Off-Farm Employment Decisions by Massachusetts Farm Households

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The off-farm labor participation and supply decisions of Massachusetts farm families were estimated in a model which allows for joint decisions. The hypothesis of joint off-farm participation decisions by operators and spouses was rejected. However, there was some evidence that the hours supplied by the farm operator was dependent upon the decision by the spouse to work off-farm. Farm operators were found to respond to both family and farm characteristics in making participation and supply decisions. Spouses respond to the characteristics of the farm and family in participation decisions while family characteristics determined hours worked by the spouse.

Introduction

The decisions by farm families to participate in off-farm employment has received increased attention in recent years (i.e. Lee, Huffman, Sumner, Simpson and Kapitany). Given the importance of off-farm employment income to farm families, the attention is certainly justified. In 1944, fewer than 30% of farm operators worked off-farm. By 1982, 53% of farm operators reported working some days off-farm and over 34% reported working 200 or more days off-farm (Ahearn and Lee). Thus, many farm families are just as sensitive to general economic conditions as they are to farm profitability and farm policy.

The increasing proportion of farm families with off-farm employment constitutes a change in farm structure. Knowledge of the ways that different members of the farm family respond to changes in exogenous factors is limited. The relative importance of farm, family, financial, and local economic characteristics to decisions by the farm operator and the spouse are crucial to understanding this change in farm structure. Nationally, it is important for farm policy formulation to consider these changes in farm structure. Reliable characterizations of the farm sector, including interactions between the farm and nonfarm components of family income, are necessary to assess accurately the impacts of policy changes on family welfare, income distribution, and farm program participation. These factors are important to understanding and forecasting land use and rural development changes as well.

While theoretical models have focused on time allocation by the family (Huffman, Gronau), empirical models of participation in off-farm labor markets and hours worked off-farm have typically been limited to one family member. For example, Jensen and Salant and Simpson and Kapitany focused on the farm operator. Alternatively, decisions by either farm men (Huffman, Sumner) or farm women (Rosenfeld) have been modeled. Furtan et al. and Thompson estimated models for both the husband and wife separately. An appropriate model should take into account the joint nature of household decisions. Huffman and Lange, in an application to Iowa farm households, provide an important development in modeling the joint decision process of farm families.

The objective of this paper is to employ an empirical framework that explicitly accounts for joint off-farm participation and labor supply decisions by farm family members. In the following section, the decisions to work off-farm by the farm operator and spouse are cast in the framework of utility maximization. The theoretical model provides solutions for all choices by the household. This paper concentrates upon the off-farm participation decisions and the supply of off-farm labor. Off-

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farm employment participation models for the operator and spouse are estimated jointly for a sample of Massachusetts farm families. The results are used to infer the importance of joint participation decisions by farm families in Massachusetts. Finally, off-farm labor supply equations are estimated for the operator and spouse and the conditional nature of labor supply is considered.

Model Specification

Farm households are assumed to maximize utility by choosing levels of purchased goods (Y) and leisure (L). While the leisure of all family members may be important, it is assumed for simplicity that consideration of the farm operator's leisure (L_1) and spouse's leisure (L_2) are sufficient for the maximization of household utility (Gronau). In addition, vectors of exogenous levels of individual human capital (H_1 and H_2) and household characteristics (E) determine the level of household utility. Both the operator and spouse are assumed to have opportunities to supply on-farm labor (F_1 and F_2) and off-farm labor (M_1 and M_2). The typical budget constraint is imposed on the household with farm profits and off-farm wages contributing to household income. Constraints for the total amount of time available to the operator and the spouse are imposed. Leisure, on-farm labor, and off-farm labor compete for the allocation of total time. The problem is then similar to the analysis of multiple job holdings by Shishko and Rostker. An important difference arises in that the wage received for farm work is not assumed constant. Given the normal regularity conditions for the production function, on-farm labor by both the operator and spouse will face diminishing marginal returns. The production function therefore imposes an additional constraint on the maximization of utility by the farm household.

Following Huffman and Gronau, the model is stated formally as the maximization of utility:

$$(1) \quad U = U(Y, L_1, L_2; H_1, H_2, E),$$

subject to the constraints:

$$(2) \quad P_y\, Y = P_q\, Q - R\, X + w_1\, M_1 + w_2\, M_2 + V;$$

$$(3) \quad Q = f(X, F_1, F_2; H_1, H_2, G); \text{ and}$$

$$(4) \quad T_i = L_i + F_i + M_i, \quad M_i \geq 0, \text{ for } i = 1, 2.$$

The final constraint, equation (4), includes an inequality constraint on hours of off-farm work. The number of hours of off-farm work may be zero for either the operator or spouse.

The household chooses the levels of purchased goods, leisure, farm labor, off-farm labor, farm inputs (X), and farm output (Q) given prices (P_y, P_q, R), off-farm wages (w_1, w_2), other income (V) and other exogenous factors which shift the production function (G). An interior solution exists if the optimal allocations of time to leisure, on-farm work and off-farm work are all non-zero. The optimal levels of the choice variables can then be determined by solving the set of first order conditions (see Huffman). However, corner solutions may exist for off-farm work by both the operator and spouse. The Kuhn-Tucker conditions are then appropriate and provide the following participation rules:

$$(5) \quad D_i = \begin{cases} 1 \text{ if } w_i^* > 0 \text{ (individual participates)} \\ 0 \text{ if } w_i^* \leq 0 \text{ (individual does not participate)} \end{cases}$$

where:

$$(6) \quad w_i^* = \left(w_i - P_q \frac{\partial Q}{\partial F_i}\right)\Bigg|_{M_i = 0}$$

is the unobserved difference between the market wage and the shadow value of farm labor for the operator or spouse evaluated at zero hours of off-farm employment. If the market value of time is less than the shadow value of farm labor, then the individual does not work off-farm; a corner solution is observed. A market wage greater than the shadow value of farm labor will result in an allocation of time to both farm and off-farm activities.

Supply equations for off-farm labor by the operator and spouse are determined by simultaneous solution of the Kuhn-Tucker conditions. If interior solutions for both the operator and the spouse occur, we observe supply functions for both the operator and the spouse:

$$(7) \quad S_1 = s_1(w_1, w_2, P_y, P_q, R, H_1, H_2, E, V, G); \text{ and}$$

$$(8) \quad S_2 = s_2(w_1, w_2, P_y, P_q, R, H_1, H_2, E, V, G).$$

If an individual does not work off-farm, neither the off-farm wage or hours worked are observed. The reduced form of the off-farm supply function for individual i given individual j does not participate is then:

(9) $S_i = s_i(w_i, P_y, P_q, R, H_i, H_j, E, V, G)$.

In this case, the supply function does not depend upon the non-participant's wage. However, the supply function is conditional upon the participation decision by the non-participant.

Solving the set of Kuhn-Tucker conditions in terms of the exogenous factors gives the empirical specification of equation (6):

$$w_i^* = Z_i \beta_i' + u_i, \tag{10}$$

where Z_i represents a vector of exogenous factors including H_1, E, G and V. Using (10), the binary decision rule can now be expressed in terms of the observable exogenous factors and the stochastic error:

$$D_i = \begin{cases} 1 \text{ if } -(Z_i \beta_i') < u_i \\ 0 \text{ if } -(Z_i \beta_i') \geq u_i. \end{cases} \tag{11}$$

The appropriate empirical form for estimation of the unobservable participation rules is one of the probability models. Operator and spouse participation decisions are linked by the assumption that stochastic errors are normally and jointly distributed with $\text{Cov}(u_1, u_2) = \rho$. The appropriate statistical model is then the bivariate probit model:

$$\Pr(D_1 = 1, D_2 = 1) = \Phi(Z_1\beta_1'; Z_2\beta_2'; \rho). \tag{12}$$

Decision rules for the operator and spouse are also assumed to be jointly dependent. Extending the empirical structure in (10) to include the assumption of simultaneous decisions yields:

$$\begin{aligned} w_1^* &= \gamma_1 w_2^* + Z_1 \beta_1 + u_1, \\ w_2^* &= \gamma_2 w_1^* + Z_2 \beta_2 + u_2. \end{aligned} \tag{13}$$

Binary indicators are again used for the unobservable decision rule variables. The final empirical model accounts for joint and simultaneous participation decisions by the operator and spouse and will be applied in the following analysis.

The off-farm labor supply functions are conditional upon the individual's participation decision and the participation decision by her spouse. The truncated nature of the dependent variable, hours worked, can lead to bias if estimation is by ordinary least squares. Estimation techniques developed by Heckman and Tobin to correct for such bias are well established in the literature. An individual's labor supply function is also conditional upon the spouse's participation decision. To account for this factor a two-stage estimation procedure was employed utilizing predicted probabilities from probit models to eliminate possible simultaneous equation bias.

Data

The data set used in the analysis was obtained from a survey of Massachusetts farm households. A sample of 671 farms was randomly drawn from tapes of the Agricultural Stabilization and Conservation Services (ASCS). Active telephone numbers were obtained for a total of 507 farmers from the original sample. The survey was conducted by telephone interview from November 1986 through April 1987. There were 159 completed questionnaires for Massachusetts farm households, a response rate of 31.3 percent.

The ASCS list of farms in Massachusetts may not accurately represent the true farm population for the following reasons. First, the proportion of farmers enrolled in national farm programs may be lower than desired. Given the crop mix in Massachusetts, farmers would not be expected to take advantage of federal farm programs. Secondly, there may be a larger percentage of rural families who own several acres of woodland or pasture that has been included in a program designed to preserve open space. The discrepancy between the USDA estimate of the number of farms in Massachusetts (about 6,000) and the ASCS population size on the tape (8,229) indicated that the latter problem existed. Respondents who were not currently farming were screened early in the interview. The first problem could not be addressed easily.

The sample was checked against the Census of Agriculture conducted in 1982. As shown in Table 1, the distribution of farms by sales class closely matches the results obtained by the 1982 Census of Agriculture. The sample

Table 1. Distribution of Massachusetts Farms by Cash Sales

	Percentage of Farms	
Cash Sales	1985 Off-Farm Labor Survey	1982 Census of Agriculture
Less than $10,000	57.5	55.4
$10,000–$39,000	18.5	19.6
$40,000–$99,000	11.0	13.1
$100,000–$499,000	11.6	10.6
Greater than $500,000	1.4	1.3

also appears representative in terms of the size of farms. The Census estimated that the average farm size in Massachusetts was 113 acres in 1982. The average farm size for the sample was about 129 acres. The average age of operators in 1982, 51.5 years, compares closely to the survey mean of 52.5 years. The Census reported that 89.4% of operators were male, while the survey found that 88.6% of the operators were male in 1985. Survey farms were also comparable in terms of farm type. The census reported that 13.5% of the farms produced field crops as the principal crop while the survey found that 16.3% of the farms produced field crops. Vegetables were produced on 15.6% of the Census farms compared to 20.1% of the survey farms. Both the Census and the survey found that dairy farms represented 14.5% of the Massachusetts farms. Other livestock products represented 31.2% of the Census farms compared to 28.4% of the survey farms. These comparisons were made for two different years; however, the survey sample appears to represent the farm population of Massachusetts.

There were 125 valid observations for farm operators after eliminating observations with missing values. Of these 125 farm operators, there were 114 who indicated they had a spouse.[1] The joint distribution of the off-farm work decisions by the operator and the spouse can be seen in Figure 1. The numbers in the cells of the matrix represent the number of respondents in the four categories for the subset. As seen in Figure 1, the number of farm families surveyed with some form of off-farm employment predominates. A total of 77 of the 114 farm families obtained part of their income from off-farm sources of employment. Off-farm employment was also more prevalent for the operators than the spouses of farm families. Sixty-two of the total 114 married farm operators, about 55%, worked off the farm. By comparison, a total of 51 (about 45%) of the spouses worked off-farm in 1985.

Theory suggests that prices and other exogenous factors should be arguments of the participation models. However, it was assumed that all households in the sample face similar price levels. The analysis will focus on the impacts of other exogenous factors on the participation and supply decisions.

Figure 1. Joint Off-Farm Work Decisions by Massachusetts Farm Families

Operator Works Off-Farm	Spouse Works Off-Farm: Yes	No	Total
Yes	36	26	62
No	15	37	52
Total	51	63	114

Means, standard deviations and the units of measurement for the variables used in the analysis are presented in Table 2. Individual characteristics include measures of human capital stock, age and sex for the operator and spouse. Farm experience, education, off-farm experience and job training are assumed to measure the stock of an individual's human capital. Human capital enhances an individual's productivity on farm, raising the shadow value of farm labor. A similar relationship is observed for off-farm wages. The combination of these impacts on the probability of off-farm participation is uncertain. Previous empirical evidence has generally found positive impacts of education on both the participation in and supply of off-farm labor (see Findeis, et al., Huffman, or Lass, et al. for reviews). Farm experience has been shown to decrease the probability of participation and the hours supplied. Off-farm experience has generally had the opposite impact.

Age is generally included in quadratic form to capture life-cycle effects. Recent studies have found evidence of a life-cycle effect (Huffman and Lange) while others have found conflicting results (Rosenfeld, Leistritz, et al.). Where the life-cycle effect is observed, participation and hours supplied peak between ages 45 and 55. Sex is included in the model to capture differences between male and female participation and supply. The final individual variable included is the off-farm wage rate. The wage rate is assumed to represent market demand for labor and an exogenous evaluation of the individuals stock of human capital. Wage functions are often modeled and used in supply equations as predicted endogenous variables (Huffman and Lange, Sumner); however, doing so eliminates important variation in individual wage rates. Wage rates are only arguments of labor supply functions. They represent a component of the dependent variable in the participation models and should not be included as regressors.

[1] Since marriage is not an institution chosen by everyone, we may have introduced some bias by inadvertently excluding "partners" during the survey. This appears to be a possibility for only a small portion of the sample.

Table 2. Summary Statistics for Variables in Participation and Supply Models

Variable	Operator	Spouse
Individual Characteristics:		
Farm Experience (years)	23.91	23.91
	(16.43)	(16.43)
Age (years)	51.53	50.25
	(12.83)	(13.25)
Education (years)	13.52	13.66
	(3.08)	(2.28)
Off-Farm Experience[a] (years)	22.76	13.74
	(13.47)	(11.05)
Job Training[a] (binary, yes = 1)	0.32	0.42
	(0.47)	(0.50)
Sex of Individual (binary,	0.93	0.11
male = 1)	(0.26)	(0.32)
Off-Farm Wage ($ per hour)	14.05	10.63
	(11.20)	(11.28)
Family Characteristics:		
Number of Children < Age 5	0.21	0.21
	(0.56)	(0.56)
Number of Children Ages 5–18	0.69	0.69
	(1.21)	(1.21)
Farm Characteristics:		
Sales (categorical)	1.79	1.79
	(1.19)	(1.19)
Organization (Corporation = 1)	0.07	0.07
	(0.26)	(0.26)
Dairy	0.15	0.15
	(0.36)	(0.36)
Field Crops	0.18	0.19
	(0.39)	(0.39)
Vegetables	0.18	0.19
	(0.39)	(0.39)
Tree Nuts and Forestry	0.17	0.17
	(0.37)	(0.37)
Fruit	0.04	0.04
	(0.21)	(0.21)
Financial Characteristics:		
Other Income (%)	7.11	7.11
	(15.72)	(15.72)
Location:		
Distance to Town (miles)	2.29	2.29
	(2.73)	(2.73)
Unemployment Rate (%)	3.82	
	(1.64)	
Commuting Distance[a] (miles)	9.39	13.17
	(9.84)	(22.24)

Note: Numbers in parentheses are standard deviations.
[a] Means computed for observations used in labor supply models. For the operator, n = 41, and for the spouse, n = 31.

The number of children in the household have been found to be most important to participation and supply decision by women (Rosenfeld, Thompson). Since 89 per cent of spouses in the sample were woman, it is expected that a greater number of children in the household will decrease participation and hours supplied by the spouse. Age of the children has also been shown to be important with pre-school children having the greatest impacts. The impacts on decisions by operators is uncertain.

A number of categorical and binary variables are included as characteristics of the farm. Ideally, the quasi-rent or production function would be estimated and predicted values included in the participation and supply models (Huffman, Streeter and Saupe). However, the necessary data were not available from the survey. A categorical variable measuring farm sales was used as an alternative. Categories for the sales variable range from one to five and are consistent with the categories in Table 1. In addition, binary variables for farm organization and farm type were included. Livestock farms are used as the basis of comparison for farm type binary variables.

Financial characteristics of the farm family are included to capture the effects of exogenous non-wage income on participation and supply decisions. If leisure is a normal good, higher levels of other income would result in fewer hours of off-farm employment. Previous empirical results generally support this hypothesis although estimates have been inelastic. The final set of variables capture location and vitality of the local labor markets. Two distance measures are included, the distance to the nearest town and the individual's commuting distance. It is expected that location near a town provides access to more opportunities. Commuting distance indicates the fixed costs associated with participation and labor supply. Cogan has shown that the effects of such "time costs" are ambiguous. The final variable included, the unemployment rate for 1985, was collected for the sample by town of residence (Massachusetts Department of Employment and Training). Greater levels of unemployment should result in lower levels of participation and fewer hours supplied due to excess supply in local labor markets.

Results

Participation Models

Investigation of the factors affecting operator and spouse participation decisions was conducted as follows. A simultaneous equation bivariate probit model was estimated for the sample of married operators and spouses. A three-stage procedure was followed to estimate the structural parameters of the model (Maddala, pp. 246-247). In the first stage, reduced form probit models were estimated for the operator and the spouse. Second stage probit models were estimated using predicted probabilities of participation from the first stage as regressors. Parameter estimates from the second stage were used as starting values for final estimation of a bivariate probit model. The bivariate probit model accounts for correlation of error terms and provides full information maximum likelihood estimates.

Results from the final bivariate probit model are presented in Table 3. It is surprising to note that the estimated parameters for the predicted endogenous variables were both positive. In other words, an increase in the probability of the operator (spouse) working off-farm results in an increase in the probability of the spouse (operator) working off-farm. However, the resulting parameter estimates were not significantly different from zero. Parameters for the predicted endogenous variables and the correlation between models were restricted to zero to test for joint and simultaneous decisions by the operator and spouse. The null hypothesis that the three parameters were jointly zero was not rejected at the 5% level of significance using a likelihood ratio test. Given the results of the hypothesis test, univariate probit models were estimated for the operator and spouse (Table 4) and will be discussed below. However, parameter estimates obtained from the univariate models were consistent in sign and magnitude with the bivariate results.

Likelihood ratios were used to test the hypotheses that all slope parameters were jointly zero. We reject the hypotheses that all slope parameters were jointly zero at the 1% level of significance for operator and spouse models. Calculation of R^2 for probit models is not appropriate; however, there are several measures which indicate the "goodness of fit." Amemiya suggests a pseudo measure of R^2 calculated from the likelihood function.[2] The pseudo R^2 measures for the farm operator and spouse models were 0.47 and 0.25, respectively. In addition, the models correctly predicted 82% of the actual outcomes for farm operators and 76% for spouses.

Interpretation of parameter estimates from probit models is not straightforward. However, parameter signs, relative magnitudes and levels of significance are consistent in their influence on the probability of working

Table 3. Bivariate Probit Estimates for Joint Operator and Spouse Decisions

Variable	Operator	Spouse
Individual Characteristics:		
Farm Experience	−0.0001	−0.0032
	(0.06)	(0.19)
Age	0.3105	0.2507
	(1.35)	(1.55)
$(\text{Age})^2$	0.0032	−0.0028
	(1.39)	(1.64)
Education	0.1616	0.1208
	(1.45)	(0.97)
Sex	1.4816	−0.0698
	(1.71)*	(0.07)
Family Characteristics:		
Children (<5)	0.8242	−0.0423
	(1.45)	(0.09)
Children (5–18)	−0.1299	−0.0686
	(0.58)	(0.40)
Farm Characteristics:		
Sales	−0.6735	−0.4417
	(1.81)*	(1.25)
Organization	2.6358	2.2240
	(0.95)	(0.84)
Dairy	−0.7862	−0.2541
	(0.73)	(0.29)
Field Crops	0.0241	−0.3533
	(0.03)	(0.60)
Vegetables	0.2046	0.3519
	(0.26)	(0.65)
Forestry Products	1.5385	−0.0450
	(1.25)	(0.05)
Fruit	−0.7233	0.1604
	(0.60)	(0.13)
Financial Characteristics:		
Other Income	−0.0440	−0.0210
	(0.87)	(1.18)
Location:		
Distance to Town	−0.0316	−0.0430
	(0.24)	(0.59)
Unemployment Rate	0.0717	−0.0423
	(0.47)	(0.34)
Predicted Endogenous Variable[a]	0.0929	−0.4342
	(0.05)	(0.29)
Correlation Coefficient	0.2330	
	(0.79)	

Note: Numbers in parentheses are absolute values of asymptotic t-statistics.
* Statistically different from zero at the 5% level or better.
[a] Predicted endogenous variables obtained from reduced form equations.

[2] Amemiya's measure is calculated as follows: $R^2 = 1 - [\ln L(u)/\ln L(r)]$, where L(u) is the value of the unrestricted likelihood function and L(r) is the value of the likelihood function when all slope parameters are restricted to zero.

Table 4. Univariate Probit Estimates for the Farm Operator and Spouse

Variable	Operator	Spouse
Individual Characteristics:		
Farm Experience	−0.0006	−0.0018
	(0.03)	(0.13)
Age	0.3089*	0.2180*
	(2.17)	(2.18)
$(\text{Age})^2$	−0.0032*	−0.0025*
	(2.31)	(2.45)
Education	0.1550*	0.1115
	(2.19)	(1.55)
Sex	1.4895*	0.0870
	(2.80)	(0.18)
Family Characteristics:		
Children (ages <5)	0.8646*	−0.1163
	(2.38)	(0.41)
Children (ages 5–18)	−0.1375	−0.0501
	(0.81)	(0.38)
Farm Characteristics:		
Sales	−0.6844*	−0.3764*
	(3.17)	(2.26)
Organization	2.7181*	1.8758*
	(2.98)	(2.43)
Dairy	−0.8085	−0.1366
	(1.23)	(0.26)
Field Crops	0.0589	−0.3918
	(0.12)	(0.93)
Vegetables	0.2285	0.3454
	(0.45)	(0.81)
Forestry Products	1.5607*	−0.1830
	(2.20)	(0.38)
Fruit	−0.6261	0.2118
	(0.69)	(0.26)
Financial Characteristics:		
Other Income	−0.0506*	−0.0176
	(1.79)	(1.49)
Location:		
Distance	−0.0245	−0.0391
	(0.32)	(0.76)
Unemployment Rate	0.0645	−0.0549
	(0.63)	(0.63)
Chi-Squared	74.18*	38.46*

Note: Numbers in parentheses are absolute values of asymptotic t-statistics.
* Statistically different from zero at the 5% level or better.

off-farm and are discussed within that context. The effects of individual characteristics on the probability of off-farm participation were generally consistent with expectations. The effects of farming experience were negative; however, estimated parameters were very close to zero and were insignificant. Age was included in the models in quadratic form to account for life-cycle effects. Results support the life-cycle hypothesis with the maximum probability of working off-farm for the operator occurring at age 48. The results suggest that the probability of the spouse working off-farm increased until age 44 and then declined. Education represents the accumulation of human capital which increases the value of labor both on and off the farm. An increase in education results in higher probabilities of working off-farm for both operators and spouses. The effects of education on off-farm wages appear to outweigh the effects on the marginal productivity of on-farm labor for both the operator and spouse. Males were found to work off-farm more frequently in both the operator and spouse models.

Family characteristics had mixed effects on decisions to work off-farm. Preschool children have been shown to decrease the probability of off-farm work for the spouse (Thompson). Expectations for the operator are not as clearly defined. It is interesting to note that the effect of pre-school children was to significantly increase the probability of off-farm employment for the operator. It appears that operators react to the finalcial burdens of children. The parameter estimate for the spouse had the expected negative sign, but was not significantly different from zero. The number of school-age children had a negative effect on both the operator and spouse decisions. However, the parameter estimates were not significantly different from zero.

Several variables were included to characterize the farm operation. A categorical variable, gross farm sales, was included to capture the effects of farm size on the probability of working off-farm. As expected, the results indicated that off-farm participation declines as sales increase.[3] A binary variable was included to indicate whether the farm business was incorporated. Operators and spouses were found to work off-farm more frequently when the farm was incorporated. It is possible that this binary variable captured the effects of managerial capabilities which release the farm family to pursue off-farm opportunities. Alternatively, respondents may have been investors and the farm enterprise was secondary to their primary careers. Dummy variables were also included to capture the impacts of different farm enterprises. Dairy

[3] The relationship between the number of acres, an alternative measure of farm size, and the probability of off-farm employment was also investigated. Acreage was found to have little effect on the off-farm decision, possibly due to the fact that many farmers had substantial acreage which is relatively unproductive. However, tillable acreage also performed poorly in the models. We therefore settled on gross sales as the measure of farm size.

farmers, for example, are expected to work off-farm less frequently than farmers involved in other enterprises. For the purpose of this study, farmers engaged in livestock production were used as the base group. Dummy variables were included for dairy, field crops vegetables, tree nuts and forestry products and fruit. Results indicated that operators involved in the production of dairy and fruit worked off-farm less frequently than their livestock counterparts. Farmers producing field crops, vegetables and tree nuts and forestry products were found to work off-farm more frequently than those engaged in livestock production. Of the five binary variables included for type of farm enterprise, only the parameter estimate for tree nuts and forestry products was significantly different from zero. None of the enterprise effects were significant for the spouse.

To capture the effects of family financial characteristics the percentage of income received from sources other than the farm or off-farm employment was included. The results indicate that such sources of income reduce the probability of working off-farm for the farm operator and the spouse. The relative magnitudes of the parameters were small but statistically different from zero for the farm operator.

The final variables included in the model were the distance to the nearest town and the unemployment rate for the town of residence. The distance variable was included to act as a proxy for location relative to labor markets. While parameter estimates had the expected negative signs, they were not statistically different from zero. This result is consistent with prior research. Distance variables appear to perform poorly in capturing the impacts of rural labor markets participation decisions by farm families. Unemployment rates also had little effect on the participation decisions by farm operators and spouses.

Labor Supply Models

Off-farm labor supply models were estimated for the operator and spouse using Heckman's two-stage procedure to adjust for sample selection bias. The asymptotic t-statistics for the parameters of the sample selection variables indicate that sample selection bias was not a concern in the models. The models fit the data well; R^2 measures for the operator and spouse models were 0.72 and 0.74, respectively. Parameter estimates and summary statistics are presented in Table 5.

Relationships between wages and hours worked depend upon the complementarities and substitutions between leisure, farm work and off-farm work and are theoretically ambiguous. Wage rates were found to be inversely related to the number of hours worked for operators and spouses. The effect of higher

Table 5. Labor Supply Functions for the Farm Operator and Spouse

Variable	Operator (n = 41)	Spouse (n = 31)
Wage	−20.57*	−11.01
	(2.65)	(1.43)
Individual Characteristics:		
Farm Experience	2.11	−8.99
	(0.34)	(1.06)
Age	−17.31*	−27.92*
	(1.82)	(1.98)
Education	29.38	−45.36
	(0.91)	(0.78)
Off-Farm Experience	20.00*	60.41*
	(2.30)	(3.63)
Job Training	−451.02*	−151.75
	(2.94)	(0.63)
Sex	779.70*	−512.01
	(2.60)	(1.10)
Family Characteristics:		
Children (ages <5)	−339.08*	−48.90
	(2.54)	(0.26)
Children (ages 5–18)	107.12*	−127.07*
	(2.05)	(2.24)
Predicted Endogenous[a]	−1,394.61*	60.79
	(3.06)	(0.15)
Farm Characteristics:		
Sales	−471.44*	−0.29
	(3.26)	(0.00)
Organization	2,105.70*	−119.28
	(4.68)	(0.23)
Dairy	−1,140.37*	−605.87
	(1.35)	(3.25)
Financial Characteristics:		
Other Income	5.92	9.66
	(0.33)	(0.33)
Location:		
Commuting Distance	8.31*	−15.19
	(2.45)	(1.11)
Unemployment Rate	−101.46*	−14.48
	(2.50)	(0.26)
Lambda[b]	−57.40	−427.32
	(0.26)	(1.08)
R^2	0.72	0.74
Chi-Squared	70.37*	59.27*

Note: Numbers in parentheses are absolute values of asymptotic t-statistics.
* Statistically different from zero at the 5% level or better.
[a] Predicted probabilities of participation for individual's spouse.
[b] Sample selection adjustment variable.

wages was statistically significant for the operator. Calculated elasticities of hours worked with respect to wages indicate responses by the operator (-0.15) and spouse (-0.06) were inelastic. Increases in the off-farm wage apparently result in an allocation of more time to either the farm or leisure. These results are consistent with farm family preferences for farm work or leisure over off-farm employment and suggests the use of off-farm employment to satisfy budgetary constraints. An alternative explanation is that hired farm labor is bid away by higher off-farm wages. Both operators and spouses may substitute their labor for that of hired labor.

The interactions of operator and spouse decisions are of major interest to this paper. The hypothesis that operator and spouse participation decisions were made jointly was rejected above. Predicted probabilities for the individual's partner were included as explanatory variables to test the conditional nature of the labor supply equations. Operator hours off-farm were inversely related to the probability of the spouse working off-farm. The estimated parameter was statistically significant resulting in the rejection of the null hypothesis that operator hours supplied were chosen independently of spouse participation. This was not true for spouses. The probability of the operator working off-farm had little impact on the spouse's hours of off-farm labor. Thus, we find limited support for joint decision-making by the farm family.

Several individual characteristics of the operator and spouse had significant impacts on hours supplied. Experience in off-farm employment was found to be positively related to the number of hours supplied. Each additional year of experience resulted in an additional 20 hours of work annually for the operator and about 60 hours for the spouse. Although statistically significant, the impacts of a year of experience represent annual adjustments of only 1.1% and 3.3% in hours worked for the operator and spouse, respectively.

While the probabilities of working off-farm followed the expected life-cycle pattern, the number of hours supplied declines with age. Negative relationships between age and hours worked were statistically significant for operators and spouses. Job related training also had a negative impact on the number of hours worked. On average, operators worked 450 fewer hours annually when they had received training. Male operators were found to work nearly 780 more hours off-farm annually than their female counterparts. Male spouses were found to work fewer hours off-farm although the parameter estimate was not significantly different from zero.

It is evident from the results that family characteristics are important to the supply decisions of both the operator and spouse. Each child under age five reduced the operator's time off-farm by about 340 hours. This result, combined with participation results, suggests that operators with pre-school children more frequently work part-time off-farm and contribute to child care. The spouse's time off-farm was reduced by pre-school children, but not significantly. School-age children significantly reduced off-farm work by the spouse and increased hours worked by the operator. Operators may be released from farm chores as children become valuable sources of labor. In addition, operators may increase hours worked due to greater financial needs.

Farm characteristics had significant impacts on the operator's supply, but little impact on the supply of the spouse. Thompson suggested that operator decisions are primarily determined by the farm operation while the spouse's decisions depend on family characteristics. These results support her hypothesis for farm spouses; however, the operator was found to respond to both household and farm factors.

It was anticipated that greater sources of other income would decrease the number of hours worked off-farm. Parameter estimates for both the operator and spouse indicated there were no significant impacts on hours worked. Supply by the spouse was also unresponsive to local economic conditions. Operators, however, worked more hours in response to commuting distance and worked fewer hours when labor markets exhibited relatively greater excess supply. The positive effect of commuting distance suggests that operators are aware of the time-costs associated with participation. By working more hours, fixed time-costs are partially offset.

Summary and Conclusions

This paper extends empirical models of off-farm labor participation and supply to consider joint decisions by the operator and spouse. Results indicate that participation decisions are not made jointly by the operator and spouse. However, results did indicate that the number of hours supplied by the farm operator depends on the participation decision of the spouse. Thus, analyses which ignore the jointness of participation and supply decisions may lead to erroneous conclusions.

Previous empirical information on participation and supply by the farm spouse has been limited. Thompson suggested that family characteristics should be relevant to decisions by the spouse while the operator should be responsive to farm characteristics. Results from this study indicate that operators and spouses respond to both family and farm characteristics. While the hours worked by the spouse were relatively unaffected by characteristics of the farm enterprise, these factors were important to the decision by the spouse to enter the off-farm labor market. Family and farm characteristics were important to both the participation decision and hours worked by the farm operator.

The results provide information necessary to predict impacts of exogenous changes on family welfare. Higher real wages were found to decrease the number of hours worked off-farm. Operators and spouses apparently increase their allocations of time to leisure, farm labor or both in response to higher off-farm wages. Unemployment and location did not appear to affect participation decisions, but local unemployment and commuting distance were important to the operator's choice of hours worked. Rural economic development programs which improve labor market conditions will affect the farm family directly, through responses to opportunity, and indirectly via market wages.

The results obtained here provide only limited support for the hypothesis that farm operators and spouses make joint decisions. Huffman and Lange arrive at a different conclusion for a sample of Iowa farms. Further research is warranted to provide information on regional differences. Off-farm employment by the operator or spouse clearly has important impacts on farm family welfare, an issue of interest to policy-makers as the coming farm bill is formulated.

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