The Role of Farm Ownership in Off-Farm Work Participation

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A labor supply model is used to examine the relationship between farm ownership and operators' participation in the off-farm labor market for the Northeast region. The results indicate that ownership significantly influences operators' off-farm employment participation. In particular, part-owners significantly allocate labor services to off-farm activities. The results also show that the participation rate among part-owner operators is high partly because the availability of other income sources accelerates the process of acquiring assets to become full-owner operators.

Among the factors influencing the decisions of farm operators to participate in off-farm work, farm ownership has received little attention in the literature.[1] The failure is particularly salient because of the increasing importance of off-farm income to farm families (Ahearn, Johnson, and Strickland 1985; Ahearn and Lee 1991). Moreover, understanding the reasons for off-farm work participation may help guide land policy and other public policies that affect not only the structure of farm ownership but also the behavior of farmers' labor supply decisions.

Nationally, the percentage of farm operators reporting any off-farm work was approximately 54% in 1982, 56% in 1987, and 55% in 1992. Thirty-four percent of the operators reporting any off-farm work had worked 200 days or more per year off their farms (U.S. Department of Commerce 1992; hereafter 1992 Census of Agriculture). Although off-farm employment participation has been viewed as an important means of stabilizing total household income (Ahearn and Lee 1991; Fuller 1991; Gebremehdin 1991; Spitze and Mahoney 1991; Bartlett 1991), the examination of farm operators' income stabilization efforts across farm ownership categories (i.e., full-owners, part-owners, and tenants) has been ignored in the literature.

This study hypothesizes that farm ownership influences decisions regarding off-farm work participation because operators in different categories are likely to have different objectives and face different economic constraints. For instance, tenants and part-owner operators are more likely than full-owner operators to expand their production base because they might perceive off-farm income as necessary capital for full-ownership.

A brief survey of the literature indicates that researchers have focused on four factors influencing off-farm work participation. The *first* factor addresses the effect of *human capital and local labor market developments* on off-farm work participation (Huffman 1977a, 1977b, 1980; Huffman and Lange 1989; Sumner 1982; Ahearn, Johnson, and Strickland 1985; Jensen and Salant 1985; Gould and Saupe 1989; Gladwin 1991; Lass and Gempesaw 1992). Huffman presents evidence that investment in education and agricultural extension services increases farmers' off-farm labor supply by increasing the reallocative ability of farmers. Sumner shows that urbanization positively contributes to returns from off-farm activities because of increasing off-farm job opportunities. The *second* factor examines the importance of the *farm characteristics and farm family structure* in the decision to participate in off-farm work (Kilkenny 1993; Kimhi 1994). Kilkenny and Kimhi present evidence that participation in the off-farm labor market differs across type of farming and marital status of farm families. The *third* factor addresses the importance of *urbanization and its effects on agriculture through land conversion, input-output price distortions, and regulatory arrangements*

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[1] Off-farm employment does not necessarily mean that the employment is in the nonagricultural sector, since an operator who chooses to work on another farm will be classified as an off-farm operator. The Census of Agriculture defines the term *off-farm* broadly to capture all the activities undertaken out of the operator's own farm.

(Lopez, Adelaja, and Andrews 1988; Berry 1978). The authors observe that during the process of urbanization, land tends to be idle in anticipation of conversion, which creates pressures to increase income from off-farm employment. *Finally,* Gustafson and Bills (1984), Lee (1982, 1983), Lewis (1978), Wunderlich (1991, 1993), and USDA (1994) argue that *during the urbanization process farmland ownership patterns tend to change before conversion.* Gustafson and Bills show that about one-third of the land with the potential for conversion in the Northeast is located in the most urbanized counties, which implies a possible change in farm ownership pattern. Overall, urbanization changes farmland ownership pattern and directs farm operators toward off-farm work to enhance farm household income. Thus, it is important to investigate ownership patterns and off-farm work tendencies of farm operators in urbanized areas.

It is clear from the above studies that research has ignored the influence of farm ownership on off-farm work participation. Furthermore, to our knowledge, the relationships among farm ownership, off-work participation, and urbanization, which are of particular importance to the Northeast, have not been examined in the literature. As a result of these omissions, research has failed to inform the public debate on off-farm work participation and land-use issues and thus has provided little guidance to policymakers examining land-use policy. We hypothesize that the increasing nonfarm-use value of farmland due to high urbanization (measured by population density in persons per square mile) and the land ownership structure in the Northeast are likely (1) to cause inefficient input decisions due to distorted farm input prices, (2) to create an unwillingness to invest in farming, and (3) to lead to the conversion of farmland into nonfarm use. During this process of conversion, farm organizations with shorter planning horizons tend to own a greater proportion of farmland for speculative purposes (speculation is measured by the ratio of the value of per acre land in the Northeast to the value of per acre land in the United States) and to rely on off-farm employment activities to supplement their incomes (Spitze and Mahoney 1991; Saupe and Gould 1991; Gebremedhin 1991; Gladwin 1991).

Some of the results obtained from the estimation of the off-farm work participation model are as follows. First, declining farm output encourages farm operators to seek employment opportunities in the off-farm labor market. Second, participation in the off-farm labor market is high among part-owner operators because they engage in seasonal agricultural production. Third, age and gender of operators significantly contribute to off-farm work participation. In particular, female and elderly operators are more likely to participate in off-farm activities. Finally, both farming experience and the existence of supplementary income reduce off-farm work participation. Overall, the results with respect to the relationship between ownership and off-farm employment suggest that part-owner operators tend to work off the farm mainly because off-farm employment is seen as a source of supplementary income required for the continuation of farming activities.

The paper is organized as follows. Following the introduction, we discuss some of the relationships among farm ownership, type of farming activities, and off-farm work participation using a correlation matrix. In the next section, we present a labor supply model for farm operators who have the option of allocating labor to either farm or nonfarm activities. The following section describes the econometric estimation used in the analysis. We then discuss some features of the data and define the variables used in the estimation. The next section discusses the results of the empirical framework developed above. Finally, we summarize the major conclusions and discuss their implications.

Background

The correlation matrix provides some insights with respect to the relationship between off-farm employment and farm ownership. These relationships are discussed in detail below.

The correlation of –0.91 between urbanization and the acres of land held by a full-owner operator indicates that such operators are less likely to have farmland in highly urbanized areas. This result may be due to the high opportunity cost of farming in urbanized areas, where the estimated market value of land is significant. Essentially, the same relationship (–0.74) holds for part-owners as well. These findings suggest that full-owner and part-owner operators tend to hold small parcels of land in areas where the land value is high.

The findings also lead to the following observations. First, full/part-owner operators tend *not* to hold land with immediate potential for conversion. This observation is consistent with the conventional wisdom that suggests that the size of farmland (measured by the acres of land per farm) is negatively correlated with urbanization and market value of land. The correlations for size and urbanization and for size and market value are –0.86 and –0.80, respectively. It is also important to observe that the correlation of −0.45 between age of an operator and acres of land held by a part-owner operator implies that in states where part-owner operators are in the majority, the average age is low or to some degree the average age of part-owner operators is low. In this respect, part-owners are expected to be more likely to expand their production base than are other agents.

A careful examination of the correlation between the type of land an operator owns and farm ownership provides a framework for understanding the relationship between ownership and farming activities. First, part-owner operators are more likely to hold cropland than are full-owner operators. This observation is supported by the correlation of acres of cropland per farm with acres of land per part-owner and full-owner operator (the correlations are 0.89 and 0.72, respectively). Second, compared with part-owner operators, full-owner operators engage in labor-intensive livestock and poultry farming. This conclusion is also supported by the correlation of acres of land per full-owner (0.68) and part-owner operator (0.62) with per farm livestock and poultry sales. To this end, full-owners tend to hold land for livestock and poultry farming, which reduces the chances for participating in off-farm work, while part-owners are involved mostly in seasonal crop farming, which allows them to look for job opportunities off the farm.

The comparison of the two different farming activities with respect to off-farm employment suggests that farm operators in states where crop farming dominates are more likely to work off the farm. This observation is supported by the correlations between off-farm work participation and per farm cropland, −0.59, and per farm livestock sales, −0.61. The inference that both livestock/poultry and nursery/greenhouse are more labor intensive than crop farming is also supported by the positive correlation of per farm livestock/poultry sales and of per farm nursery/greenhouse sales with the number of years an operator spends on the present farm (0.58 and 0.63; see table 1).

The above observations summarize the importance of farm ownership structure on land conversion and suggest implications for off-farm work participation. Farm ownership may also impact farm productivity. This hypothesis is tested empirically by estimating a Cobb-Douglas production function that includes ownership categories. In particular, full ownership influences farm output negatively, while a positive relationship exists between tenancy and farm output (table 2). The results of the estimation of the production function present evidence that farm ownership is important in farm production decisions. The analysis indirectly suggests that full-owners, part-owners, and tenants differ in their output and input decisions. The ultimate question addressed by this study is the extent to which these differences and farmers' characteristics account for the variation in off-farm work participation. To address this question, we examine the relationships among the structure of farm ownership, farm output, and the propensity to participate in off-farm work for the Northeast region. The initial evidence indicates that participation is high in states where the average age of an operator and the number of female operators (relative to male) are high, and participation is low in states where per farm total sales, per farm livestock/poultry sales, the number of farm enterprises organized as partnerships, and per farm cropland are high (see table 1).

While the above observations strongly indicate that the characteristics of farming and farm operators are important factors that help explain the motivation for participating in off-farm work, what is less clear, and to our knowledge has not been addressed in the literature, is the role of farm ownership in the off-farm work participation.

The Model

The labor supply model, developed by Huffman (1980), is treated as a set of joint decisions for leisure and market goods. The model assumes that utility is derived from farm production that is subject to the constraints of time, farm production, and income. This model describes a commercial farm that employs both hired and family labor and that markets all its output and operates in a competitive labor market (Barnum and Squire 1979; Huffman 1980).

Operators' off-farm work participation is formulated in such a way that each operator maximizes his/her utility, $U(C,T_L;V_1)$. The function U(.) is assumed to be strictly concave and satisfy $U_C(C,T_L;V_1) \equiv \partial U(.)/\partial C > 0$ and $U_{T_L}(C,T_L;V_1) \equiv \partial U(.)/\partial T_L > 0$. The total amount of goods purchased by an operator is denoted by C and the total leisure time of the operator by T_L. The vector, $V_1 \equiv (V_1^1,\ldots, V_1^m)$, includes factors exogenous to operators' consumption and leisure decisions.

An operator faces the time constraint,

$$\bar{T} = T_F + T_{OF} + T_L \tag{1}$$

where his/her total time endowment is denoted by $\bar{T}$; T_F and T_{OF} denote the time allocated for farm and off-farm activities, respectively. The farm production function,

Table 1. Correlation Matrix (greater than or equal to 0.35)

	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)	X(7)	X(8)	X(9)	X(10)
X(1)	1.00	−0.76	−0.57		−0.54		−0.70	0.74		
X(2)		1.00	0.85	−0.37	0.67		0.97	−0.89		0.68
X(3)			1.00	−0.45	0.87		0.94	−0.73		0.62
X(4)				1.00	−0.49	−0.55	−0.45		0.59	−0.46
X(5)					1.00	0.39	0.82	−0.58	−0.56	0.65
X(6)						1.00			−0.59	0.76
X(7)							1.00	−0.84	−0.40	0.74
X(8)								1.00		−0.51
X(9)									1.00	−0.61
X(10)										1.00

	X(11)	X(12)	X(13)	X(14)	X(15)	X(16)	X(17)	X(18)	X(19)
X(1)	0.35	0.37		−0.56		0.36		0.70	0.73
X(2)		−0.54	−0.44	0.72		−0.36		−0.87	−0.91
X(3)		−0.38		0.89		−0.55		−0.61	−0.74
X(4)			0.42	−0.52		0.40			
X(5)				0.99	0.39	−0.81	0.47	−0.47	−0.52
X(6)	0.35	0.44		0.41	0.78	−0.44	0.73		
X(7)		−0.44		0.86		−0.51		−0.80	−0.86
X(8)	0.48	0.39	0.38	−0.63		0.48		0.91	0.85
X(9)				−0.59	−0.38	0.59	−0.70	0.35	
X(10)			−0.48	0.70	0.58	−0.53	0.48	−0.69	−0.70
X(11)	1.00					0.49			
X(12)		1.00			0.63	−0.36	0.48		
X(13)			1.00					0.65	0.64
X(14)				1.00	0.41	−0.80	0.46	−0.54	−0.57
X(15)					1.00	−0.55	0.63		
X(16)						1.00	−0.40	0.39	
X(17)							1.00		
X(18)								1.00	0.93
X(19)									1.00

X(1) = Per farm crop sales (including nursery, $1,000)
X(2) = Per full-owner operator's land (acres)
X(3) = Per part-owner operator's land (acres)
X(4) = Average age of an operator
X(5) = Per farm harvested cropland (acres)
X(6) = Per farm total sales ($1,000)
X(7) = Per farm total land (acres)
X(8) = Per farm land value ($1,000)
X(9) = Number of off-farm operators (any/none)
X(10) = Per farm livestock/poultry sales ($1,000)
X(11) = Per farm dairy sales ($1,000)
X(12) = Per farm nursery/greenhouse sales ($1,000)
X(13) = Per farm grain sales ($1,000)
X(14) = Per farm cropland (acres)
X(15) = Average number of years spent on present farm
X(16) = Number of operators (female/male)
X(17) = Number of farms (partnership/family)
X(18) = Estimated market value of land ($1,000) (SPECU)
X(19) = 1990 population per square mile (URBAN)

(2) $$Q = F(T_F, \Omega; \mathbf{V}_2, A),$$

is assumed to be strictly concave and to exhibit constant returns to scale. Let Q and A denote the farm output and the amount of land used in farm production, respectively. The vector, $\Omega \equiv (\Omega_1, \ldots, \Omega_s)$, denotes other variable inputs with the associated input price vector $\omega \equiv (\omega_1, \ldots, \omega_s)$. These inputs include hired farm labor, capital, and energy. The vector, $\mathbf{V}_2$, represents farm characteristics that are taken as given by the operator at the time he/she makes production and input-use decisions. These characteristics include tenure of organization (full-owner or part-owner operators and tenants) and type of organization (i.e., individual/family, partnership, and corporation).

We assume that farm operators face the following budget constraint:

(3) $$P_C C + \omega . \Omega = P_Q Q + w T_{OF} + R$$

Table 2. Estimation of Farm Output with Farm Ownership Variables

Independent Variables	Model 1		Model 2		Model 3	
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
C	−0.26	(−0.35)	−0.56	(−0.81)	−0.98	(−1.47)
ln(CAPITAL)	0.34	(1.73) *	0.26	(1.42)	0.34	(1.76)*
ln(LABOR)	0.09	(2.39)**	0.08	(2.03)**	0.07	(1.87)*
ln(LAND)	−0.11	(−1.51)	0.02	(0.32)	0.03	(0.39)
ln(LST)	0.00	(3.04)**	0.00	(3.24)**	0.00	(3.10)**
ln(ρ*LST)	0.00	(2.54)**	0.00	(2.75)**	0.00	(2.82)**
ln(ENERGY)	0.09	(1.44)	0.09	(1.53)	0.07	(1.29)
ln(FEED)	0.31	(9.22)**	0.30	(8.90)**	0.31	(9.31)**
ln(FER-SEED)	0.35	(5.21)**	0.32	(4.81)**	0.34	(5.12)**
ln(F-OWN)	−0.09	(−1.01)	−0.11	(−1.67)*		
ln(P-OWN)	0.14	(1.69)*			−0.06	(−0.84)
ln(TENANT)			0.14	(2.94)**	0.11	(2.14)**
R^2	0.73		0.74		0.74	
n	158		158		158	

* and **, respectively, indicate 0.1 and 0.05 significance levels. The ownership variables, F-OWN, P-OWN, and TENANT, are defined as the proportion of full-owner, part-owner, and tenant operators, respectively (F-OWN + P-OWN + TENANT = 1).

where P_Q and P_C denote for the price of farm output and the price vector of purchased goods, respectively. The variable R is the operator's nonwage income and is considered exogenous to his/her consumption and leisure decisions.

Given $(\omega, w, P_Q, P_C, T, A, R, \mathbf{V}_1, \mathbf{V}_2)$, a farm operator maximizes his/her utility subject to the constraints (1), (2), (3), and nonnegativity conditions $(C, Q, \Omega, T_F, T_{OF}, T_L) \geq 0$. The choice variables include $(C, Q, \Omega, T_F, T_{OF}, T_L)$. The Lagrangian equation, $\mathfrak{L}(C, Q, \Omega, T_F, T_{OF}, T_L, \mu_1, \mu_2, \mu_3)$, corresponding to the maximization problem is,

$$(4) \qquad U(.) + \mu_1[T - T_F - T_{OF} - T_L] + \mu_2[P_Q Q + wT_{OF} + R - P_C C - \omega.\Omega] + \mu_3\,[F(T_F, \Omega; \mathbf{V}_2, A) - Q].$$

Assuming an interior solution, $(C, Q, \Omega, T_F, T_{OF}, T_L, \mu_1, \mu_2, \mu_3) > 0$, the equilibrium is characterized by the following first-order conditions:[2]

$$(5) \qquad \frac{U_C(C, T_L; V_1)}{U_{T_L}(C, T_L; V_1)} = \frac{P_C}{w} \Rightarrow T_L = T_L(C)$$

$$(6) \quad P_Q \frac{\partial F(T_F, \Omega; V_2, A)}{\delta T_F} = w \Rightarrow T_F = T_F(Q)$$

$$(7) \quad P_Q \frac{\partial F(T_F, \Omega; V_2, A)}{\delta \Omega_j} = \omega_j \Rightarrow \Omega_j = \Omega_j(Q, \Omega_{-j}) \quad \text{for } \forall_{j=1,\ldots,s}$$

$$(8) \quad T_{OF} = T_{OF}(T_F, T_L), \quad \text{``time constraint''}$$

$$(9) \quad Q = Q(T_F, \Omega), \quad \text{``production function''}$$

$$(10) \quad C = C(Q, \Omega, T_{OF}), \quad \text{``budget constraint''}$$

where Ω_{-j} denotes the vector of inputs excluding Ω_j. Equations (5)–(10) show that an operator's decision to participate in off-farm work, T_{OF}, is made simultaneously with decisions regarding the use of farm inputs, including operator's on-farm work, T_F. In other words, the system of equations (5)–(10) is simultaneously solved for the variables $(C, Q, W, T_F, T_{OF}, T_L)$ as a function of the production and utility parameters and exogenous variables. Strict concavity of farm production and operators' utility functions together with the linear constraints guarantee the existence and uniqueness of the solution.[3] The solution of the system (5)–(10) yields the off-farm labor supply function,

$$(11) \qquad \mathrm{T_{OF}} = \mathrm{T_{OF}}(\mathbf{X}), \text{ where } \mathbf{X} \equiv (\mathrm{w}, \omega, \mathrm{P_Q}, \mathrm{P_C}, \mathrm{T}, \mathrm{R}, \mathrm{A}, \mathbf{V}_1, \mathbf{V}_2).$$

Econometric Model

In the ideal situation, data on time allocated to off-farm activities should be used to estimate equation (11). Because such data are not available in the Census of Agriculture data set used in this study, the number of farm operators reporting at least four hours a day of off-farm work is used as a proxy for participation in the off-farm labor market. This

[2] The vector of variables $(w, \omega_j, P_Q, P_C, V_1, V_2, A, R, T)$ taken as given have been dropped for notational convenience.

[3] The Arrow-Hurwicz-Uzawa theorem in Takayama (1985) guarantees the existence and uniqueness of the solution.

participation is considered to be a function of farm characteristics (such as farm ownership and organization type), operators' personal characteristics (such as age and gender), and general economic conditions (such as developments in input-output markets). Specifically, the dependent variable, T_{OF}, is approximated by the participation rate R_j defined as,

$$R_j = \frac{N_j^0}{N_j} \text{ and } N_j = N_j^0 + N_j^f$$

where N_j^o and N_j^f denote the number of farm operators reporting any off-farm work days and operators reporting no off-farm work days in county j, respectively; N_j is the total number of operators in county j. The relationship between county j's participation rate, R_j, and explanatory variables, X_j, is stated as,

$$(12) \qquad R_j = \frac{1}{[1 + \exp^{(-\beta_0 - \beta_1 \ln X_j - \epsilon_j)}]}$$

where ϵ_j is the vector of random disturbances. Equation (12) is transformed into the logit function,

$$(13) \qquad \ln\left(\frac{R_j}{1 - R_j}\right) \equiv [\ln(R_j) - \ln(1 - R_j)] = \beta_0 + \beta_1 \ln X_j + \epsilon_j,$$

which provided the best goodness of fit and t-ratios.[4] The transformed dependent variable now becomes the difference between the natural logarithm of off-farm work participation and the natural logarithm of on-farm work participation rates; that is, $\ln(N_j^o/N_j^f)$. This difference reflects the amount by which operators' off-farm labor supply is favored. Thus equation (13) is estimated to approximate the relationship obtained in equation (11).

The coefficient $\beta_1 = \partial \ln(R_j/(1 - R_j))/\partial \ln X_j$ is the percentage change in $\ln(N_j^o/N_j^f)$ corresponding to one percentage change in X_j. Disturbances in equation (13) are assumed to follow an independent normal distribution with zero mean and variance, $1/m_j R_j(1 - R_j)$, where m_j is the number of farms in county j. The variance is a consequence of a binomial distribution underlying R_j (Zellner and Lee 1965).

[4] Alternatives include semi-log specification, $\ln(N_j^o/N_j^f) = \beta_0 + \beta_1 X_j + \epsilon_j$. N_j^o and N_j^f respectively denote the number of operators reporting any off-farm work days and the number of operators reporting no off-farm work days in county j.

Description of the 1992 Census Data Set

Data

The data used in this study are obtained from the 1992 Census of Agriculture. The sample includes the Northeast states of Maine (ME), New Hampshire (NH), Vermont (VT), Massachusetts (MA), Rhode Island (RI), Connecticut (CT), New York (NY), New Jersey (NJ), and Pennsylvania (PA). These states have a total of 218 counties, each of which is a unit of observation. Table 3 defines the variables, which are expressed as per farm figures. For example, per farm output in county j, Q_j, is the ratio of total farm output to the number of farms in county j.

The data contain county-based information on (1) personal characteristics, such as average age of an operator, number of male and female operators, number of black operators, and number of years an operator has spent on the present farm; (2) tenure of organization, such as number of operators who fully or partly own farms, and number who are tenants; (3) type of organization, such as number of farms operated by individuals/families, partners, and corporations; (4) residence of operators, such as number of operators who live on farm; and (5) off-farm employment information, such as number of operators working off-farm between 0 and 49 days a year, between 50 and 99 days a year, and so on.

Data used in estimating the production function are expressed in real terms. The real values for the output and input variables are obtained by dividing monetary variables by their respective price indices (with 1990–92 = 100).[5] The price indices include production, feed, livestock and poultry, seed, fertilizer, fuels, supplies and repairs, autos and trucks, farm machinery, and building materials.

Descriptive Statistics

In this section we briefly discuss some of the important features of the variables used and provide an overall picture of the data set using the means, the standard deviations, and the correlation coefficients.

The participation rates in off-farm work for the Northeast states are as follows: Connecticut, 0.55; Maine, 0.58; New Hampshire, 0.59; New Jersey, 0.59; New York, 0.48; Massachusetts, 0.54; Rhode Island, 0.50; Vermont, 0.49; and Pennsylvania,

[5] The base year, (1990–92) = 100, means that the average of an index over the time period 1990–92 is equal to 100.

Table 3. Definition of the Variables (1992 Census of Agriculture)

Variable Names	Definitions
AGE	Operators' average age in a county.
CAPITAL	Number of motor trucks, wheel tractors other than garden tractors and motor tillers, grain and bean combines, mower conditioners, and pickup balers.
ENERGY	Real value of gasoline, other petroleum fuel, and oil purchased for the farm business (including gasoline, diesel fuel, natural gas, LP gas, fuel oil, kerosene, motor oil, and grease) and electricity.
FAMILY	Farm or business organization controlled and operated by an individual/family, including family operations that are not incorporated and not operated under a partnership agreement.
FEED	Real value of feed purchased for livestock and poultry (i.e., grain, hay, silage, mixed feeds, concentrates, etc.).
FER-SEED	Sum of real values of commercial fertilizer purchased (all forms, including rock phosphate and gypsum) and real cost of seed for corn, grains, soybeans, tobacco, cotton.
F-OWN	Number of full-owner operators.
GOV	Payments received for participating in federal farm programs, including deficiency and support price payments, disaster payments, paid land diversion, inventory reduction payments, and payments received for approved soil and water water conservation projects.
[(GOV)* (P-OWN)]	Interaction term between government payments and part-ownership.
LABOR	Number of farm workers.
LAND	Acres of total land used in farming.
LST	Real value of livestock and poultry purchased (cattle, calves, hogs, pigs, sheep, lambs, goats, horses, chicks, poults, started pullets).
ρ	Share of livestock and poultry sold in total farm output.
MALE	Number of male operators.
OFI	Other farm income, including custom work (includes income earned when the farm operator provides labor and these operations are conducted in conjunction with other agricultural operations), rental income (associated with renting out land or crop allotments), forest products (income from only forest products or Christmas trees), and other farm-related income (includes income from hunting leases, fishing fees, and other recreational services, sales of farm by-products, and other businesses or income closely related to the agricultural operation).
OI	(GOV + OFI).
[(OI)* (P-OWN)]	Interaction term between other income and part-ownership.
Q	Real value of total farm output.
$\hat{Q}$	Fitted value of Q from the production function.
PARTNER	Number of farms operated by two or more persons in partnership. Partnership operation is defined as two or more persons who have agreed on the amount of their contribution (capital and labor) and distribution of profits. Coownership of land by husband and wife or joint filling of income tax forms by husband and wife does not constitute a partnership unless a specific agreement to share contributions, decision making, profits, and liabilities exists. Production under contract or under a share rental agreement does not constitute a partnership.
P-OWN	Number of part-owner operators.
TENANT	Number of tenant operators.
$R_i = N_i^o/N_i$	County *i*'s participation rate. N_i^o and N_i respectively denote the number of operators reporting any off-farm work days and the total number of operators in county *i*. The Census of Agriculture classifies an operator as one participating in off-farm work if he/she spends at least four hours a day on off-farm work.
SPECU	Speculative pressure, defined as the ratio of county *i*'s estimated market value ($) per acre of land and buildings to that of the United States. The operator's estimated market value obtained from the 1992 Census of Agriculture includes market value of the operator's dwelling, value of farm buildings, dwellings used by laborers, fruit packing sheds, vegetable sheds, etc., that are used to prepare farm products for marketing. The variable SPECU does *not* include (1) value of major agricultural manufacturing or processing plants, such as cotton gins or sugar mills, and (2) value of institutional or other buildings used for nonagricultural purposes, such as hospitals, dormitories, stores, filling stations, factories, etc. In the case of an operator renting land from others, the market value of the land and buildings is that operator's estimated value.
URBAN	Population per square mile as a proxy for urbanization.
WAGE	Ratio of county's total payroll to the number of farm workers.
YEARS	Average number of years spent on the present farm.

Table 4. Descriptive Statistics of Farm Tenure Variables (Averages)

	CT	ME	NH	NJ	NY	MA	RI	VT	PA	North-east
F-OWN	0.64	0.67	0.68	0.74	0.62	0.67	0.59	0.54	0.59	0.63
P-OWN	0.28	0.29	0.27	0.17	0.31	0.23	0.29	0.38	0.32	0.29
TENANT	0.08	0.04	0.06	0.09	0.07	0.10	0.12	0.07	0.09	0.08
FAMILY	0.81	0.89	0.88	0.78	0.80	0.78	0.80	0.86	0.88	0.84
PARTNER	0.09	0.05	0.06	0.08	0.10	0.06	0.07	0.08	0.09	0.08
OTHERS	0.10	0.06	0.06	0.14	0.10	0.16	0.13	0.06	0.03	0.08

(F-OWN + P-OWN + TENANT) = 1 and (FAMILY + PARTNER + OTHERS) = 1.

0.53. The highest participation rates are found in Maine, New Hampshire, and New Jersey, where most farms are controlled by full-owner operators. Furthermore, most part-owner operators are in New York (0.31), Vermont (0.38), and Pennsylvania (0.32) (table 4). Regarding the organization type, we observe that family/individual farm organizations are strongly dominant in all of the states. The average percentage of family/individual farms in the Northeast is approximately 0.84, which implies that most full-owner and part-owner operators run family/individual farm organizations. Partnership farms, which are not dominant in any states, are negatively correlated (–0.70) to off-farm participation (table 1). However, in states where partnership farms are important, per farm livestock/poultry and nursery/greenhouse sales are high. Also, the number of years an operator has spent on the present farm is positively correlated with partnership farms (0.63 in table 1). This result supports the case that operators of partnership farms stay in farming relatively longer than do operators of family farms.

A historical overview of the data shows a significant change in the number of farms engaging in dairy and nursery products. The first change took place in the dairy sector during the period 1987–92. Because of the 1985 buyout program, the number of farms in the dairy sector decreased, although total sales increased. As a result, the dairy sector in the Northeast region experienced a noticeable increase in per farm dairy sales (figures 1a, 1b, 2a, 2b, and 2c). The second change occurred in the nursery/greenhouse sector during the same period, which is consistent with expectations that the increasing value of land in the Northeast directed farmers to high-return agricultural products such as nursery/greenhouse crops and away from grain. Thus, the number of farmers producing high-return products increased in the region (Figures 3a, 3b, and 3c). Overall, both the shrinking in the labor-intensive dairy sector and the moderate growth in the nursery sector are expected to contribute to off-farm work participation.

The mean values of the ownership categories—full-owners (F-OWN), part-owners (P-OWN), and others—are given in table 4. As the table shows, 63% of operators in the Northeast are full-owner operators, 29% are part-owner operators, and 8%

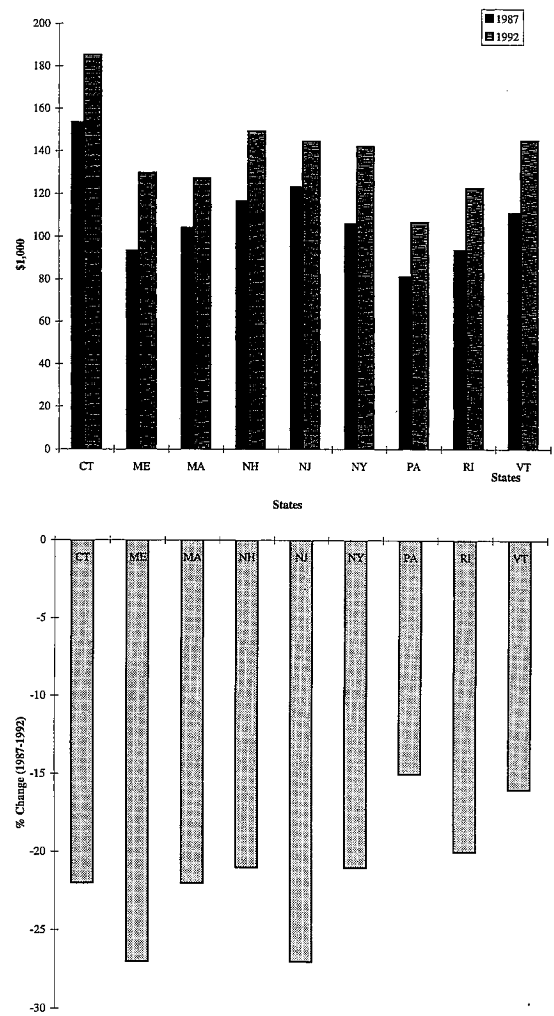

Figure 1. a. Per Farm Dairy Sales. b. Number of Farms.

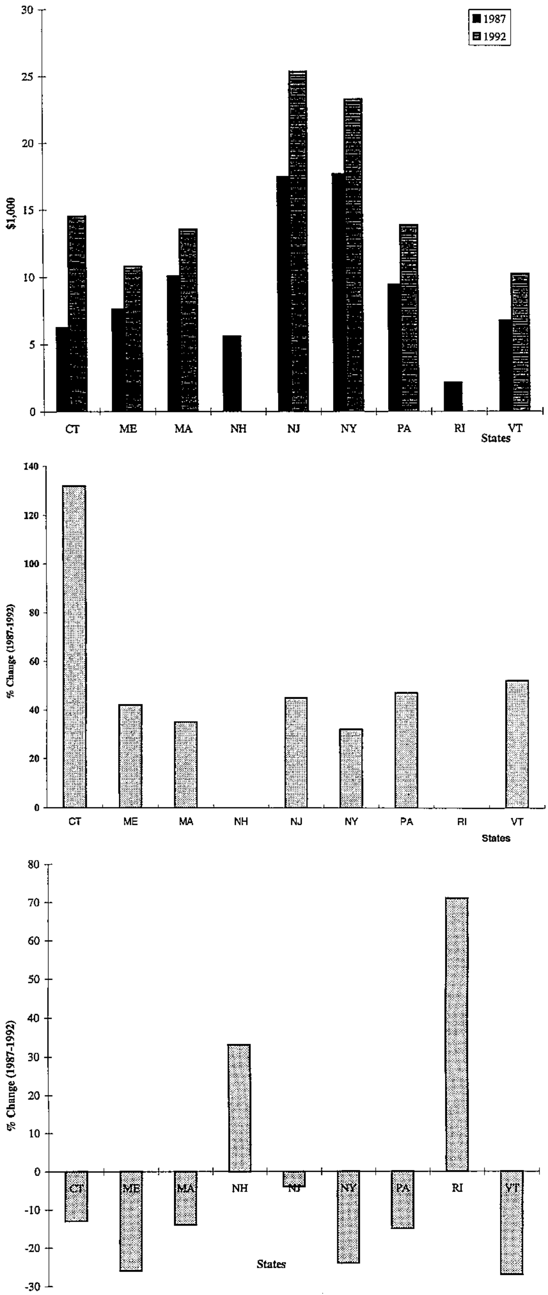

Figure 2. a. Per Farm Grain Sale. b. Per Farm Grain Sales. c. Number of Farms.

are tenants (sum to one). New Jersey has the highest percentage of full-owner operators (74%), Vermont has the highest percentage of part-owner operators (38%), and Rhode Island has the highest percentage of tenants (12%).

A similar classification involves the variables related to the type of organization, such as the number of farms operated by a family/individual (FAMILY) or by a partnership (PARTNER). These variables are constructed such that (FAMILY + PARTNER + OTHERS) ≡ 1. Therefore only the FAMILY and PARTNER categories are included in the estimations. Their estimated coefficients are interpreted as the difference from OTHERS. The data indicate that 84% of the farms in the Northeast region are operated by families/individuals. The highest percentage (89%) of farms categorized as FAMILY is found in Maine.

The correlation coefficient (0.70) between the number of family farms and off-farm participation suggests that these farms are more likely to supply labor off the farm. According to the correlation coefficients, these farms are also less likely to engage in livestock production (–0.48) and nursery farming (–0.48) and to invest time in their present farming activity (–0.63). Hence, the data suggest that per farm total sales are generally low in states with a high percentage of family-operated farms (correlation coefficient of –0.73) (table 1).

Table 5 presents average values of the variables across individual states and the Northeast region. It is observed that the participation rates (denoted by R) for Maine (0.58), New Hampshire (0.59), and New Jersey (0.59) are above the mean participation rate for the entire region (0.52). This observation, together with the evidence that Connecticut, New Jersey, and Rhode Island have the highest per acre estimated market values of land at $74,162, $123,656, and $76,082, respectively (1992 Census of Agriculture), argues that there is a strong motivation for farmers to hold land for speculative purposes and be reluctant to invest in farming.[6]

Estimation Results

The system of equations (5)–(10) is solved simultaneously for the endogenous variables including farm output, consumption, production inputs, and off-farm labor supply. However, simultaneity bias presents a problem in estimating equation (13) because of the simultaneous determination of T_F in equation (6), Q in equation (9), and T_{OF} in equation (8). To address this problem, farm output from the estimated production function is assumed to be the expected profit maximizing output and is used as an instrumental variable in the estimation of the

[6] The variable SPECU does not exactly reflect the estimated farm-use value of land, since in its calculation the general price levels, rather than agricultural input-output prices. are used. Net cash rent, defined as cash rent minus property tax, is one of the proxies for the farm-use value of land. This measure was suggested in a conversation with G. Wunderlich.

Table 5. Descriptive Statistics of the Variables in Logarithm (Averages)

	CT	ME	NH	NJ	NY	MA	RI	VT	PA	North-east
ln(Q)	−2.39	−2.91	−2.92	−2.93	−2.58	−2.93	−2.73	−2.77	−2.85	−2.76
ln(CAPITAL)	2.07	2.02	1.89	2.09	2.16	2.14	2.11	2.10	2.09	2.10
ln(LABOR)	2.18	1.83	1.47	2.01	1.52	1.85	1.67	1.27	1.33	1.54
ln(LAND)	4.63	5.36	5.14	4.48	5.44	4.63	4.33	5.39	5.09	5.13
ln(ENERGY)	−4.27	−4.61	−4.61	−4.09	−4.10	−4.03	−4.50	−4.50	−4.37	−4.29
ln(LST)	−4.94	−5.25	−5.61	−5.76	−4.81	−5.54	−5.07	−5.04	−4.91	−5.04
ln(FER-SEED)	−4.01	−4.54	−4.46	−4.17	−4.29	−4.38	−4.34	−4.62	−4.57	−4.42
ln(ρ*LST)	−313	−416	−317	−310	−431	−333	−484	−415	−517	−436
R	0.55	0.58	0.59	0.59	0.48	0.54	0.50	0.49	0.53	0.52
ln(R/1 − R)	0.19	0.33	0.37	0.36	−0.07	0.14	0.01	−0.06	0.10	0.09
ln(WAGE)	−5.11	−6.32	−5.30	−5.70	−6.21	−5.83	−4.63	−5.91	−6.37	−6.08
ln(AGE)	6.31	6.27	6.27	6.29	6.26	6.28	6.29	6.25	6.27	6.27
ln(MALE)	8.22	8.10	7.67	8.40	8.59	8.21	7.33	8.06	8.66	8.44
ln(FEMALE)	6.45	6.02	6.07	6.56	6.24	6.46	5.26	6.10	5.95	6.14
ln(F-OWN)	7.91	7.79	7.43	8.22	8.14	7.89	6.98	7.58	8.20	8.03
ln(P-OWN)	7.16	7.00	6.61	6.81	7.65	7.13	6.06	7.24	7.58	7.37
ln(TENANT)	5.73	5.02	4.96	6.13	5.82	5.93	5.19	5.59	6.20	5.87
ln(FAMILY)	8.17	8.11	7.73	8.37	8.52	8.18	7.27	8.04	8.61	8.39
ln(PARTNER)	6.00	5.26	5.11	5.90	6.39	5.88	4.31	5.74	6.28	6.07
ln(GOV)	−6.03	−5.87	−6.20	−5.72	−5.81	−5.96	−6.18	−6.20	−5.94	−5.92
ln(OFI)	−5.62	−6.27	−7.45	−6.20	−6.52	−6.27	−5.46	−6.21	−7.11	−5.41
ln(OI)	−5.08	−5.31	−5.71	−5.12	−5.38	−5.25	−4.87	−5.47	−5.59	−5.42
ln(AVGYRS)	5.36	5.29	5.25	5.25	5.34	5.31	5.25	5.26	5.36	5.32
ln(BLACK)	1.61	1.61	1.61	2.78	1.74	1.98	1.61	1.61	1.86	1.85
ln(SPECU)	4.36	2.70	3.26	4.50	2.79	4.13	4.46	2.99	3.18	3.26

participation model.[7] This approach also allows us to capture the effect of inefficient input-output decisions on off-farm work participation. A statistically significant and negative coefficient of the variable $\hat{\ln Q}$ in the participation model would imply that inefficiency in the input-output choices partly directs operators toward off-farm employment.

Production Function

Most firms in agriculture are multiproduct firms that produce at least two broad classes of final products—crop products and livestock products. The production of these final products requires many of the same inputs, but the technical relationship between inputs and outputs seems likely to differ. For example, when livestock products dominate output, the livestock input-to-output ratio is likely to be higher than that when crop products dominate output. In order to capture differences of input parameters due to product mix differences, we formulate agriculture as a multiproduct industry (Huffman 1976) and specify the technical relationship between outputs and inputs as

$$Q = Q_l + Q_c = A\prod_{i=1}^{n} X_i^{\alpha_i + \beta_i \rho}.$$

Q_l and Q_c are respectively the values of final livestock output and final crop output. ρ is the share of final livestock products in total final output. A, α_i, and β_i are unknown parameters. Separate production functions for the two final products are not implied and production is joint. Furthermore, it is a useful simplifying assumption that the true coefficients in the production function depend on the share of livestock products in the total output, ρ.

The production function estimated is then specified as

$$(14) \qquad \ln Q = \ln(A) + \sum_{i=1}^{n}(\alpha_i + \rho\beta_i)\ln X_i + \epsilon.$$

The dependent variable for the production function is county j's real farm output, Q_j, defined as the ratio of the total sales deflated by the price index of all farm products. To permit the input-output relationship to vary by farm product mix and thereby to better fit observations differing widely in mix of crop and livestock output, the measure for the mix of output (the livestock output share of total farm output, ρ) is included as a separate input into the

[7] Huffman (1980) adopts the same approach to avoid the simultaneous equation bias.

production function. The coefficients of the estimated production function,

$$\frac{\partial \ln Q}{\partial \ln X_i} = (\alpha_i + \rho\beta_i),$$

are the elasticity of the independent variable X_i with respect to farm output Q. Notice that the parameter ρ is also another variable. The coefficient β_i measures the influence of ρ on

$$\frac{\partial \ln Q}{\partial \ln X_i}, \text{ that is } \frac{\partial\left(\frac{\partial \ln Q}{\partial \ln X_i}\right)}{\partial \rho} = \beta_i.$$

A positive β_i represents an increase in the output elasticity due to marginal increase in the output share of, for example, livestock products.

The farm production function (equation [14]) is estimated by ordinary least squares technique. The estimation of log-log production function shows that 72% of the variation in farm output is explained by the conventional input variables (table 6). All of the inputs (except LAND) are statistically significant at the 0.05 level or better. Not surprisingly, the estimated coefficient of LAND is negative, implying that farm output is low in counties where farm land is abundant. This finding validates the argument that as land for agriculture becomes scarcer and values increase, operators switch from land-intensive farming to higher-valued dairy, nursery, and greenhouse enterprises. This result is in fact supported by the correlation coefficients between per farm land value and per farm dairy sales (0.48) and per farm nursery and greenhouse sales (0.39). Another explanation for this negative relationship between LAND and farm output is that the increasing value of land due to urbanization leads to land speculation, which results in decreasing investment in maintaining the quality of farmland. To this end, we observe that holding land for speculative purposes reduces per acre farm output. One of the implications of the negative relation of land with agricultural production is that farmland preservation policies in effect have a limited capacity to offset the conversion of land to nonfarm uses, a finding supported by Lopez, Adelaja, and Andrews (1988).

Off-Farm Work Participation Model

The dependent variable for the participation model is the natural logarithm of the odds of participating in the off-farm labor market, $\ln(R_j/(1 - R_j))$ or $\ln(N_j^o/N_j^f)$. The independent variables related to farm ownership categories include full-owner operators (F-OWN), part-owner operators (P-OWN),

Table 6. Production Function and Off-Farm Work Participation Model

	Production Function		Participation Model	
	Dependent Variable: lnQ		Dependent Variable: ln(R/(1 − R))	
Independent Variables	Coeff.	t-stat.	Coeff.	t-stat.
CONSTANT	−0.31	(−0.49)		
ln(CAPITAL)	0.41	(2.10)**		
ln(LABOR)	0.09	(2.30)**		
ln(LAND)	−0.04	(−0.66)		
ln(LST)	0.00	(3.11)**		
ρ*ln(LST)	0.00	(2.36)**		
ln(ENERGY)	0.10	(1.64)*		
ln(FEED)	0.33	(9.88)**		
ln(FER-SEED)	0.35	(5.34)**		
CONSTANT			−29.95	(−6.52)**
$\widehat{\ln Q}$			−0.22	(−4.02)**
ln(WAGE)			−0.02	(−1.06)
ln(P-OWN)			1.32	(3.72)**
ln(TENANT)			−0.01	(−0.23)
ln(PARTNER)			−0.15	(−2.23)**
ln(AGE)			4.00	(5.61)**
ln(YEARS)			−1.11	(−3.77)**
ln(FEMALE/MALE)			0.22	(1.82)*
ln(OI)			−1.83	(−3.98)**
ln(OI*(P-OWN))			0.26	(4.02)**
R^2	0.72		0.51	
n	158		158	

** and *, respectively, show the variables significant at the 0.05 and 0.1 levels. The variable $\widehat{\ln Q}$ is the fitted value of farm output $\ln Q$ from the estimation of the production function in the first column of table 6.

and tenants (TENANT). A full-owner operator is one who owns the land he/she operates. This definition does *not* exclude the case where he/she might have a parcel of land rented out. Similarly, a part-owner operator is one who partially owns the land he/she operates. This also does *not* exclude the case where he/she might own a parcel of land operated by others. Furthermore, a tenant does *not* exclude the case where he/she might own a parcel of land operated by others. These variables are expressed as proportions. For example, F-OWN is defined as the ratio of the number of full-owner operators to the total number of operators, which implies (F-OWN + P-OWN + TENANT) ≡ 1. Therefore, one of the ownership categories is dropped from the estimations to avoid multicollinearity. The estimated coefficient of the relevant ownership variable is then interpreted as the difference from the coefficient of the dropped variable.

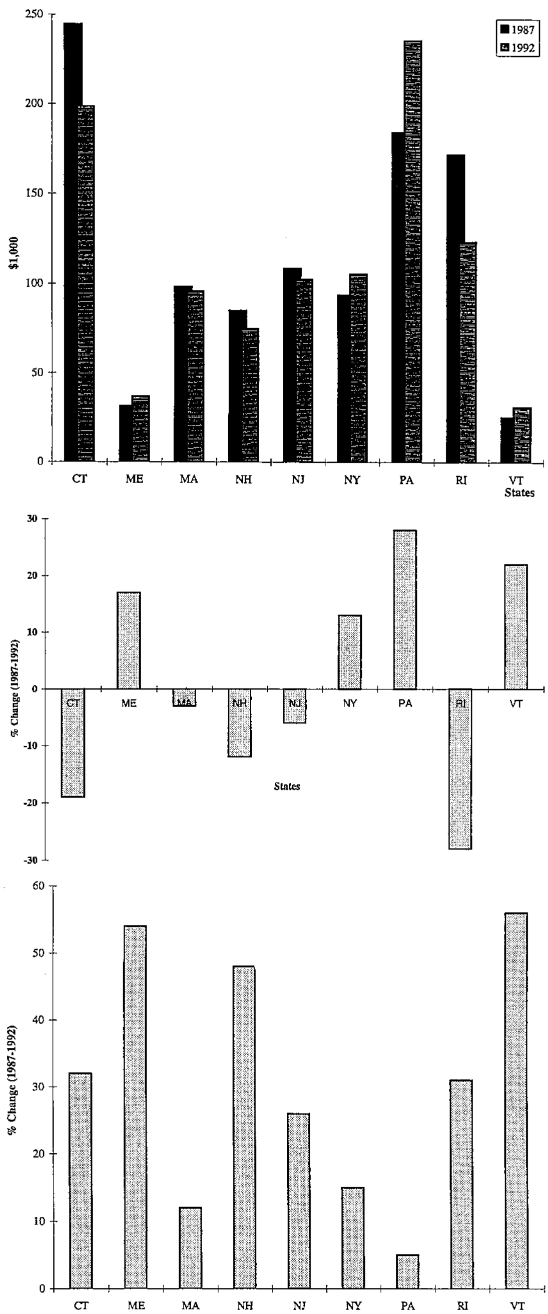

Figure 3. a. Per Farm Nursery Sales. b. Per Farm Nursery Sales. c. Number of Farms.

The parameter estimates of the participation model are reported in table 6. The parameters have the expected signs. All of the variables are in natural logarithms; therefore, the estimated coefficients represent elasticities with respect to off-farm work participation. The model explains 51% of the variation in off-farm work participation in the Northeast.

The participation model includes the fitted values of farm output ($\ln\hat{Q}$) as an independent variable to account for the extent to which input-output decisions affect off-farm employment. Because off-farm employment is most prevalent among small farms, it is not surprising to find that participation is inversely related to farm output.[8] The coefficient of $\ln\hat{Q}$ is, as expected, negative and statistically significant, and it suggests that a 10% increase in farm output decreases off-farm participation by 2.2%. Hence, agricultural and public policies that increase farm income decrease the likelihood that farm operators will participate in the off-farm labor market. The negative coefficient of wages for hired labor suggests that participation is low in counties where wages are high. However, this relationship is not statistically significant.

The ownership participation elasticities indicate that farm ownership affects the decision to participate in off-farm work. Specifically the findings suggest that a 10% increase in farms operated by part-owner operators increases participation in off-farm work by 13.2%. This finding supports our earlier argument that part-owners are mostly engaged in seasonal crop farming. Moreover, the results show a decreased tendency on the part of tenants to participate in off-farm employment primarily because they have already committed themselves to farming by renting farmland. More specifically, a 10% increase in farms operated by ten-

[8] See table 1.2 in Ahearn and Lee (1991) for the negative relationship between farm size (in sales) and off-farm income in the United States, 1986.

ants lowers the participation by 0.1%. This negative relationship is also supported by the estimation result in table 2, which suggests that tenants positively contribute to farm output and hence tend to concentrate on farm activities.

It bears noting that the type of farm organization is also significant in explaining the variation in off-farm work participation. In particular, the sign of the partnership variable, PARTNER, is negative, which indicates that farm operators of farm enterprises organized as partnerships are less likely to participate in the off-farm labor market. This finding may be due in part to the large capital and human resource investments necessary to operate commercial farm businesses. The results thus suggest that the commercialization of agriculture decreases competition between farm and nonfarm labor.

The personal characteristics of farm operators, such as age and gender, significantly contribute to off-farm employment. The results show that farm operators increasingly allocate labor to off-farm work as they grow older. This result is also supported by the correlation coefficient of 0.59 between age and off-farm participation. The finding seems to contradict the life-cycle hypothesis, which suggests that elderly operators tend to consume what they earned when young. The hypothesis projects a low off-farm participation at later stages in life.[9] A possible reason for this finding is that older farm operators may have shorter planning horizons and are thus reluctant to make substantial investments in new technology. The positive correlation coefficient of 0.42 between AGE and per farm grain sales suggests that older farm operators may switch from the more labor intensive enterprises such as dairy and vegetables to grain production.

The results also suggest that gender plays an important role in off-farm participation. The analysis shows that the coefficient of the variable FEMALE/MALE is positive and significant and indicates female operators are more likely to participate in off-farm activities than are male operators. A positive correlation of 0.49 between FEMALE/MALE and per farm dairy sales illustrates that female operators engage in labor-intensive farming and surprisingly participate in off-farm work as well (correlation 0.59). This finding is surprising because, although dairy farming is highly labor intensive, female operators are able to invest time in off-farm activities.

Farming experience is proxied by the variable YEARS, defined as the average number of years that an operator has been operating the present farm. The coefficient of YEARS, −1.11, implies that a 10% increase in the number of years of on-farm experience reduces the likelihood of off-farm participation by 11.1%. Thus, as farming experience increases, the likelihood that a farm operator will participate in off-farm work decreases. However, the estimated coefficient of AGE of an operator suggests the opposite effect. This result is puzzling and perhaps suggests that farm operators are entering farming at older ages. This assumption is supported to some extent by the lack of significance between AGE and YEARS.

The estimated coefficient for other income, OI (payments received for participation in federal farm programs denoted by GOV and income from other farm activities denoted by OFI), is significant and positive. The results indicate that a 10% increase in supplementary income reduces off-farm work participation by approximately 2%. This finding suggests, in part, that government farm-income policy subsidizes off-farm work.

The effects of other income on participation can be further evaluated with reference to the estimated coefficient for the interaction (OI*P-OWN) term. This coefficient is significant and positive. Thus, as the supplementary income of part-owner operators increases, so does the tendency to participate in off-farm activities.[10] In other words, part-operators are more responsive to off-farm work opportunities as their supplementary income increases.

Conclusion

An off-farm work participation model for the Northeast region is estimated to capture the relationship between farm ownership and operators' off-farm work decisions. A novel feature of this study is the conceptualization of the importance of farm ownership in off-farm employment decisions. The empirical framework involves the estimation of a farm production function and a participation

[9] When the variables AGE and $(AGE)^2$ are simultaneously included in the participation model, it is found that AGE is convex with respect to $\ln(N_j^o/N_j^f)$. In particular, we find $\partial \ln(N_j^o/N_j^f)/\partial \ln(AGE) < 0$ and $\partial^2 \ln(N_j^o/N_j^f)/\partial \ln(AGE)^2 > 0$, which imply that up to a certain age, off-farm work is not desirable, but after the critical age, off-farm work participation gains momentum. Among the factors behind this convex labor supply decision are farmers' risk-averse attitudes toward likely health problems at later ages. (These estimation results can be obtained from the authors upon request.)

[10] The interactions between the payments and full-owners and between the payments and tenants are also estimated but are found to be insignificant.

rate model. The estimations are performed by the heteroscedasticity-consistent ordinary least square technique using per farm averages for the Northeast region.

In summary, the empirical evidence suggests that (1) ownership plays a significant role in farm operators' off-farm work participation decisions, and in particular, part-owner operators increasingly allocate labor from self-employed farm work to off-farm activities; (2) specialization in farming reduces the likelihood that an operator will seek off-farm work; and (3) other incomes operate as subsidies and reduce the likelihood that farm operators will participate in off-farm work. It is important to reemphasize that ownership variables interact with supplementary income from other farm-related activities and payments from federal farm programs. In particular, part-owner operators are very responsive to participating in the off-farm labor market as opportunities for supplementary income arise.

Theoretically, an interesting question to be investigated is the relationship between the farm as a multiproduct or single-product firm and off-farm work participation. However, operators' risk attitudes and farm product characteristics need to be analyzed together to provide a complete picture of the developments in agricultural labor markets.

A significant contribution of this study is that part-owner operators are likely to be the most responsive ownership category with respect to participating in the off-farm labor market because of inadequate income and capital and land constraints. Conversely, full-owner operators enjoy the financial, personal, and familial advantages of farming. Our study points to the need for future research on the determination of factors that help describe the relationship between type of farm specialty and off-farm employment decisions.[11] Hence, investigating the ownership structure in the subsectors that have the highest proportion of off-farm income is crucial for designing effective sector-specific policies.

References

Ahearn, M., J. Johnson, and R. Strickland. 1985. "The Distribution of Income and Wealth of Farm Operator Households." *American Journal of Agricultural Economics* 67: 1087–94.

Ahearn, M., and J.E. Lee. 1991. "Multiple Job-holding among Farm Operator Households in the US." In *Multiple Job-holding among Farm Families,* ed. M.C. Hallberg, J.L. Findeis, and D.A. Lass. Ames: Iowa State University Press.

Barlett, P. 1991. "Motivations for Part-time Farmers." In *Multiple Job-holding among Farm Families,* ed. M.C. Hallberg, J.L. Findeis, and D.A. Lass. Ames: Iowa State University Press.

Barnum, N.H., and L. Squire. 1979. "An Econometric Application of the Theory of the Farm-household." *Journal of Development Economics* 6:79–102.

Berry, D. 1978. "Effects of Urbanization on Agricultural Activities." *Growth and Change* 9:2–8.

Carriker, L.G., R.M. Langemeier, T.C. Schroeder, and M.A. Featherstone. 1993. "Propensity to Consume Farm Family Disposable Income from Separate Sources." *American Journal of Agricultural Economics* 75:739–44.

Fuller, A. 1991. "Multiple Job-holding among Farm Families in Canada." In *Multiple Job-holding among Farm Families,* ed. M.C. Hallberg, J.L. Findeis, and D.A. Lass. Ames: Iowa State University Press.

Gebremehdin, T.G. 1991. "Off-farm Employment Participation in Louisiana: An Analysis of Survey Results." In *Multiple Job-holding among Farm Families,* ed. M.C. Hallberg, J.L. Findeis, and D.A. Lass. Ames: Iowa State University Press.

Gladwin, H.C. 1991. "Multiple Job-holding among Farm Families and the Increase in Women's Farming." In *Multiple Job-holding among Farm Families,* ed. M.C. Hallberg, J.L. Findeis, and D.A. Lass. Ames: Iowa State University Press.

Gould, W.B., and E.W. Saupe. 1989. "Off-farm Labor Market Entry and Exit." *American Journal of Agricultural Economics* 71(4):960–69.

Gustafson, G.C., and N.L. Bills. 1984. "U.S. Cropland, Urbanization, and Land Ownership Patterns." AER Publication 520. Washington, D.C.: U.S. Department of Agriculture, Economic Research Service.

Huang, C.H. 1993. "The Rationale of Excessive Pesticide Use: Hypothesis Testing and Implications." Presented at the Seventh Congress of the European Association of Agricultural Economists, Stresa, Italy.

Huffman, W.E. 1977a. "Allocative Efficiency: The Role of Human Capital." *Quarterly Journal of Economics.* 91(1): 59–79.

______. 1977b. "Interactions between Farm and Nonfarm Labor Markets." *American Journal of Agricultural Economics* 59:1054–61.

______. 1980. "Farm and Off-farm Work Decisions: The Role of Human Capital." *Review of Economics and Statistics* 62(1):14–23.

Huffman, E.W., and D.M. Lange. 1989. "Off-farm Work Decisions of Husbands and Wives: Joint Decision Making." *Review of Economics and Statistics* 71:471–80.

Jensen, H.H., and P. Salant. 1985. "The Role of Fringe Benefits in Operator Off-farm Labor Supply." *American Journal of Agricultural Economics* 67:1095–99.

Kilkenny, M. 1993. "Rural/Urban Effects of Terminating Farm Subsidies." *American Journal of Agricultural Economics* 75:968–80.

Kimhi, A. 1994. "Participation of Farm Owners in Farm and

[11] Ahearn and Lee (1991) indicate that the cattle/hogs/sheep subsector and the cash grain subsector obtain 45% and 18% of their total income from off-farm activities in 1986, respectively. Furthermore, in the same year, farms with sales of less than or equal to $40,000 received 81% of their total income from off-farm work.

Off-farm Work Including the Option of Full-time Off-farm Work.'' *Journal of Agricultural Economics* 45(2):232–39.

Lass, A.D., and M.C. Gempesaw II. 1992. ''The Supply of Off-farm Labor: A Random Coefficients Approach.'' *American Journal of Agricultural Economics* 74(2):400–410.

Lee, L.K. 1982. ''Potential Cropland: The Ownership Factor.'' AER Publication 476. Washington, D.C.: U.S. Department of Agriculture, Economic Research Service.

______. 1983. ''Linkages between Land Ownership and Rural Land.'' AIB Publication 454. Washington, D.C.: U.S. Department of Agriculture, Economic Research Service.

Lewis, J.A. 1978. ''Land Ownership in the United States.'' AIB Publication 435. Washington, D.C.: U.S. Department of Agriculture, Economics, Statistics, and Cooperative Services.

Lopez, A.R., A.O. Adelaja, and M.S. Andrews. 1988. ''The Effects of Suburbanization on Agriculture.'' *American Journal of Agricultural Economics* 70(2):347–58.

Reardon, T., E. Crawford, and V. Kelly. 1994. ''Links between Nonfarm Income and Farm Investment in African Households: Adding the Capital Market Perspective.'' *American Journal of Agricultural Economics* 76:1172–76.

Saupe, W., and B.W. Gould. 1991. ''Multiple Job-holding among Farm Families: Results from the Wisconsin Family Farm Surveys.'' In *Multiple Job-holding among Farm Families,* ed. M.C. Hallberg, J.L. Findeis, and D.A. Lass. Ames: Iowa State University Press.

Spitze, G.F.R., and R.K. Mahoney. 1991. ''Evolving Dimensions of Dual Employment of Illinois Farm Families.'' In *Multiple Job-holding among Farm Families,* ed. M.C. Hallberg, J.L. Findeis, and D.A. Lass. Ames: Iowa State University Press.

Sumner, A.D. 1982. ''The Off-farm Labor Supply of Farmers.'' *American Journal of Agricultural Economics* 64(3):499–509.

Takayama, A. 1985. *Mathematical Economics,* 2d ed. Cambridge: Cambridge University Press.

U.S. Department of Agriculture (USDA). 1994. ''Agricultural Resources and Environmental Indicators.'' Washington, D.C.

U.S. Department of Commerce. Bureau of the Census. 1988. ''Characteristics of Agriculture in the U.S.'' Publication no. AC87-BR-1. Washington, D.C.

______. 1992. ''1992 Census of Agriculture.'' Washington, D.C.

Wales, J.T., and A.D. Woodland. 1977. ''Estimation of the Allocation of Time for Work, Leisure, and Housework.'' *Econometrica* 45(1):115–32.

Wunderlich, G. 1991. ''Owning Farmland in the United States.'' AIB Publication 637. Washington, D.C.: U.S. Department of Agriculture, Economic Research Service.

______. 1993. ''U.S. Farmland Ownership: A Century of Change.'' *Agricultural Outlook.* Washington, D.C.: U.S. Department of Agriculture, Economic Research Service.

Zellner, A., and H.T. Lee. 1965. ''Joint Estimation of Relationships Involving Discrete Random Variables.'' *Econometrica* 33:382–94.