients of LOGLER have negative signs and statistically significant at five percent level in both estimations. However, a stronger relationship is observed in 2SLS analogue. The regression coefficient of LOGLER is −0.16 in logit whereas it is −0.89 in 2SLS analogue.

Farm operator's age does not influence farm household participation in off-farm work. This finding is not consistent with life-cycle labor supply theory. A quadratic relationship between farm operator's off-farm work participation and age were discussed in previous studies (Huffman, 1980; Sumner, 1982). There are two possible reasons for the negative insignificant coefficient or lack of any relationship between age and off-farm employment: (a) younger age groups are more likely to work in non-agricultural jobs because of lower future expected income from agriculture; and (b) the farming offers lower social status than alternative off-farm occupations. Consequently, farmers in every age bracket are equally likely to participate in off-farm work.

If the operator's sex was female, the farm households were more likely to participate in off-farm work. When a husband works off the farm, usually his wife becomes the farm operator. Also it is easier in Korea for husbands to get off-farm jobs, and their employment provides higher earnings.

Education is expected to provide general human capital valuable to both on and off-farm occupations. The estimated coefficients of EDUCATION is consistent with this expectation.

The size of land holdings were negatively related with off-farm work. This is because farmers with larger land holdings can provide fuller employment and consequenty earn more farm income than farmers with less land.

Power tillers had a negative and insignificant coefficient. This implies that the main purpose of farm mechanization in Korea (up to this time) was to substitute for the labor shortages. In other words, they were not cost reducing in nature.

The significant coefficient of NADULT, number of adults in a family, implies that an increase of adult family members will increase the probability of off-farm work participation by the households.

The coefficient of NONWORK INCOME was negative and statistically significant. This finding is consistent with the theory of labor supply. That is, the income effect over-shadows the price (opportunity cost) effect associate with off-farm employment.

TABLE 3 LOGIT AND 2SLS ANALOGUE ESTIMATES OF OFF-FARM EMPLOYMENT PARTICIPATION FUNCTION

Explanatory Variable	Logit Coefficient		2SLS Analogue Coefficient		2SLS Analogue Partial Probability
INTERCEPT	2.11**	(0.62)	4.74**	(1.08)	—
AGE[2]	—0.60	(0.53)	0.04	(0.06)	a
DSEX	—0.95**	(0.13)	—0.93**	(0.17)	—0.14
EDUCATION	0.05**	(0.01)	0.06**	(0.01)	0.01
LOGLER	—0.16*	(0.08)	—0.89*	(0.37)	—0.14
NADULT	0.51**	(0.06)	0.53**	(0.06)	0.08
NONWORK INCOME[3]	—0.23**	(0.06)	—0.28**	(0.01)	—0.04
LOGLAND	—0.53**	(0.07)	—0.89**	(0.13)	—0.14
DTILLER	—0.18	(0.13)	0.01	(0.15)	a
CHILDREN	—0.09	(0.07)	—0.04	(0.08)	—a
DISTANCE	—0.02**	(0.01)	—0.01**	(0.01)	—a
RATIO RENTED	—0.06	(0.15)	0.01	(0.19)	a
DINDUSTRY	0.55**	(0.20)	0.45	(0.25)	0.07
DURAL CITY	0.02	(0.16)	—0.08	(0.19)	—0.01
DRURBAN	0.43*	(0.18)	0.45*	(0.22)	0.07
DMINING	0.05	(0.24)	0.11	(0.29)	0.02
DOTHERS	0.13	(0.22)	0.30	(0.25)	0.05
SPECIALIZE	0.92**	(0.27)	0.93**	(0.35)	0.14
Dependent variable	log (DOFF/1−DOFF)		log (DOFF/1−DOFF)		
No. of obs.	3,269				2,627
Model chi-square (W) =	297.8(17df)				215.4(17df)

Note: 1. The figures in the parentheses are standard errors of the estimates.
2. Estimates have been multipled by 10^2
3. Estimates have been multiplied by 10^6.
4. ** statistically significant at 1% level
* statistically significant at 5% level
+ statistically significant at 10% level
5. a 0.01
6. Variables are defined as: operator's age (AGE), sex (DSEK = 1 if male), years of schooling (EDUCATION); log of LER(LOGLER); number of family adults (NADULT); log of land size in ha (LOGLAND); number of children less than 4 years (CHILDREN); ownership of power tiller (DTILLER 1, if owner); commuting distance in km (DISTANCE); ratio of group = general agricultural area): DINDUSTRY = 1 if industrial part area; DRURAL CITY = 1 if rural city; DURBAN = 1 if urban area; DMINING = 1 if mining area; DOTHERS = 1 if other area; and agricultural enterprise specialization (SPECIALIZE).

Number of children (child < 6 years of age) in the household does not influence off-farm work participation by farm households. The variable CHILDREN has a insignificant but negative coefficient. It was expected that the larger the number of children, the larger the demand for household time of the household members for child rearing activities; hence, less time for off-farm work. Some possible explanations for an insignificant statistical results are: (a) the male household member's time is not an important input in child rearing, and the majority of the off-farm workers are males; (b) as the number of children increase, not only the demand for household time, the need for more income would be arised, so that the net effect on the probability of working is negligible; and (c) to the majority Korean farmers the child rearing may not be a serious problem for off-farm work because the average farm operator's age is around 50 years.

Commuting distance strongly influences off-farm work by Korean farmers. Under-development of the rural transport system is a contributing factor to the relative large amount of time required for commuting. Types of off-farm job opportunities were important and the estimated coefficients of these variables were generally consistent with expectations. Farmers living near rural industrial parks or urban areas had more off-farm jobs than those living in other agricultural areas. As expected, the DURBAN coefficient was positive and significant at the 10 percent level. The coefficient of "industrial park area" was insignificant but positive. Off-farm job opportunities therefore, appear to be a factor in off-farm employment.

Enterprise specialization in farming was used as a proxy variable for the riskiness of farm income. The estimated coefficient of SPECIALIZE is positive and significant at the 1 percent level. This implies, other factor held constant, that the more specialized a farm, the more likely the farm operator to participate in off-farm work, possibly to avoid income risk in farming. Too, enterprise specialization can be associated with peak and valley labor requirements. Seasons with low labor requirements can afford the opportunity for off-farm employment, yet maintain specialized farm production activities without reduced farm income. This finding is consistent with other research results (Sumner, 1982).

To evaluate the impact of a change in an explanatory variable on the probability of off-farm employment participation, a coefficient of partial probability was calculated for each explanatory variable. These coefficients are contained in column 6 of Table 3. The coefficient of partial probability for a certain explanatory variable X_i at its mean is estimated by $\partial \mathrm{DOFF} / \partial \mathrm{X}_i = b\,\overline{\mathrm{DOFF}}(1 - \overline{\mathrm{DOFF}})$ where b is an estimated regression coefficient and $\overline{\mathrm{DOFF}}$ is the mean value of DOFF variable.

From column 6 of Table 3, observe that DSEX, LOGLER, NADULT AND SPECIALIZE variables have higher partial probability coefficient than other variables (excluding intercept). For example, an increase in one unit of LOGLER will increase the odds of off-farm work participation by 14 percent. For NADULT variable, this probability is 8 percent.

Table 4 presents the estimation results of OLS and 2SLS analogue of the land-use cropping intensity function. The dependent variable is a natural log transformed land equivalent ratio (LOGLER). The LER has some advantages over the multiple cropping index (MCI) or other land-

TABLE 4 OLS AND 2SLS ANALOGUE ESTIMATES OF THE LAND EQUIVALENT RATIO FUNCTION

Explanatory Variable	OLS Coefficient		2SLS Analogue Coefficient		2SLS Analogue Elasticity
INTERCEPT	2.40**	(14.7)	2.91**	(15.0)	—
AGE	—0.13	(—1.4)	—0.17	(—1.8)	—0.08
DSEX	0.10**	(3.3)	0.72	(0.2)	0.61
EDUCATION	0.45*	(2.0)	0.93**	(3.8)	0.08
NADULT	2.05	(1.9)	6.29**	(4.7)	0.14
DTILLER	0.15**	(6.8)	0.14**	(6.3)	0.03
PRECIPITATE[b]	9.86**	(2.5)	10.05**	(2.6)	0.13
TEMPERATURE	0.02**	(7.7)	0.01**	(5.1)	0.07
LOGLAND	—0.25**	(—15.6)	—0.33**	(—14.5)	—0.33
LOGRATIO PADDY	0.08**	(3.4)	0.07**	(3.2)	0.07
LOGRATIO LIVESTOCK	—0.07**	(—10.1)	—0.07**	(—9.8)	—0.07
RATIO RENTED	—0.14**	(—4.8)	—0.12**	(—4.0)	—0.03
DMOUNTAIN	—0.14**	(—3.4)	—0.18**	(—4.3)	—0.01
DESMIMTIN	—0.08**	(—3.2)	—0.11**	(—3.8)	—0.02
DSEMIPLAIN	—0.09**	(—4.1)	—0.08**	(—3.8)	—0.02
SPECIALIZE	—0.62**	(—9.1)	—0.50**	(—6.9)	—0.24
FARM WAGE[c]	—2.11*	(—2.1)	—6.83	(—0.6)	—0.42
DOFF	—0.07**	(—3.0)	—0.79**	(—5.2)	—0.15
Dependent variables	LOGLER		LOGLER		
No. of observations	2,627		2,627		
R^2	0.21		0.21		
F	40.4		41.7		

Note: [a] Coefficient has been multiplied by 10^2

[b] Coefficient has been multiplied by 10^5

[c] ** statistically significant at 1% level

* statistically significant at 5% level

+ statistically significant at 10% level

[d] Figures in the parentheses are t-values of the estimates.

[e] Variables are defined as: annual precipitation measures in mm (PRECIPITATE); ratio of paddy land (RATIO PADDY); ratio of livestock income (RATIO LIVESTOCK); dummies for land slope (control group = plain area): DMOUNTAIN = 1 if mountaineous; DSEMIMTIN=1 if semi-mountaineous; DSEMIPLAIN=1 if semiplain area; daily farm wage rate (FARM WAGE), and other variables are defined as in Table 1.

use cropping intensity indices. The LER measures not only the number of sequential crops produced on a given unit of land but also the total output of a farm per unit of land. The index reflects the efficiency of land-use (Mosher and West, 1952; Price, 1984).

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 labor, having a power tiller, favorable 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.

In Table 4, the coefficient of AGE is negative and significant at the 10 percent level. This means that the intensity of land use was more likely to be practiced on farms with younger farm operators than those with older farm operators.

Operator's sex does not appear to influence land-use cropping intensity. In OLS estimation the coefficient of DSEX is significant at the 1 percent level in the LOGLER function. This implies that operator's sex is less important for increasing cropping intensity when cropping intensity and off-farm employment participation are considered simultaneously. This may happen because when a husband works off the farm, usually his wife becomes the farm operator; hence, the operator's sex is not an important explanatory factor. Instead, the number of adults in a farm household may be more important for increasing cropping intensity in this joint determination. The significant and stronger coefficient of the NADULT variables with 2SLS analogue estimation supports this connection.

Operator's formal education was found significant at the 1 percent level. This confirms the hypothesis that the better educated farmers access information which 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 (1 percent level of significance). This implies that having a power tiller increases the land-use efficiency. This fits the hypothesis that a power tiller increases land productivity through increments of multiple cropping. Consequently, improved management and associated yeild increases are likely.

Climate was found important to increased land-use cropping intensity in Korea. Both annual precipitation and the minimum temperature in January had positive and significant coefficients in the LOGLER function. This implies that the more favorable climatic conditions (mainly temperature and precipitation) a farm has, the more intensively land will be used.

Size of farm impacts dramatically on cropping intensity since it has a large elasticity. The coefficient for size was negative and significant at the 1 percent level. This supports the hypothesis that the smaller sized farms use land more intensively than the larger size farms.

The ratio of paddy land to total farm land gives a positive relationship to cropping intensity. This shows that land productivities of paddy lands are still higher than that of uplands in Korea.

The variables relating to land slope were found to be negatively related to cropping intensity. Intensive land use is more likely to be practiced on farms with a flat topography than sloping lands with erosion problems.

The ratio of rented area to total land was found negative and significant at the 1 percent level. This finding supports the hypothesis that farmers can not utilize rented land as efficiently as owned land. Perhpas this is because of (a) the uncertainty of tenure on those lands, and (b) rented lands may have lower productivity.

Two of the farm organization variables, the ratio of gross livestock income to total gross income and the specialization index, were found to be negatively and significantly related with cropping intensity. This implies that a livestock or enterprise specialization utilizes farm land less efficiently from an agronomic perspective than other general crop growing farms. The implication of these results are especially important in present Korean agriculture because the general trend of farm organization is moving toward more enterprise specialization as farm operations become commercialized.

The coefficient of farm wage indicates higher wages reduce cropping intensity. But the level of probability for the likelihood of occurrence is not very high, perhaps because of low variation of this variable in our cross-sectional data.

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 17 independent variables, number of adults in a household, temperature, size of farm, the specialization index and off-farm employment are important variables determining cropping intensity or land utilization in Korea.

Summary and Implications.

This study concerns the interrelationship between two important decisions—farm household labor use and land-use intensity. Parameters on the two equation model, containing one discrete off-farm employment participation function and one continuous land-use intensity function, were estimated using cross-sectional observations on individual Korean farms. The theoretical expectations of the model are, generally, confirmed by the data analysis.

The most important result is a strong and negative interrelationship between off-farm employment and land-use intensity. For example, a ten percent increase in the off-farm employment will result in 1.5 percent reduction of 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 being 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 these policy conflicts are increased resources devoted to farmers' education and farm mechanization activities.

Farmers' education and farm mechanization are shown to be positively associated with off-farm employment and cropping intensity. Especially farmers' education variable has a strong and positive effect on both policy conflict variables. Farm mechanization (holding a power tiller) has a strong and positive effect on cropping intensity, and positive effect on off-farm employment (although it is not significant). Efforts that successfully increase farmers' education can be expected to increase off-farm employment and farm output. Also, increase farm mechanization can be expected to increase food production without reductions in off-farm employment.

To minimize this conflicts, rural industrialization and agricultural production policies should be coordinated. Implementation policies should not be at the same location. When regional conflicts do arise however, a balanced approach should be pursued. For example, the government can give priority of farm mechanization and educational supports to a region where those conflicts are expected.

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FOOTNOTES

1. This number was chosen since it is the average of annual off-farm work days of the sample.
2. The LER is computed as

$$\sum_{j=1}^{n} (y_{ij}/Y_j)/X_i$$

where y_i denotes output of a farm, i, of each product j; Y_j is the standard yield of output j per unit of land (here the national average of output j is used as a standard yield), and X_i represents the amount of land available to farm i.