NON-PECUNIARY BENEFITS AND FARM AND OFF-FARM LABOR SUPPLY OF FARM HOUSEHOLDS

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CHAPTER I

INTRODUCTION

The Farm Labor Revolution in Rural America

American agriculture has experienced a farm labor revolution. Fueled by changing technology and facilitated by public policy, the revolution has created a surplus of farmers, leading to a massive exodus from the sector. Farm labor and management are confronted continually with the necessity to adjust resource use in response to the squeeze between the inelastic demand for food and fiber and rising opportunity costs for labor and capital. Part of the adjustment takes the form of migration of labor and capital resources out of agriculture and part emerges as dual employment. Characteristics data of U.S. farm operator households are summarized in Table 1. According to the USDA farm survey, 87.3 percent of total farm household income was from off-farm sources in 1988. Farm households with gross sales < \$50,000 account for 71.8 percent of total number of farms and 13.1 percent of gross sales, have operators that work an average 23 hours per week on farm, and on average have negative \$3,136 farm income. Eighty-eight percent of households where the operator works off-farm belong to this class. On the other end of the scale, 1.8 percent of the farm households have gross sales ≥ \$500,000, account for 29.0 percent of all farm gross sales, have operators that work on average 59.8 hours per week on farm, and on average have \$113,446 of farm income. Most of the operators and spouses in this class don't work off-farm. However, off-farm

TABLE 1

CHARACTERISTICS OF U.S. FARM OPERATOR HOUSEHOLDS, BY ECONOMIC SIZE OF FARM, 1988

	Gross Farm Sales				
Item	Less than $50,000	$50,000 - $249,000	$250,000 - $499,999	$500,000 and more	All Households
Number	1,255,814	392,958	68,072	32,001	1,748,845
Total Value of Production (%)	13.1	39.5	18.4	29.0	100.0
Household Income (Average Dollars)					
Farm	-3,136	13,146	36,547	113,446	4,201
Off-Farm					
Wage/Salaries	15,555	7,714	5,694	2,773	13,176
Other	16,531	12,138	14,570	26,713	15,653
Total	28,950	32,998	56,811	142,932	33,030
Time Operators Worked on the Farm (Number)					
Hours per year	1,206	2,797	3,096	3,110	1,672
Off-Farm Work (%)(1)					
Neither Works	60.9	27.3	8.2	3.6	100.0
Only Spouse	52.8	31.7	13.0	2.5	100.0
Only Operator	88.4	9.3	2.3	--	100.0
Both Work	87.5	10.8	1.7	--	100.0
Sample Size	5,228	4,726	1,732	1,375	13,061

(Note) (1) Based on 2,911 Farm Operator Resource Version Sample.
Source: (Ahearn, Perry, and El-Osta, 1993)

income of the households averaged $32,086 for the small farm classification and $29,486 for the large farm classification.

The growth in off-farm income relative to farm income which has occurred may make farm families just as susceptible to economic conditions of the non-farm economy as they are to the profitability of farming. Economic conditions faced by farm households are summarized by Spitze and Mahoney (1991): Highly variable net farm income per farm; declining per farm off-farm income in constant dollars; total farm family income variable but moderated by more stable off-farm income; persistently declining number of farms and farm population; rising unemployment rate; spousal earnings growing in importance both in absolute and proportionate terms; and inflation clouding the effect of increased off-farm income.

Even though the importance of off-farm work has been growing over time, as Tweeten (1991) describes it, the direct effect of off-farm work on farm structure has been underrated but the influence of farm commodity programs has been overrated in the sense that farm programs have been given much more importance than off-farm work.

In addition to the high variance and instability of farm income, we also observe that farm operators are continuously supplying their labor to farming in quantities above their profit maximizing point. In 1990, 55.3 percent of all farm households experienced negative farm income or, expressed differently, 67.7 percent of households with farm sales less than $50,000 a year experienced negative farm income (Ahearn et al. 1993). Even though these figures are said to be somewhat inflated, they indicate that the marginal value product of farm work for a considerable share of farm operator households may be lower than the off-farm wage rate. This implies that farm operator households work more time on farming than the profit maximizing level of labor input in the classical production function. Hence their 'virtual wage' in farming is smaller than the exogenous wage rate, that is, they are over-supplying labor to farm work. Farmers are expected to work in the second stage of production where the marginal productivity of labor resources used in farming decreases and profits are maximized. This study tries to find why farmers are over-supplying their labor to farm work.

Since Lee's (1965) suggested model on farm operator allocation of time, the basic assumption has been that optimal allocation of time is determined where the marginal value of time is identical between home time, farm work, and off-farm work. Here the "value" of time is determined by the marginal contribution of time to increased utility. Because utility has been assumed to be a function of goods consumed[1] and home time, the value of work time is evaluated by the amount of goods contributed per unit of time. This implies that, because all goods are assumed to be purchased, work time is evaluated by the marginal contribution of time to increase in income and farm operators are indifferent between farm income and off-farm income if they can purchase the same amount of goods. If work time is evaluated only by the amount of income contributed, then the marginal value product of farming should be equal to the off-farm wage. If they are not equal, farm operators are not maximizing their utility.

The following are possible explanations for the discrepancy between the marginal value product of farm work of the farm operator and the off-farm wage rate.

First, there exists regulation on non-farm working time. Working time in non-farm work is usually decided by contract between employer and worker. This contracted working time may be either larger or smaller than what the worker is willing to work. The general result is that non-farm operator households' contracted time is smaller than what the worker is willing to work.

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1 Becker(1965) differentiates goods from commodities. He treats the former as an input to the production of the latter in his household production function.

Hence, farm operator households work more time farming than what equates the marginal farm work time with the off-farm wage rate.

Second, there exists preferences for type of work. If farm operator households prefer farm to non-farm work, then they will accept lower returns in farming compared to non-farm work. This implies that farm work and non-farm work are not perfect substitutes. Farm and off-farm work may produce non-pecuniary benefits which are directly consumed by farm household members. Farm and off-farm work increases utility either by income or by non-pecuniary benefits. Farm household members may not be indifferent between non-pecuniary benefits from farm work and off-farm work. This result leads to the relaxation of the usual assumption that agricultural production is independent of the consumption decision.

Third, hired labor is not a perfect substitute for farm operator household labor because of extra monitoring or search costs of hired labor. For small farm operators the chances to be hired by commercial farms will become smaller because of the off-set of monitoring and search costs.

Fourth, labor is not perfectly mobile between industries and regions. As non-farm wages increase, some lag time is needed for farm operator households to migrate to non-farm work. Hence, we can expect an excess supply of labor in farming which causes lower returns to farm work compared to non-farm work. "Improvements in transportation have reduced the cost and time necessary for travel. The result has been an increase in the opportunities open to the farmer in that he is no longer tied to his land but can, if he desires, divide his time between work on his farm and non-farm employment" (Polzin & McDonald, 1971, pp. 540-45). As the improvements in transportation proceed, the non-farm wage rate facing the farm will approach the actual non-farm wage from the virtual wage in autarky. The difference represents the adjustment cost of switching to non-farm work. Technology development will shift the marginal value product curve (the demand curve for labor) to the right resulting in the increase in the employment in agriculture.

Fifth, according to the expected utility hypothesis, farm operator households migrate or accept non-farm work when their expected wage rate from non-farm work, which is non-farm wage rate times the expected employment rate (probability) in non-farm work, is equal to the farm wage rate. This implies that a higher non-farm wage rate than farm wage rate is required to induce the farm operator households to migrate.

Sixth, farmers may have expectation on the increase in farm asset income. This may make farmers continue farming with low returns to farming and increase off-farm work participation.

Objectives

The major objective of this study is to find effects, if any, of the non-pecuniary benefits on farm and off-farm labor supply of farm operators and their spouses. We hypothesize that the non-pecuniary effect is the major, though not the only, source of pecuniary discrepancy between the off-farm wage and the marginal productivity of farm operator household work in farming.

We start with the assumption that there exist two kinds of production functions in farm and off-farm activities. In farm activities, there exists a pecuniary production function and a production function in which non-pecuniary benefits are reflected. The latter shifts the pecuniary function because of non-pecuniary effects. For off-farm activities, there exists a pecuniary market wage function and a wage function in which non-pecuniary benefits are reflected. The latter shifts the pecuniary function because of non-pecuniary effects. We are not able to observe the production functions with non-pecuniary effects but are able to observe indirectly the shifted off-farm labor supply function with net non-pecuniary effects.

Farm household members allocate their time according to these latter production functions in which non-pecuniary benefits are reflected and these non-pecuniary effects cause the original pecuniary off-farm labor supply function to shift and hence causes a discrepancy between the pecuniary market wage and the pecuniary marginal value product of farm work. Therefore, if the off-farm labor supply function is estimated based on survey data, then we actually estimate this "shifted" function.

This study asserts that we can also estimate the original "pecuniary" farm and off-farm production functions based on survey data and hence the "pecuniary" off-farm labor supply function which exists without non-pecuniary effects. We then can compare the original and shifted off-farm labor supply functions and determine which factors shift the farm and off-farm production functions and hence the off-farm labor supply function assuming that the shift is wholly attributable to the net non-pecuniary effects.

Procedures

The utility maximization model is applied to explain labor demand and supply behavior of farm households and to derive off-farm labor supply and other related functions. Various econometric procedures are used for the empirical analyses including weighted least squares, probit, Heckman's two stage procedure, and two stage least squares. The data used were obtained from 2,687 farm households surveyed by the United States Department of Agriculture in 1991. A set of exogenous variables are defined which are expected to have non-pecuniary effects and the effects are statistically estimated.

Chapter II reviews the previous studies and their assumptions and empirical results are compared. Chapter III explains graphically the principles of time allocation behavior of farm households and the effects of non-pecuniary benefits are analyzed. A mathematical model of the effects of non-pecuniary benefits is defined and empirical model for estimation is discussed in Chapter IV. Chapter V explains the properties of the data used and the empirical variables for each function estimated are defined. Chapter VI shows the empirical results of the analysis and summary and conclusions are given in Chapter VII.

CHAPTER II

OFF-FARM LABOR SUPPLY OF FARM HOUSEHOLDS: A LITERATURE REVIEW

Issues on Multiple Job-holding

Fundamental Questions

Why does multiple job-holding occur in agriculture? One possible answer is because farming is inefficient, that is, inefficient farmers participate in off-farm work because income from farming is not sufficient. This result emphasizes the participation of farmers in off-farm work. However, multiple job-holding occurs in agriculture in two ways: (1) farmer's participation in off-farm work and (2) non-farm worker's participation in farm work.

Farmers can be technically inefficient in which case we are concerned with increasing the level of farm output given the input mix. In this case we are interested in reaching the frontier of the farm production function. When we are addressing technical efficiency, the form of the utility function and the trade-offs of the family between leisure and consumption are important because, if "scenery" is an important component of what the particular family is producing and consuming on their farm, this affects the measurement of output (Bollman 1991).

Farmers can also be allocatively inefficient in which case farmers are not at the optimal position on the farm production function. The issue of how to price labor of the operator is related to the allocation of farm household resources. If farmers adjust part of their labor to off-farm work because they recognize their farming activity to be inefficient, then part-time farming may be part of the solution, not part of the problem (Bollman 1991).

Multiple job-holding may occur in agriculture if farming has non-pecuniary benefits. This result emphasizes the off-farm worker's participation in farm work. The inefficiency in farming may be the result of, not the cause of, part-time farming. Negative income in farming may be the price of a rural lifestyle that many of the off-farm workers who participate in farming desire to consume (Huffman 1991).

The question "why farmers participate in off-farm work?" is applied to farmers who work off-farm. Yet we can ask "why non-farm workers participate in farm work?". The answer to the first question may be that it enhances the allocative efficiency of farm households by reducing the surplus labor in farm production. The answer to the second question may be that it enhances the technical efficiency of farming by adding non-pecuniary benefits to the farm production function. Non-farm workers may also participate in farming even with negative farm income because of expected capital gains from farmland appreciation (Huffman 1991).

<u>Who participates in part-time farming (multiple job-holding)?</u> Bollman (1991) asks if policy makers would view the outcome of part-time farming differently if the families participating in part-time farming were the smaller scale lower income farm families versus the higher income non-farm families searching for amenities of the rural lifestyle. Agricultural and rural development policy may be viewed very differently if the majority of multiple job-holders in

agriculture are the former versus the latter. Recently a greater number of non-farm families are participating in farm work.

Carlin and Bentley (1991) have identified three possible policy groups who are interested in the part-time farming phenomenon. The first group is interested in human resource development whose concern is the increase in the well-being of target populations. The second group is interested in the structure of agriculture in which a relatively small number of farm firms produce the bulk of the food and fiber, while the majority produce very little. This group is mainly interested in the productivity of agriculture. The third group is those who are interested in rural community development. Their concern is how the local farming sector might adjust to expanded non-farm employment opportunities.

Why has growth in off-farm income of farm operator households slowed? Spitze and Mahoney (1991) found, according to an Illinois farm survey, that the relative importance of off-farm income remained substantially unchanged from 1971 to 1985 - 52 percent versus 53 percent. These results mirror the changes at the national level from 1970 to 1985 - 56 percent versus 57 percent. They also found that the rate of growth in off-farm income in constant dollars has slowed substantially over the twenty-five year period 1960 to 1985 until essentially there was no growth in the first-half of the 1980s.

One possible explanation of no growth in off-farm income is the deterioration of employment conditions in off-farm labor markets. As Spitze and Mahoney (1991) suggest, the recent trend of no growth raises a serious question of whether farm families can depend in the near future upon off-farm jobs to serve as both a supplementing and stabilizing income source as they did during the post World War II period. Another possible explanation of no growth in off-farm income is the substitution of non-pecuniary benefits of farm work for pecuniary benefits of off-farm work. This implies non-pecuniary benefits are superior goods.

Views on Multiple Job-holding

Transitional Phenomenon. Multiple job-holding is looked upon as a transitional stage or a window through which farmers prepare to leave farm work, generally when they expect high levels of employment in the off-farm sector. Non-farm workers may prepare to start full-time farming if they expect a recession in the non-farm sector (Sumner 1991, Bollman 1991).

Temporary Phenomenon. Farm family members may be expected to participate in off-farm work when the returns to farm labor are temporarily low (Sumner 1991).

Permanent Phenomenon. Farming may be viewed not only as a production process but also as a way of life. Hence farm output includes not only pecuniary benefits but also non-pecuniary benefits such as scenery or a "way of life" (Bollman 1991). Non-pecuniary benefits may be from a basket of goods including fresh air, open space, good place to raise children, being one's own boss, income in kind, psychic income, and home-produced benefits (Bollman 1991).

Approaches to the Question of Multiple Job-holding

Multiple job-holding is a problem of how farm family members allocate their resources between farm and non-farm work. Yet it is also a problem of how and why farm family members choose off-farm work and how non-farm workers choose farming.

Models for Allocation Decision. The agricultural household model is an approach in which time allocation decisions of farm household members are viewed as the result of household utility maximization subject to the constraints of time, other income, and farm and off-farm production conditions (Huffman 1980, Sumner 1982). The agricultural household model combines the behavior of farm household members as producers and consumers into a single conceptual framework and explains the time allocation of each member (Huffman 1991). In this framework, the observational unit is the farm household rather than farm firm and farmers allocate their time so that the marginal value of time is equal in all uses. Interest is in allocation decisions of the farm family rather than farm operator and maximizing current income from resources available for farming may not be the primary objective of the household (Carlin and Bentley 1991).

In the household production model Becker (1965) explains the time allocation behavior of a household assuming utility maximization, but the arguments of the utility function are commodities which are produced in the household using market goods.

Models for Choice Decision. The industry choice model endogenizes the choice to work on-farm as well as the choice to work off-farm, while the traditional off-farm labor supply framework treats off-farm work as a choice that is made after the decision to farm has been selected. Hence, whether one chooses to work on-farm only, off-farm only, or to have multiple-jobs would be part of the whole choice system (Sumner 1991). Hence, we should ask the question why non-farm workers participate in farming as we ask why farm household members participate in off-farm work.

The occupation/residence choice model combines occupation and residence by weighing pecuniary remuneration from occupational choice and local public goods from residential choice. Commuting is a means of combining a preferred residential choice with a preferred occupational choice. The household maximizes utility which is a function of pecuniary benefits, local public goods, and commuting which combines the two choices of occupation and residence.

Local public goods include education facilities, public services, transportation, other public services, environmental esthetics, and proximity to family and friends. In terms of the occupation/residence choice, part-time farm families either choose farming as one of their occupations, or they choose a farm as their residence (Johnson 1991). Farmers who participate in off-farm work most likely have chosen off-farm work as their occupation, and non-farm workers who participate in farming most likely have made the residence choice. In this sense, part-time farms are not viewed as farms at all but as merely rural residences of urban workers (Tweeten 1991).

Other Issues

Definitional Issues. Off-farm work was once defined as a record of all time spent off the farm for pay, income, or profit. That is, work of the operator in connection with a filling station, store, garage, tourist camp, or other nonfarm business conducted at the farm was considered as work off the farm (United States Department of Commerce, 1935). Yet the household utility maximization models (Lee 1965) define off-farm work as work for wage income and exclude the work for business income which is counted as other income.

Ahearn and Lee (1991) differentiate part-time farming and part-time farm. Part-time farming is applied to individuals or households engaged in farming activities, and it relates to the allocation of their time among various activities, including leisure and is more relevant to questions regarding the welfare of people. Part-time farm applies to farm businesses or establishments and generally relates to aspects of production technology and is more relevant to the issue of efficient use of scarce resources.

Part-time farming is either an income-based concept or a residence-based concept. The residence-based concept depends on whether or not the household resides on a farm. The income-based concept depends on whether a household's farm income is larger than their off-farm income.

Sumner (1991) defines farmer as the self-employed operator of a farm rather than a hired farm employee and defines farm family as one which includes the operator, spouse, and children.

Recursive or Simultaneous? Once off-farm labor market and hired labor market are introduced to a farm household, and if family labor and hired labor are perfect substitutes, then the production decision of the farm household is determined independently of the consumption decision, but not vice versa. The reason is that all output and input prices are determined in the external market (Huffman 1991, Bollman 1991). If non-pecuniary benefits are added to the farm output, then the farm production decision clearly depends on the household characteristics because family labor and hired labor are not perfect substitutes. Farm labor produces more "output" than hired labor even if both are assumed to have identical human capital stock. Empirically a non-recursive model provides a better fit to the data compared to a recursive model. Lopez (1984) rejected the hypothesis that production and consumption decisions are independent and showed that important gains in explanatory power result from estimating the consumption and production sectors jointly.

Commercialization. Spitze and Mahoney (1991) find that multiple job-holding among farm families has prevailed since U.S. agriculture commenced rapid commercialization. Does this contradict the fact that commercial farms participate less in off-farm work than small farms? This suggests the hypothesis that U.S. agriculture has experienced a structural polarization: commercial farms versus part-time farms.

Effect of Inflation. Spitze and Mahoney (1991) find that inflation has clouded the measured increase in off-farm income. They found that the rate of increase in off-farm income in constant dollars has slowed substantially to essentially no growth in the first half of the 1980s. Yet we have few empirical studies on the effect of inflation on off-farm labor supply.

Shape of the Production Function and Off-farm Labor Demand. Tweeten (1991) suggests that the marginal value product curve of the operator's labor in agriculture slopes upward to the right because of economies of size when land, labor, and capital are allowed to vary in least-cost combination. Similarly, the marginal value product of operator labor in off-farm employment also slopes upward to the right because part-time non-farm jobs either are unavailable or pay less per hour than full-time jobs.

Model Structure and Assumptions

The review of studies concentrates on agricultural household models which assume that farm households maximize utility under the constraints of farm and off-farm production functions, and time.

Utility

Huffman (1980) defines the arguments of the utility function on the basis of two categories of variables: endogenous and exogenous. The endogenous variables include a vector of household member's leisure and a vector of purchased goods. The exogenous variables include a vector of factors exogenous to current household consumption decisions such as member's age, education, and household size.

The exogenous variables are divided into two categories. The first category includes human capital variables that are currently fixed but affect the efficiency of household production, e.g., schooling and experience of adult members. The second category includes other household and area characteristics, e.g., climate, number of children in the household, and commuting distance to shopping, recreation, and schooling centers. This type of function is called single hybrid household-utility function because it results from substituting a household-production function into a standard ordinal household-utility function (Huffman 1991). Lass et al. (1991) also define a vector of exogenous environmental factors which determines the level of utility. The utility function is assumed to be ordinal and strictly concave (Huffman 1980).

Yet this type of utility function does not explain why farmers continue farming even with negative income. The change in exogenous variables may shift the utility curve, but it does not change the equilibrium of agricultural production because the production decision is independent of the consumption decision. In the standard utility function, farmers are assumed to be indifferent between farm work and off-farm work if each earns the same pecuniary income per unit of time. This implies that utility should also be a function of non-pecuniary benefits which again are functions of farm or off-farm work.

Production

The farm production function has endogenous and exogenous variables. Endogenous variables include factors such as labor, land, and capital the levels of which are determined in the system by the exogenous variables. Exogenous variables include human capital of the farm family members and farm specific characteristics on which the efficiency of farming depends. The farm production function is assumed to be strictly concave and hence on-farm labor by both the operator and spouse will face diminishing marginal returns (Huffman 1980, Lass et al. 1991).

Yet Tweeten (1991) suggests that the long-term marginal value product curve in farming slopes upward because of economies of size when land, labor, and capital are allowed to vary in least-cost combination. He also suggests that "scenery" is an output of production and an argument of the utility function. Hence psychic as well as tax and other benefits will shift the farm MVP curve upward.

Market Wage and Income

The off-farm market wage is generally assumed constant while the marginal value product of farm work falls as more time is devoted to farming (Sumner 1982). Yet Tweeten (1991) asserts that the marginal value product curve of operator labor in off-farm work slopes upward to the right because part-time nonfarm jobs either are unavailable or pay less per hour than full-time jobs. Overtime rates and fringe benefits are generally ignored in off-farm wage functions (Sumner 1991).

All income earned from farm and off-farm work, and other income is generally presumed spent on market goods with no savings or investment (Huffman 1980, Huffman 1991). The impact of taxes that may shift the relevant earnings equations are also ignored (Sumner 1991).

Labor

Labor is generally assumed to be less than perfectly mobile and hence local labor market conditions will affect real wage rates. Even if labor is perfectly mobile there generally exists equilibrium differentials. Singh et al. (1986) treat family and hired labor as perfect substitutes. This determines recursiveness of the model in the sense that farm production decisions are independent of the farm household consumption decisions. Yet Huffman (1980) treats hired labor as a purchased input which results in imperfect substitution between farm household and hired labor.

Time

A vector of time endowments of farm household members is assumed to be allocated between farm work, off-farm work, and leisure (Huffman 1980, Sumner 1982). Farm youth are engaged primarily in human capital production through formal schooling (Huffman 1991). Time is assumed to be homogeneous between farm and off-farm work in the sense that work intensity is the same between types of work but heterogeneous between individuals. For example, the time of the husband is distinguished from the wife. The gender distinction exists because endowed and acquired skills of adult males and females are assumed to be different (Huffman 1980, Huffman 1991). Time in the present is also assumed as an imperfect substitute for time in subsequent periods (Sumner 1991).

Work schedule is presumably flexible in off-farm labor markets. That is, regulations or union contracts imposing restrictions on hours of work are ignored (Huffman 1980, Sumner 1991). Yet Shishko and Rostker (1976) contend that second jobs often limit the number of hours that can be worked to less than full time in case of multiple job-holding. Time for commuting and job searching is ignored, that is, fixed costs of working is assumed to be zero (Huffman 1980, Shishko and Rostker 1976).

Other Assumptions

Input and output markets are assumed to be perfectly competitive in that input and output prices are exogenously determined (Huffman 1980). Farmers are generally not risk neutral. If farm and off-farm work require specialized skills and households are risk neutral, individuals tend to specialize in one major type of work activity. Risk neutrality leads to specialization, not to an interior solution (Huffman 1991). Shishko and Rostker (1976) assert that the second job is contingent upon or complementary to the primary employment in the case of multiple job-holding.

Factors of Multiple Job-holding

Factors Affecting Off-Farm Wage Rate

In a regional labor market, wage level is determined simultaneously by the demand for and the supply of labor. However, wage determination for an individual depends on two categories of factors: human capital stock of the individual and local labor market conditions.

Human Capital. Human capital variables are found to be important determinants of the wage that farmers receive when they work off-farm (Huffman 1980, Sumner 1982, Huffman 1991). Years of formal education is positively associated with the market wage rate (Gould and Saupe 1989, Tokle and Huffman 1991). Job experience at the current and other jobs add to wages, but vocational training frequently has a negative impact (Gould and Saupe 1989, Sumner 1982). In wage functions, age is often used as a proxy for on-the-job experience. Health condition has generally not added significantly to off-farm wage determination (Sumner 1982).

Local Labor Markets. When workers are immobile, local economic conditions affect real wage rates. Although workers are largely immobile in the short run, they are generally geographically mobile in the long run. The wage premium in localities having higher expected growth of labor demand compensates males for the costs of geographical or occupational mobility.

Tokle and Huffman (1991) found that localities with higher anticipated unemployment rates also pay higher rural wage rates for males to induce more workers to move into their area. An increase locally of the share of service jobs increases the real wage. Local cost of living which is measured as land price has positive effect on wages which reflects that workers accept higher offered wages when the cost of living is high. Locational amenities which are measured as differences in temperature have positive effects on wage rates. Sumner (1982) found that distance to the nearest town has no impact on the wage rate, but distance to the nearest city (population greater than 50,000) reduced the wage rate. Distance to the nearest town may reflect the labor mobility between regions or occupations. In other words, distance to the nearest town reflects the commuting distance and distance to the nearest city reflects the labor demand, that is, the size of local labor market faced by the worker.

Factors Affecting Off-farm Labor Supply of Farm Households

Factors affecting off-farm participation and labor supply are theoretically identical to the set of exogenous variables determining farm production, off-farm wage, and utility.

Human Capital. Micha Gissa (1965) shows that schooling has two effects on farm labor: (1) outmigration effect which increases the mobility of farm people and hence reduces farm labor supply and (2) capability effect which enhances farm productivity and hence increases farm labor supply. Hence, for example, if the outmigration effect dominates the capability effect then the higher level of schooling reduces surplus labor in agriculture.

Human capital stocks have direct and indirect effects on the supply of off-farm labor (Huffman 1980, Tokle and Huffman 1991, Lass et al. 1991). Yet Sumner (1982) finds formal education has little effect on off-farm labor supply. Off-farm work experience has positive effect on off-farm labor supply. Farm experience increases the value of time on farms and hence reduces the amount of time devoted to off-farm work (Sumner 1982, Furtan et al. 1985, Streeter et al. 1986). Wife's educational level has negative effect on the husband's off-farm labor supply. This coefficient probably reflects an income effect (Sumner 1982, Lass et al. 1991).

Farm operators build human capital through investments in education, research, extension, and training (Lass et al. 1991). Huffman (1980) finds that raising the education level of farmers and increasing the agricultural extension input increases the off-farm labor supply of farmers through efficiency effects. Increasing agricultural extension enhances the efficiency of farm production. Sumner (1982) asserts that farm training increases the value of time on farms and, therefore, reduces the amount of time devoted to off-farm work.

Life Cycle. If the age variable is used without the years of experience variable, then the age variable is used as a proxy for experience and hence reflects productivity change as well as life cycle effect (Furtan et al. 1985, Thompson 1985, Lass et al. 1991). If the age and age squared variables are used with the experience variable, then the age variables reflect only the life cycle effect. Life-cycle pattern is the familiar quadratic found in labor supply studies, but its effects are not strong (Sumner 1982).

Farm Characteristics. If farm characteristic variables are used with predicted value of farm production variable, then the change in farm characteristics may reflect non-pecuniary effects because the pecuniary effects are already reflected in the production function. Most previous studies have used the farm characteristic variables without the predicted value of farm production. In this case, the variables reflect both pecuniary and non-pecuniary effects.

We expect that increases in farm scale would reduce the supply of labor to the off-farm markets for both the operator and the spouse (Lass et al. 1991). Yet Lass and Gempesaw (1992) found that given the decision to participate, size of farm had little impact on hours supplied when both spouse and operator worked off-farm. When only one member of the household worked off-farm, farm sales had a positive impact on hours supplied for both operator and spouse. Operator and spouse may be able to substitute hired labor for their own labor more effectively on larger farms. Spitze and Mahoney (1991) found that off-farm earnings tended to decline as farm sales increased, while farm and total household income increased. Predicted value of farm production, revenue, or profit may be used as a proxy for farm scale, but, in this case, the other farm characteristics reflect only non-pecuniary effects.

Net farm income per farm is found to be highly variable since 1960 (Spitze and Mahoney 1991). Variance of farm sales, returns, or income may be used as proxy variables for risk in farming which may have an effect on the supply of off-farm labor. Previous research suggests that off-farm labor may be an important hedge against risk (Lass et al. 1991). If we expect more farm earnings from specialization which is risky, the incentives for off-farm work become greater as a form of diversification (Sumner 1982).

Sumner (1982) found that as the percentage of corn, soybean, and swine to total output increased, the off-farm labor supply followed a U shape. However, the technology of dairy farming with its low seasonality and low risk discouraged off-farm work. Yet Lass and Gempesaw (1992) found that farm type had little impact on off-farm labor supply.

Household Characteristics. The effects of children on the labor supply by male are uncertain while the presence and number of children are inversely related to the hours worked by female (Lass et al. 1991).

Locational and Economic Conditions. Locational factors have composite effects on off-farm labor supply of farm operator households. It affects offered wage through local labor market conditions. Local climate and soil conditions affect farm productivity. Regional differences in climate and "scenery" affect the utility function. Polzin and MacDonald (1971) found that the percentage of non-agricultural jobs in manufacturing was positively related to the supply of off-farm labor and the percentage of population classified as rural-farm had a significant negative effect on the off-farm labor supply.

Distance to the nearest city is included assuming that farmers located near urban areas have access to more active labor markets. Johnson (1991) expects that distance between residence and off-farm job reduces the probability that family members will take a job but increases the hours worked if they do. Distance to the job reflects the fixed costs of labor supply such as time costs.

Prices of inputs and outputs to farms and farm households are included to capture the reactions of farm families to changing economic conditions.

Other Income. Other income variables are included to capture the effects of exogenous non-wage income on the consumption of leisure. If leisure is a normal good, higher levels of income from non-wage sources would result in fewer hours of off-farm labor supply. Huffman (1980) defines income categories as follows:

- Income
  - Net farm income
  - Wage income
  - Other income
    - Realized other income
      - Income received from non-farm business and professions
      - Social security, pensions, veterans and welfare payments
      - Rent from farm and non-farm property, interest, and dividends
    - Unrealized other income
      - Accrued appreciation income on owned farm land and buildings of farm families

Some components of realized other income (social security, etc.) may be fringe benefits (Jensen and Salant 1985). Fringe benefits are related to a job and include paid vacation and/or sick leave, health insurance, private pension plans, and life insurance. Fringe benefits are frequently determined by the human capital and hence should be counted as a type of wage payment rather than other income which is exogenously given. Jensen and Salant (1985) found that both money wage and fringe benefits had a positive effect on operator hours of off-farm work.

Other income which affects off-farm labor supply should theoretically include farm income less returns to labor, spouse's off-farm income, and both realized and unrealized other income. Yet empirical application differs by study. Huffman (1980) used both realized other household income and unrealized appreciation income as the other income variable. Lass and Gempesaw (1992) used predicted total family income and found that off-farm labor supply was related with the variable suggesting that leisure is a normal good. Furtan et al. (1985) used a measure of net worth of the farm and found it to be negatively related to the supply of off-farm labor. Tokle and Huffman (1991) used asset income as the other income variable. Several cross-section studies have found small income effects on labor supply (Sumner 1982).

Market Wage. Market wage is one of the most important factors explaining the labor supply behavior of farmers. If only wage variable is used then the coefficient may be the sum of the income and substitution effects. If an income variable is used with a wage variable then the wage coefficient reflects only the substitution effect. Sumner (1982) used predicted total family income to measure the income effect. He found a strong positive relationship with an elasticity greater than unity reflecting the substitution effect outweighed the income effect. He assumed that the total labor supply elasticity was near zero and explained the strong and positive wage elasticity as indicating a high degree of flexibility in the use of operator labor on farms. Yet Lass and Gempesaw (1992) found a negative wage elasticity for the operator and spouse.

The spouse's wage also has an effect on operator's off-farm labor supply suggesting that men and women adjust their hours worked off-farm according to their spouse's opportunities. Yet empirical evidence is not consistent with this hypothesis. Huffman (1980) and Thompson (1985) found the substitution relation and Huffman and Lange (1989) found the complement relation between the variables.

Factors Affecting Labor Force Participation in Off-farm Work

Off-farm participation of farmers is determined by the difference between market (or offered) wage and reservation wage. The greater the difference, the higher the probability to work off-farm. Market wage is determined by the human capital of an individual and the regional labor market conditions. Reservation wage is determined by the same exogenous variables as for farm production and utility.

Human Capital. Human capital of farmers has three different effects: (1) effect on farm productivity, (2) effect on off-farm productivity and hence on offered wage, and (3) effect on utility. This implies human capital is an exogenous variable for all three functions which determine farm production and consumption behavior. Hence the human capital affects both market wage and reservation wage and affects off-farm participation.

Huffman (1980, 1991), Sumner (1982), and Gould and Saupe (1989) found that years of formal education of operator were positively associated with the probability of off-farm work. Gould and Saupe (1989) also found that off-farm work experience had a positive effect on off-farm participation. Sumner (1982) found a negative effect for farm experience on the operator's participation decision. He also found that vocational training for nonfarm work had a positive effect on probability to work off-farm while farm-related training did not reduce off-farm work.

Spouse's characteristics are included to reflect the assumption that farm operators and spouses make joint participation decisions. Sumner (1982) found that wife's education had a small negative effect on the participation of operator's off-farm work. Sumner (1982) found health had no significant effect on off-farm work.

Life Cycle. Age and age squared are included to capture the life cycle effect. The probability of off-farm work increases but at a decreasing rate (Sumner 1982, Bollman 1970, and Huffman and Lange 1989). Tokle and Huffman (1991) found that the life cycle effect on probability of off-farm work was quadratic for farm males but for females, the probability of off-farm work was highest at a young age.

The life cycle effect has implications for the role of off-farm work in the decision making of farm and non-farm households. If off-farm work increases with age, we can hypothesize that off-farm work supports exiting from farming. If off-farm work declines with age, then off-farm work is presumably used as a supplement to household income during entry into farming.

Farm Characteristics. Farm scale is represented by such variables as farm sales, farm income, imputed value of farm output, capital value, and acreage operated. Off-farm participation occurs most frequently among those that have relatively small gross farm sales, but it is also significant for operators of larger farms. Huffman (1980) used imputed farm output and found a negative relationship between farm size and off-farm participation of operators.

Huffman (1980) also found that variance of sales had a significant positive effect on off-farm participation.

Sumner (1982) hypothesized that specialization would increase off-farm work suggesting that the off-farm participation follows a U shaped curve for the percentage specialization of corn, soybean, and swine. He also found that, although dairy farming tended to be specialized, the technology of dairy farming, its low seasonality, and its low risk discouraged off-farm work. Spitze and Mahoney (1991) found that spouse off-farm work participation appeared unaffected by farm type. Lass and Gempesaw (1992) found that farm type had little impact on participation decisions.

Household Characteristics. Sumner (1982) found that number of children had no significant effect on operator's off-farm work participation. Huffman and Lange (1989) found a negative relationship between number of preschool children and off-farm participation of farm operator and spouse.

Locational and Economic Conditions. As in the labor supply function, locational characteristics contain variables which affect farm and off-farm productivity and the utility function. Lass et al.(1991) found that little was understood about the impacts of location on the prevalence of off-farm work. Sumner (1982) found that distance from the farm to the nearest town reduced the probability of off-farm work. Yet improved communication and transportation systems reduce the effect of the distance on the off-farm participation by enhancing the integration of farm and nonfarm labor markets. Johnson (1991) suggests that greater distances between residence and off-farm job reduces the probability that a family member will take a job but increases the hours if they do.

Johnson (1991), applying the Tiebout hypothesis, predicted that improvement in local public goods had both positive and negative effects on the off-farm labor market and hence on off-farm work participation. Improvement in local public goods increases the labor supply of nonfarm families to the area and influences the location decisions of new and relocating firms.

Tokle and Huffman (1991) suggest that off-farm work participation increases when times are difficult in agriculture and when times are good in the non-agricultural sector.

Tokle and Huffman (1991) incorporate output and input price changes in explanation of off-farm work participation. Technology development and extension activities which affect technology adoption are also possible determinants of off-farm work participation.

Other Income. Amount of other income reflects the income effect on the off-farm work participation when used with market wage. Huffman (1980) found that income from nonwork sources had a significant negative effect on the probability of off-farm work of operators.

Huffman (1991) suggests that many farm households are expected to capture significant real capital gains on farmland appreciation. This expectation on asset income will affect off-farm work participation. One possible hypothesis is that, with this expectation on the increase in farm asset income, farmers continue farming with low returns to farming and increase off-farm work participation.

Spitze and Mahoney (1991) found that the proportion of both operators and spouses working off-farm tended to increase as the debt-to-asset ratio increased.

Effects of Multiple Job-Holding

Structure of Agriculture

Johnson (1991) asserts that multiple job-holding eases the transition out of farming for those who must leave and hence reduces underemployment in agriculture. Tweeten (1991) maintains that part-time farm operators tend to choose less labor-intensive enterprises and prefer land-intensive operations such as the production of fruits and vegetables or the beef cow-calf enterprise not covered by commodity programs. He also asserts that the off-farm income effect on farm numbers is much greater than the commodity program effect and estimates that the number of farms may be as much as ten times higher today than would have been possible without off-farm income and government programs.

Rural Population

Lass et al. (1991) assert that, despite low or even negative net returns, many small farms have continued to operate principally supported by off-farm income. Tweeten (1991) also maintains that off-farm income and, to a lesser extent, commodity programs have played a major role in retaining people on farms. Huffman (1991) asserts that the increased importance of off-farm work has meant that the size of the rural population is larger than it would be otherwise and the higher density of the rural population has some advantages for the provision of quality public services to rural people.

Other Effects

Tweeten (1991) asserts that part-time farming may have consequences on farm programs because part-time farmers are less likely than full-time farmers to participate in government commodity programs. Johnson (1991) maintains that part-time farming increases farm family income and also the distribution and stability of farm income. Part-time farming may also have implications on how changes in the local nonfarm economy might affect farming.

Issues on Estimation

Because wage and off-farm labor supply are observed only for those who are working off-farm, we need to adjust the conditional nature of observations by using the economic and econometric models of choice in the estimation of wage and labor supply functions. Sumner (1982) uses Heckman's approach in the calculation of a selection-bias correction factor from a first-step estimation of the participation equation. Huffman (1991) adjusts the reaction of annual off-farm hours so that they represent the unconditional or expected average reaction of all farm operators, not just the ones that participate in off-farm work.

Either aggregate or micro data have been used in the estimation of the labor supply and off-farm participation functions. Huffman (1980) points out that some aggregation bias invariably occurs in aggregate data but measurement errors and model specification errors may be serious in micro data. Gould and Saupe (1989) point out the limitations of using cross-sectional data on the analysis of off-farm labor supply. They maintain that a major limitation of this use is the inability to analyze the response of labor supply to changes in the wage rate. That is, when using cross-sectional data, the labor force participation decisions are implicitly assumed symmetrical in that the factors affecting participation have equal but opposite effects on the probability of nonparticipation. Lass and Gempesaw (1992) found that, by using the random coefficient approach, a number of important parameters of off-farm labor supply vary substantially from the mean parameter estimates implying that policy simulation based on the standard fixed coefficient results could provide misleading conclusions. They also use the bivariate probit model in which operator and spouse participation decisions are estimated jointly, an appropriate model if univariate probit equations are correlated.

CHAPTER III

MODELS OF FARM HOUSEHOLD TIME ALLOCATION: GRAPHICAL APPROACHES

Basic Theory of Household Time Allocation

Labor supply is usually derived by the household leisure demand which is again derived by the assumption of household utility maximization. If household utility is assumed to be additive, it can be derived by summing up the utility functions of the household members. Individual utility has the form:

$$U = U\ (x,l)$$

where x is consumption of goods and l is leisure.

Individual utility is assumed to be a continuously twice differentiable concave function of x and l. We assume that wage earned by the household member is not affected by the time supplied. Then the individual supplies OL_1 of labor and earns OY_1 income in Figure 1 which maximizes utility. Here 'income' is expressed as the amount of commodities which can be purchased by the wage and non-wage income. A_0 implies non-wage income such as interest, rent, and transfer payment. T implies total time available. The slope of A_0w implies wage rate and the individual consumes L_1T of leisure. If wage varies, labor supply will either increase or decrease depending on the type of utility function, that is, tastes of the person. We can observe that individual labor

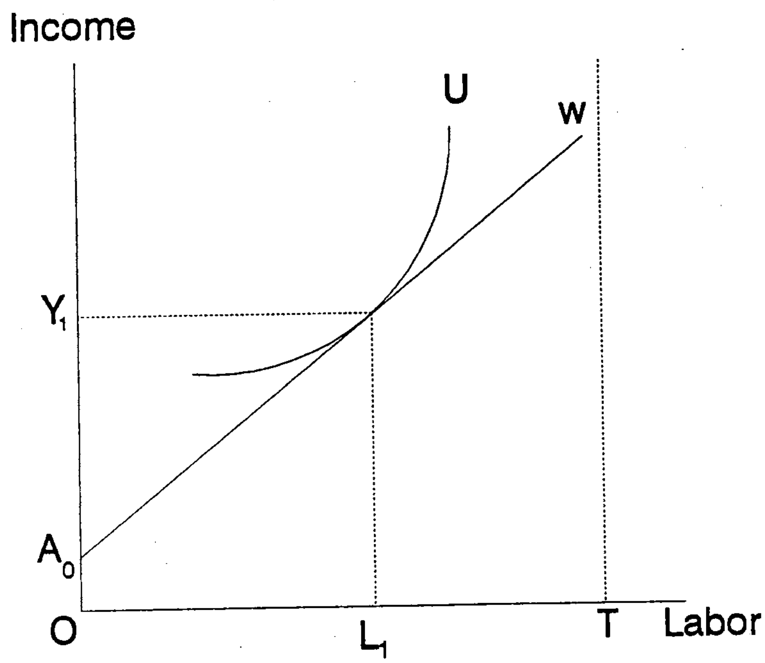

Figure 1. Individual Time Allocation Between Work and Leisure

supply finds equilibrium where the marginal rate of commodity (leisure and income) substitution is equal to the real wage rate.

Labor supply can be derived graphically by varying the slope of the wage line (Figure 2). Labor supply increases as wage increases. If wage increases beyond some level, labor supply may decrease because the income effect becomes larger than the substitution effect. If wage goes up from w_1 to w_2 in Figure 3, the substitution effect will be L_1L_2 and will always be positive but the

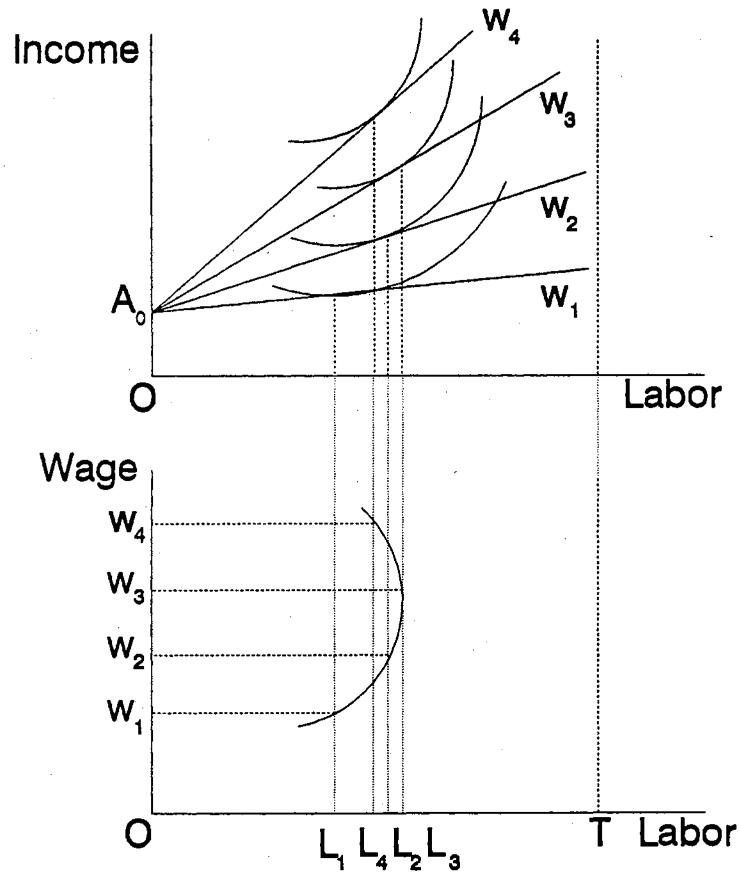

Figure 2. Graphical Derivation of Labor Supply Function

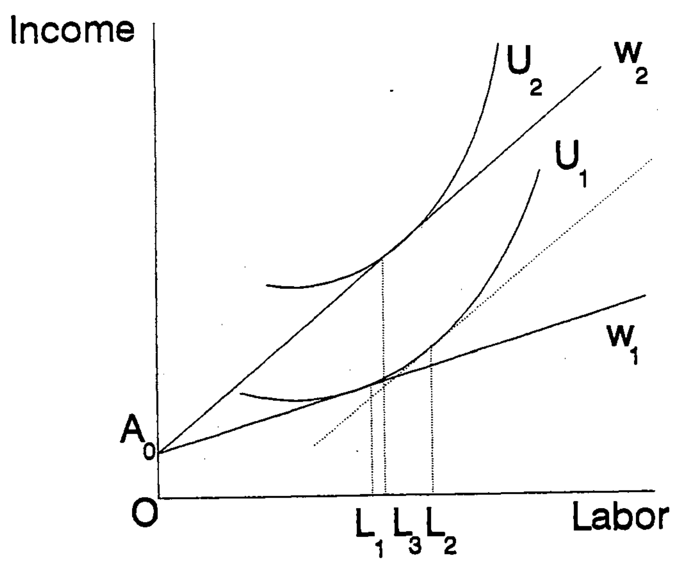

Figure 3. Substitution and Income Effect of Wage Changes

income effect is L_3L_2 and is negative if leisure is assumed to be a normal good. If wage increases beyond some level, L_3L_2 may be larger than L_1L_2 and total labor supply may decrease. This is the backward bending labor supply function.

'Simple Theory' of Multiple Job-holding

Shishko (1976) explains the phenomenon of multiple job-holding in his 'simple theory' assuming that working time in the primary job is decided by a contract with the employer. Multiple job-holding happens when the contracted working time in the primary job is less than the amount the worker is willing to work at the contracted wage level W_p in Figure 4. If there is no constraint on working hours, the worker will work L_3 hours at that wage rate and maximize utility at U_3. Suppose the worker can work only L_1 hours (for example, 40 hours a week) by contract. He will seek a secondary job as long as the wage in the secondary job is higher than the reservation wage (W_r). Suppose that the wage in the secondary job is W_s, then the worker is willing to work OL_2 of time and increases his utility from U_1 to U_2.

Off-farm Labor Supply of Farm Household

Sumner (1982) explains off-farm labor supply of farm household assuming that farm production has decreasing marginal product as labor input increases while off-farm (agriculture or non-agriculture) wage rate is constant as labor supply varies. If there exists no labor market, the household will produce and consume only for himself. In this case, he will supply OL_2 of labor in Figure 5 to his farming and will produce OY_2 which maximizes utility at U'.

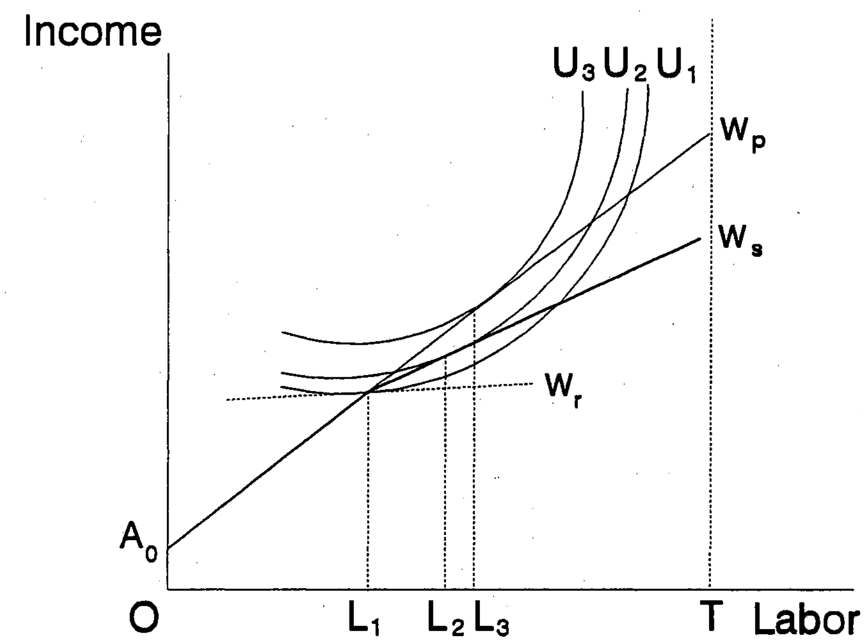

Figure 4. Multiple Job-Holding and Time Allocation

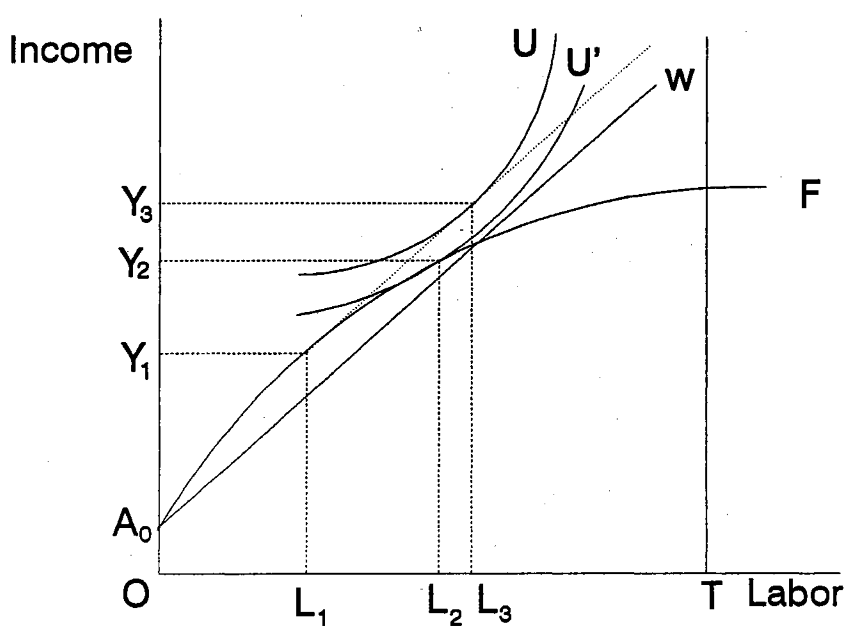

Figure 5. Time Allocation of Farm Households

If the labor market is introduced with wage rate w, he will reduce labor supply to the level of OL_1 in his farming until the marginal value product of farming is equal to the market wage rate. He will work L_1L_3 of time at the secondary job and total income will increase to OY_3. His utility also increases to U. At this point he maximizes profit as well as utility. We can observe that profit maximization in farming is a condition of utility maximization.

Labor Flow Within Agriculture

We extend the result of Sumner to agriculture where commercial and small farms exist. Let's suppose for now that the nonfarm sector doesn't exist. TR_c and TR_s in Figure 6 represent the production functions of commercial and small farms, respectively. The commercial farm is assumed to use more capital and land than the small farm. Here "commercial" and "small" farm refers only to the size of farm in terms of acreage and amount of capital used. Without the labor market the commercial farmer will work 'oc' of time and the small farmer 'od' of time for their own consumption which will maximize their utilities. If the labor market is introduced with wage rate W, the commercial farmer will reduce his own labor supply to 'ob' and will hire 'bf' of small farmer labor to expand his farming. The small farmer will reduce his labor supply to 'oa' for his own farming and will work 'ae' of additional time on the commercial farm. Here 'of' is profit maximizing labor demand for the commercial farm and 'oa' for the small farm. Without the nonfarm sector, the farm wage rate will adjust to equalize demand for and supply of hired labor, that is, W will adjust to equalize 'bf' and 'ae'.

The nonfarm sector is introduced with a wage rate higher than the above equilibrium farm wage rate. Assume labor demand in the nonfarm sector is

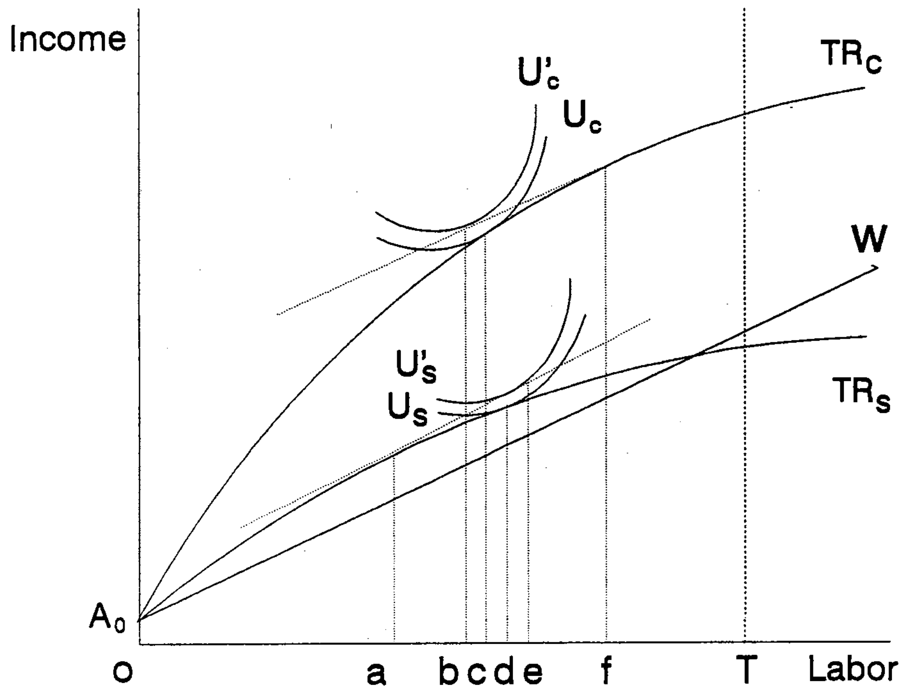

Figure 6. Equilibrium Labor Allocation of Small and Commercial Farms

perfectly elastic. Then both the commercial and the small farm may contract labor for their own farming. The commercial farm will reduce the number of hired labor and the small farm will expand nonfarm labor supply. These can be more clearly explained by labor demand and supply curves of an agricultural household.

Labor Demand and Supply of Farm Household

The most distinctive feature of the farm household may be that the household labor demand curve as well as the supply curve can be clearly derived by the farm production and utility function. Each farm household (member) has its own labor demand and supply function. Farm production decides farm household labor demand and utility decides household total labor supply. In other words, the household labor demand curve is the loci of profit maximization and the labor supply curve is the loci of utility maximization.

Equilibrium wage rate, w_3 in Figure 7, is the shadow price of labor when a farm household produces only for its own consumption and it will work 'od' of time on its farm. If the market wage rate is higher than this shadow price, e.g., w_4, then the household will reduce labor supply for his farm work to the level of 'ob' and will work 'be' time off-farm. If the market wage falls to the level of w_2, he will work on his farm 'oc' of time and will hire 'cf' labor.

If we assume that labor is mobile only within agriculture, then the agricultural wage rate will find equilibrium at w_3 in Figure 8 where excess labor supply by the small farm 'bc' equalizes excess labor demand by the commercial farm 'eh'. Here w_1 and w_2 are shadow prices of labor in small and commercial farms, respectively. If the exogenous nonfarm wage rate, w_4 , is introduced and if labor is mobile between farm and nonfarm, then both small and commercial farms will contract labor for their farming.

With wage rate w_4, the small farmer will supply total 'od' time and will allocate 'oa' time to his own farm work and 'ad' time to off-farm work. Of the off-farm work he may allocate 'oi' time to the commercial farm and 'ik' time to nonfarm work. He may again allocate some part of the nonfarm work to

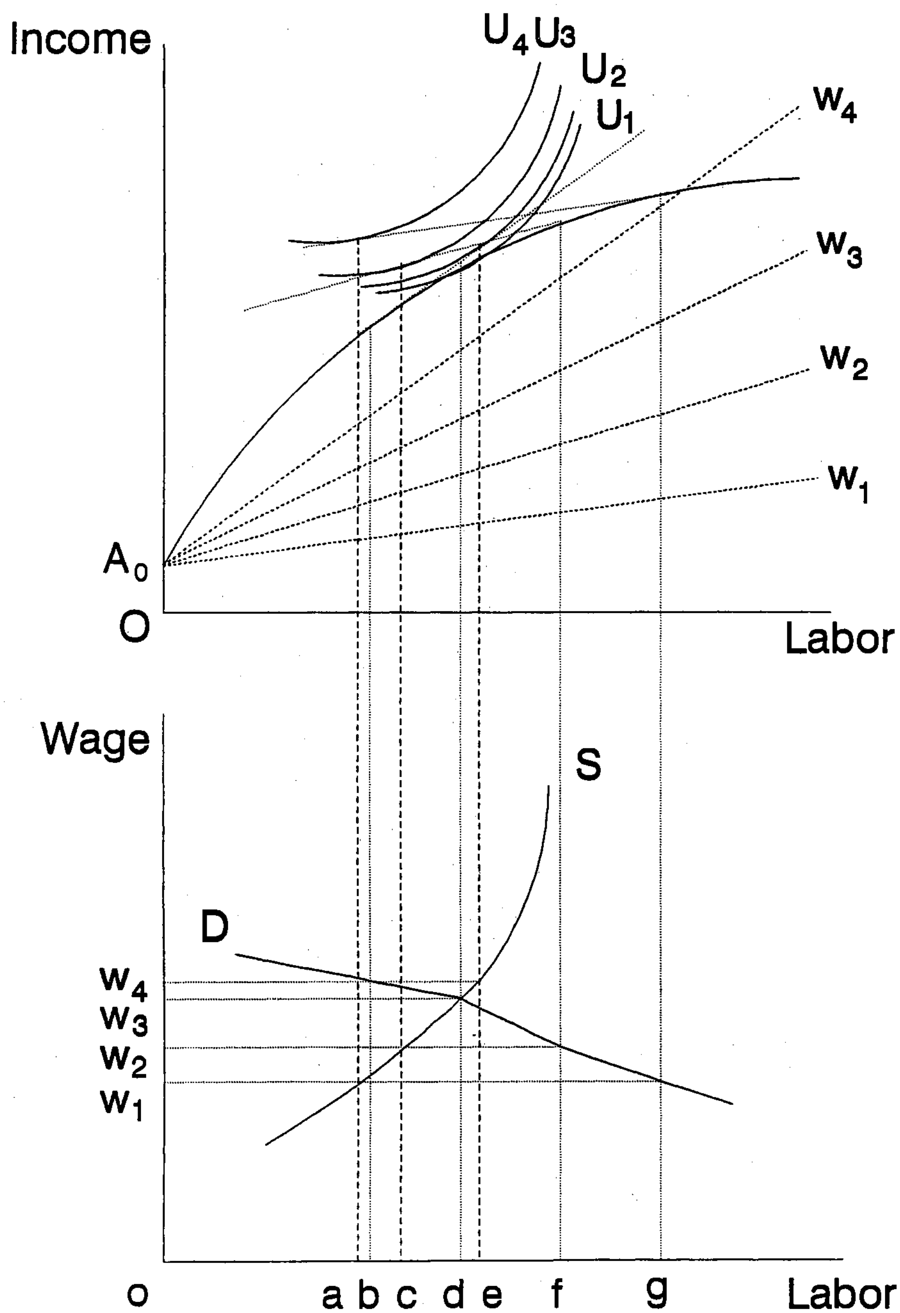

Figure 7. Labor Demand and Supply Functions of Farm Household

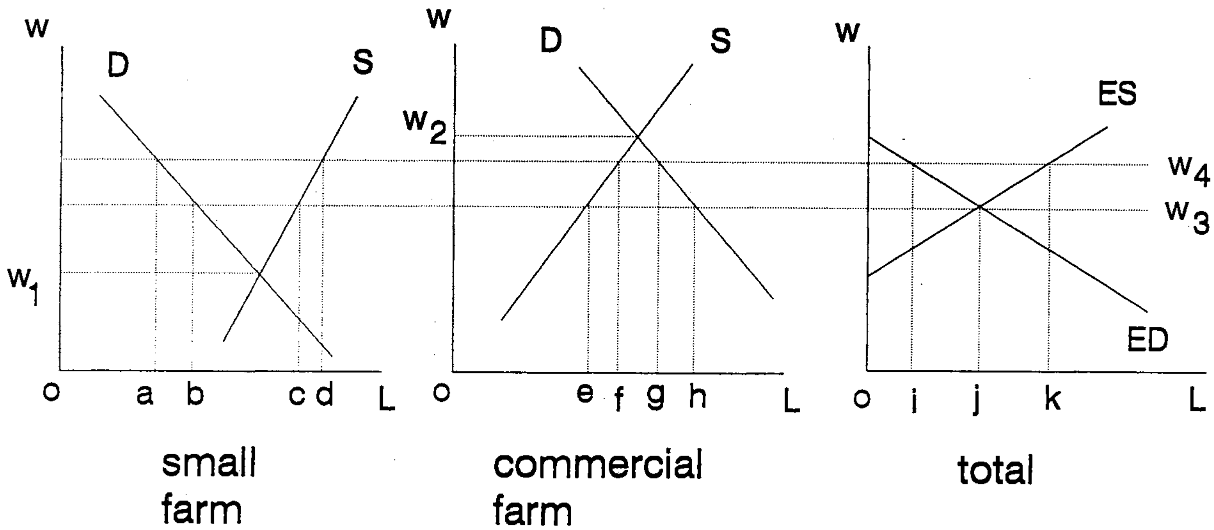

Figure 8. Labor Allocation Between Small and Commercial Farms With Wage Rate w_4

regional nonfarm and to urban nonfarm work through migration. With the same wage rate w_4, the commercial farm will demand total 'og' time of which he will allocate 'of' time from his own work time and will hire 'fg' labor.

The regional labor market finds equilibrium with wage rate w_4 because total regional labor supply is equal to total regional labor demand with excess supply of farm labor employed in the perfectly elastic nonfarm sector. The regional nonfarm sector (as distinct from the nonfarm urban sector) may have labor demand less than perfectly elastic at the w_4 wage rate. Hence some part of the excess supply of farm labor will be employed in the regional nonfarm sector and the residual will migrate to the urban nonfarm sector.

Contracted Working Time and Farm Labor Adjustment

The nonfarm sector usually has nonflexible working time because working time is usually decided by contract between the employer and worker (for example, 40 hours a week). The contracted working time may be either larger or smaller than the time the worker is willing to work.

Suppose that farm workers are required to work at least 'ce' time in nonfarm work to receive the w wage rate (Figure 9). Then farm work time has to be reduced to 'oc' and utility will be reduced to U_1 from U_2 (The change of total work time is neglected). The farmer could recover utility level U_2 by hiring 'cd' hours of labor.

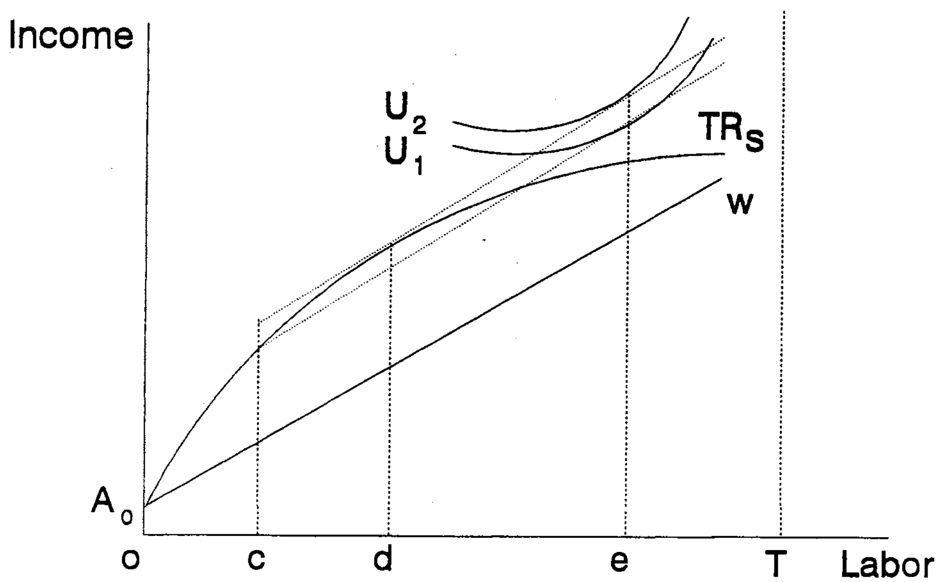

Figure 9. Labor Supply with Contracted Working Time

We again observe that farmers maximize utility by maximizing profit in farming. If the contracted nonfarm working hours are less than the worker is willing to work at wage rate w in Figure 10, he may find a secondary income source in agriculture. This reflects the fact that the worker cannot find another nonfarm job with the same nonfarm wage rate w because of inflexibility of the nonfarm labor market. Assume the nonfarm job is limited to 'bd' (= 'ac') time at wage rate w. As a secondary job the worker will work 'ob' time in agriculture with a lower marginal value product (W_f) than the nonfarm wage but higher than the reservation wage (W_r) (Total work time is assumed not to be changed).

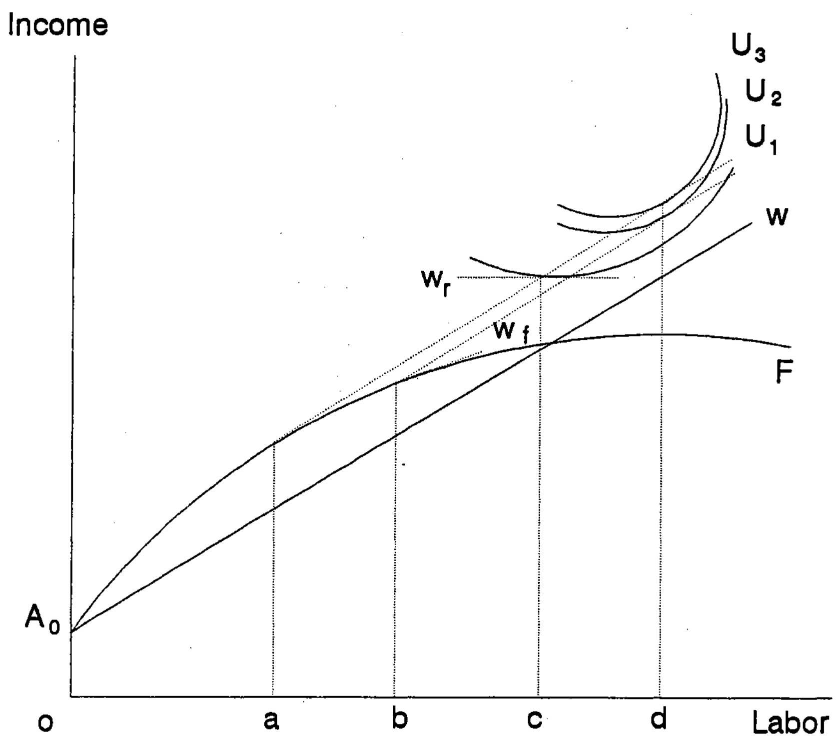

Figure 10. Off-Farm Work Time Constraint Smaller Than What Farmers Want

This explains why the farm wage may be smaller than the nonfarm wage. If we assume that labor is homogeneous then this can be explained only by assuming that there exists some restriction to the entry of the nonfarm labor market. This may also reflect a decreasing labor demand in the nonfarm sector caused by increased unemployment.

Tweeten (1990) hypothesized that the agricultural production function has increasing marginal product. He maintains that with 'traditional wisdom' (decreasing marginal product), we cannot explain the increase in the number of farms. An alternative is proposed in the next section.

Non-Pecuniary Benefit and Off-Farm Labor Supply of Farm Household

A household may be considered like a small factory where three production lines are possible, that is, home production, farm production, and off-farm production. Farm and off-farm lines produce intermediate goods and the home line produces final goods. Each production line has its own labor demand schedule and the given endowments of time for husband and wife are allocated (supplied) to each line. For farm households, farm labor demands are derived by the farm production function, demand for home time by the household utility function, and off-farm labor demand by the offered wage. While demand for home time can be derived by a household production function, our study assumes that household utility is a direct function of goods consumed, non-pecuniary benefits, and home time of household members.

From this framework each household member, including nonfarm working members, has its own reservation wage for participation in any type of work (W^{RW}) (see Figure 11), a reservation wage for participating in farming

(W^{RF}), and an offered wage (W^{N}) in the labor market. Each farm household member also has a reservation wage for off-farm work (W^{RO}). Panel (1) of Figure 11 shows labor (L) on the horizontal axis and pecuniary consumption (Y) on the vertical axis.[1] F is the farm production function measured in terms of net farm income available for pecuniary consumption and with only the household member's labor variable. U is the utility function expressing the trade-off between home time and work time with the latter measured in terms of pecuniary consumption (goods consumed). W^{N} measures income (pecuniary consumption) from off-farm work . Panel (2) shows wage rates on the vertical axis. D_f represents the demand for farm work and S is the household member's total labor supply. Panel (3) shows off-farm labor on the horizontal axis. S_{off} is the off-farm labor supply and D_{off} is off-farm labor demand.

Time allocation for each household member is explained conceptually within this framework. If the farm household member faces an offered wage rate of W^{N} which is higher than W^{RO}, then the member will participate in off-farm work. If W^{N} becomes smaller than W^{RO} then the member will give up the off-farm work. If W^{N} becomes larger than W^{RF}, then the member will quit farming. A member previously not working on the farm may participate in farming if W^{N} becomes smaller than W^{RF}. In general, a household member participates in off-farm work when faced with an offered wage which lies between the reservation wage for off-farm work and the reservation wage for farming, that is,

$$W^{RO} < W^{N} < W^{RF}.$$

From Figure 11, the sources of income and broad outlines of labor demand and supply are determined. In panel (1), with an offered wage of W^{N},

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1 Pecuniary consumption would be the same as disposable income with savings expressed as value of current consumption from future returns.

L_1 labor will be supplied to farming and L_3-L_1 labor will be supplied off-farm. Total time available to the household member is T with total work time equal to L_3 and home time equal to T-L_3. Y_o is the amount of non-labor income, Y_1-Y_o is farm labor income, Y_3-Y_1 is off-farm labor income, and Y_3 is total income used in consumption. In panel (2), D_f represents the demand for farm labor and is the value of marginal product of labor derived from F in panel (1). In general the value of marginal product is not equivalent to the factor demand which is a function of factor and output prices. Therefore, the demand for labor here is the "short-run" demand. S is total labor supply for this member and is distributed to farm and off-farm work as detailed above. Only because W^N is above W^{RO} will this member supply off-farm work. If the offered wage to this member was less than W^{RO}, farm work would employ L_2 labor and total income would be Y_2 and the member will begin to hire labor to substitute his/her own farm work. Because of the offered wage of W^N, total income increased by Y_3-Y_2, total labor supplied increased by L_3 - L_2, and farm labor decreased by L_2-L_1. In panel (3), off-farm labor supply begins when an offered wage is equal to W^{RO} and continues to increase as long as the member continues to gain utility from increased substitution of work time for home time. At the offered wage of W^N, off-farm work is M which is equal to L_3-L_1 in panel (2).

A number of exogenous variables affect W^N and a change in any one of these exogenous variables will shift the off-farm labor demand function. Similarly W^{RO} is affected by changes in exogenous variables which shift the farm production function and the household utility function.[2]

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2 This study ignores the entrance of new agricultural households coming from the population of non-agricultural households and thus becoming farm operators. The state of Oklahoma has been gaining in numbers of farms, particularly farms in the less than $50,000 gross sales class. Evidently a number of rural non-agricultural households have found farming a convenient way to employ more household labor.

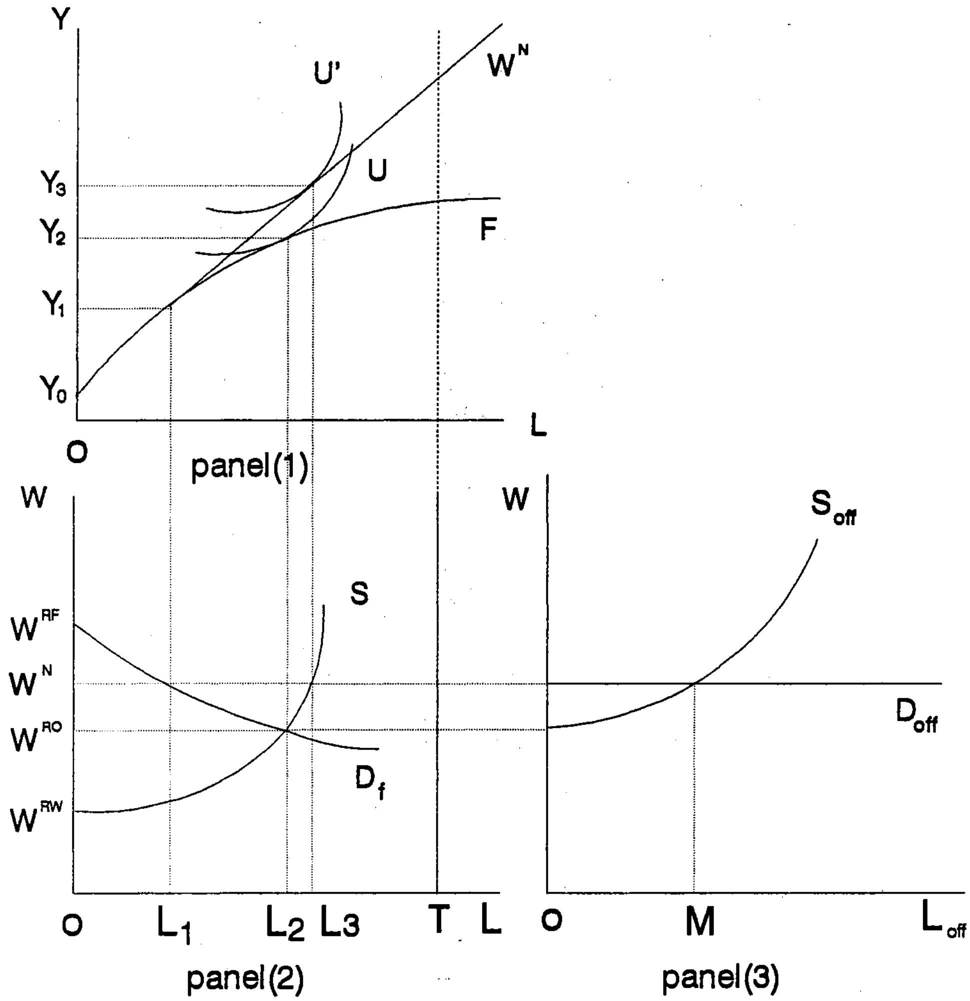

Figure 11. Time Allocation Between Farm Work, Off-farm Work, and Home Time

We now suggest that there are non-pecuniary benefits associated with farm and off-farm work time. If the non-pecuniary benefits are associated with farming, then the farm labor demand curve will shift outward. If the non-pecuniary benefits are associated with off-farm work, the off-farm labor demand curve will shift upward because non-pecuniary benefits are equivalent to an increased wage compensation. The total labor supply curve will also shift because now utility also includes non-pecuniary benefits which causes the utility curve to shift in the pecuniary-only diagram. Therefore, the net effect on off-farm labor supply is the aggregate of these effects on farm labor demand and total labor supply.

In Figure 12, farm labor is observed at L_1 where the marginal value product is equal to $W^f < W^N$, total labor supply is observed at L_2 with the offered wage rate W^N, and pecuniary consumption is Y_1. However, with the offered wage of W^N, the optimum farm labor in pecuniary benefits is L_1'. Pecuniary consumption given up by employing extra labor in farming versus employing the same amount in off-farm work is equal to (Y_2-Y_1) or the area abc in panel (2). If pecuniary consumption is given up for this allocation of labor then it stands to reason that farming must have non-pecuniary consumption benefits from this decision at least equal in utility to the pecuniary consumption benefits of Y_2-Y_1.

If all non-pecuniary benefits from farming could be replaced by income (for pecuniary consumption), then perhaps the observed results of Figure 12 are the appropriate time allocations (assuming that off-farm work has zero non-pecuniary benefits). Certainly some non-pecuniary benefits from farming (perhaps inappropriately identified as non-pecuniary benefits) could be replaced by cash income, particularly if such benefits are related to cost of living differences between a rural versus urban residence or if related to differences in

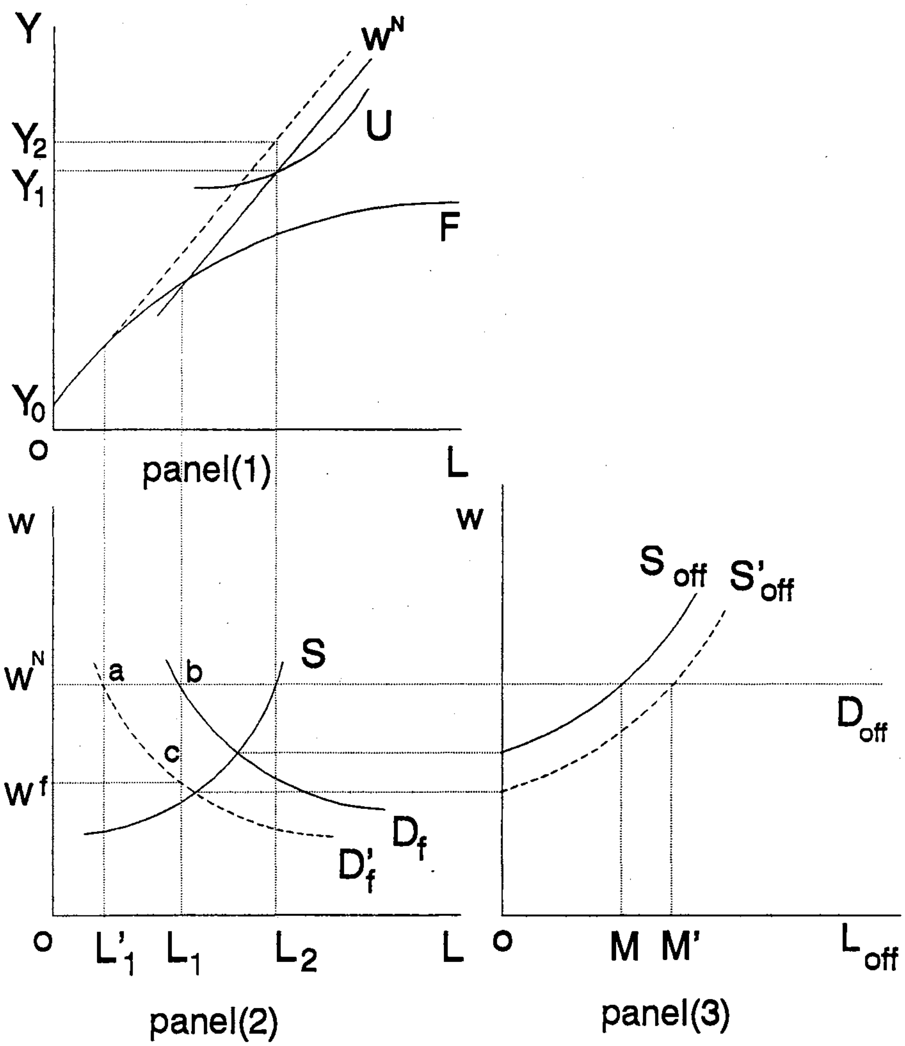

Figure 12. Time Allocation with Non-Pecuniary Benefits

tax codes as interpreted for wage income versus farm income. The results of non-pecuniary benefits from farming that can be replaced by cash income from off-farm work is to shift the demand for farm work to the right (D_f versus D_f') and to shift the supply of off-farm work to the left (S_{off} versus S_{off}') , assuming total labor supply does not change.

However, if this were the only result then households would be indifferent to the two choices. The more usual result is probably one where cash income from off-farm work can replace only part of the non-pecuniary benefits of farming. Figure 13 shows that there is a maximum utility U_1 associated with labor allocation to farm work (L_1) and off-farm work (L_2-L_1), pecuniary consumption benefits (Y_1), and some non-pecuniary consumption benefits. The latter is shown by the fact that U_1 is not tangent to W^N but that in a third dimension with non-pecuniary benefits, utility would be maximized in terms of pecuniary benefits, non-pecuniary benefits, and home time. If we extend pecuniary consumption to Y_2 indicating how pecuniary consumption could be augmented by more off-farm work and less farm work, U_2 indicates that there may still be a higher utility curve that could be reached by a different allocation of time. In this example, not only would time be reallocated between farm work and off-farm work, but a larger amount of total labor would be supplied, L_2'.

In the absence of non-pecuniary benefits, there will be some utility curve tangent to $W^{N'}$ such as U_3 but it need not be at the total labor supply of L_2. In Figure 13, the result shows a total labor supply more than L_2 or at L_2' implying that without non-pecuniary benefits from farming, the household values home time less and thus is willing to supply more total labor. In this case the total labor supply curve shifts to the right (S') with a subsequent shift in off-farm labor supply equal to S_{off}. The magnitude of this shift in total labor supply

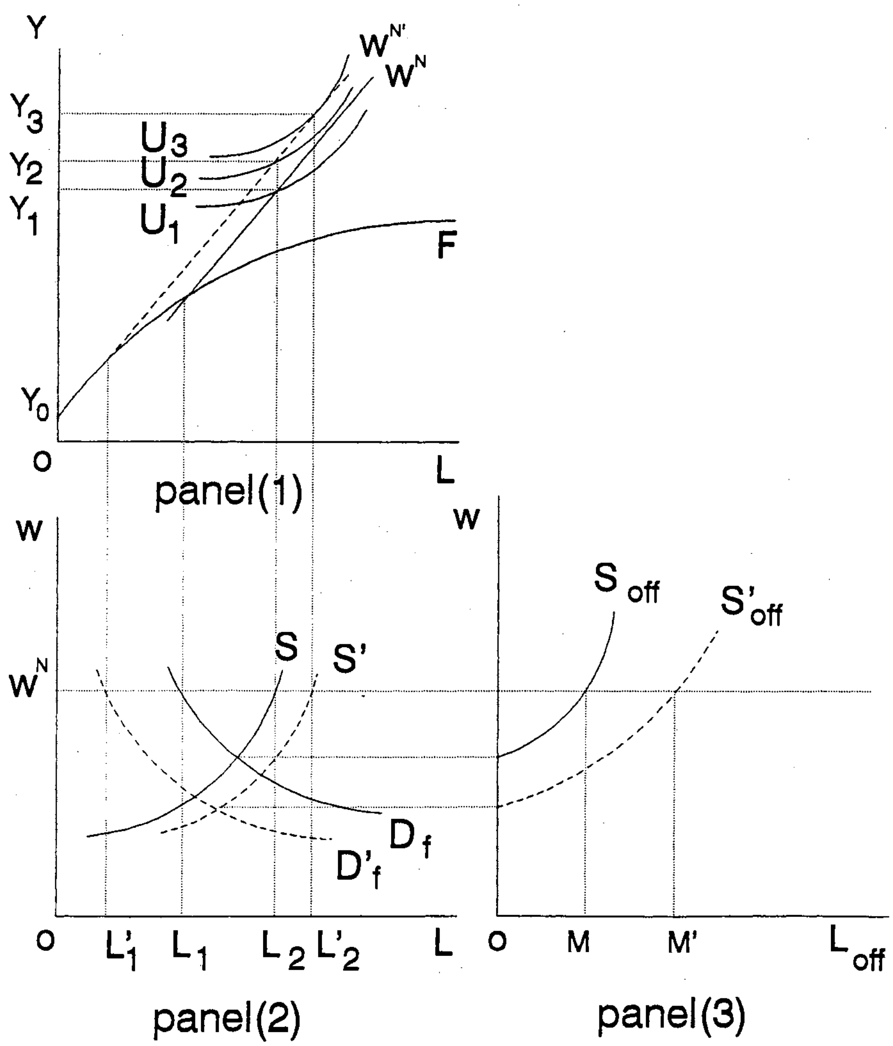

Figure 13. Time Allocation Comparing Results of Pecuniary and Non-Pecuniary Benefits and Total Labor Supply

is indeterminate without measurements of non-pecuniary benefits from farm and off-farm work.

The important result here is that observed data on time allocations between farm work, off-farm work, and home time may include the effects of non-pecuniary consumption benefits of farming and/or off-farm work. The demand for farm work (D_f), total labor supply (S), and off-farm labor supply (S_{off}) measure both pecuniary and non-pecuniary benefits of the corresponding time allocations. That is, rational agricultural households will allocate time where the marginal value product of farm work (MVP_{T_f}) plus non-pecuniary benefits of farming (NP_f) equal the offered wage rate (W^N) plus non-pecuniary benefits of off-farm work (NP_{off}) and both equal the marginal utility of home time (MU_{T_h}):

$$MVP_{T_f} + NP_f = W^N + NP_{off} = MU_{T_h}$$

If non-pecuniary benefits of farming and/or off-farm work could be measured (see Figure 13), then the pecuniary demand for farm work (D_f'), the pecuniary total supply of labor (S'), and pecuniary off-farm labor supply (S_{off}') could be estimated. However, because of their nature, non-pecuniary benefits are not directly observable. In the case of farming, the production function is measurable in pecuniary consumption terms, thus D_f' may be derived from F. If total labor supply is assumed invariant (i.e., $S=S'$) so that most of the non-pecuniary benefits come from the allocation between farm and off-farm work, then the non-pecuniary benefits of farming may be used to show the effect on off-farm labor supply (S_{off}'). In this case, non-pecuniary benefits of farming shift the supply of off-farm labor to the left and decrease pecuniary consumption (disposable income).

Notice that non-pecuniary benefits of farming tend to increase the reservation wage for off-farm work as well as shift the supply of off-farm labor to the left. Our concern is to identify which exogenous variables affect non-pecuniary benefits of farming and hence change the reservation wage for off-farm labor and shift the off-farm labor supply.

The effects of non-pecuniary benefits may allow farm operators to operate at the first stage of the traditional production function. In Figure 14, if the first stage of production is introduced then farmers will work on farm only if offered wage is smaller than W^R. If the offered wage is greater than this then the farmer will work only off-farm. Therefore, the farm labor demand curve is discontinuous. Panel (2) shows the case when the total labor supply curve passes through the discontinuous area. If an individual has high preference for farm work then the total labor supply curve may cross the farm labor demand curve and will follow the framework shown by Figure 11 through Figure 13.

If a labor market does not exist then the farm operator will work L_2 on farm and the shadow price of labor will be W^S and the operator will be working in the second stage of production. If a labor market is introduced and the wage rate is W^R which is equal to the reservation wage for off-farm work then the farm operator faces two indifferent choices. The operator may either work L_1 off-farm or L_1 on farm and hire L_1L_3 of labor and maximize profit. If the offered wage is lower than W^R then the operator will work only on-farm and increase the hiring of labor to maximize profit.

With an offered wage rate W^N the operator is expected to work only off-farm. However, because of possible non-pecuniary effects, let's suppose that we observe the operator working L_0 on farm and the remaining labor supply off-farm. Then we observe that the marginal value product of farming is lower

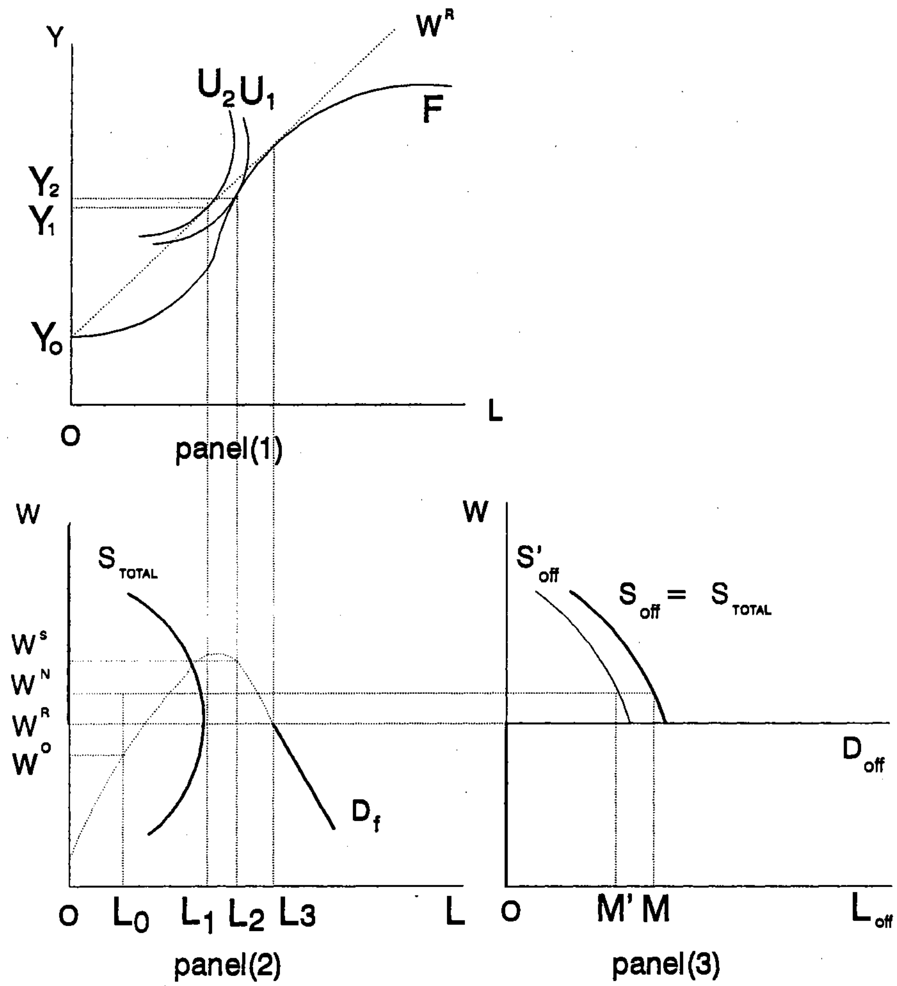

Figure 14. Time Allocation of Farm Household Members When They Are In Stage One of the Pecuniary Production Function

than the offered wage and, moreover, the marginal value product is positive reflecting that the operator is in the first stage of the traditional farm production function. The only possible explanation is that the non-pecuniary effects are increasing faster than the total (pecuniary and non-pecuniary) effects and hence the pecuniary effects are showing a diminishing marginal value product and thus a second stage of production. If that result doesn't hold, then the operator should be hiring more farm labor until the second stage of pecuniary production is reached.

The pecuniary effect shifts the off-farm labor supply curve leftward to S'_{off} and the net change is M'M which is equal to L_0. This framework perhaps explains why many farm operators are operating under negative net farm returns and thus in the first stage of farm production.

CHAPTER IV

THE ANALYTICAL MODEL OF OFF-FARM LABOR SUPPLY OF FARM HOUSEHOLD

Mathematical Analysis

Following the framework of Huffman and Lange(1989), agricultural production (Q) of a farm household depends on the operator's and spouse's farm labor (T_f^M, T_f^F), and purchased inputs (X) including hired labor; exogenous variables such as human capital of the operator and spouse which are relevant to farm productivity (E_f^M, E_f^F), and other farm specific characteristics (ϕ):

$$(1) \qquad Q = Q\left(T_f^M, T_f^F, X ; E_f^M, E_f^F, \phi\right)$$

Land and capital are treated as exogenous variables and belong to other farm characteristics. In the long-run, land and capital inputs are determined endogenously given exogenous conditions such as output and input prices and human capital. This study assumes short-run decision making in farm production.

The off-farm labor demand or wage-offer net of commuting cost function facing member (i), $W^i(\tau)$, is assumed to depend on that member's marketable human capital relevant to market productivity (E_m^i) and local labor market characteristics relevant to that member (ψ^i) but are assumed to be independent of their current hours of work:

(2) $$W^i(\tau) = W^i(E^i_m, \psi^i) ; i = M,F$$

where τ represents commuting cost.

In addition to the above farm and off-farm production constraints, the farm household is assumed to have the following time and cash income constraints:

(3) $$T^i = T^i_f + T^i_m + T^i_h$$
$$T^i_f > 0$$
$$T^i_h > 0$$
$$T^i_m \geq 0 , i = M,F$$

(4) $$W^M T^M_m + W^F T^F_m + P_q Q - P_x X + V = P_Y Y$$

Husband and wife allocate their total time to on-farm work (T^M_f , T^F_f), off-farm work (T^M_m , T^F_m), and home work (T^M_h , T^F_h). We assume that the output price (P_q), price of consumption goods (P_y), price of purchased input (P_x), total time available (T) of the operator and spouse (each has T of endowed time), and other income (V) are exogenously given. Y is the goods purchased for consumption by the household.

A farm household's utility (U) depends on the inputs of home time of the operator and spouse; goods purchased for direct and indirect consumption; non-pecuniary benefits from farming (N^M_f , N^F_f) such as outdoor work, family lifestyle, and sense of self-sufficiency associated with farm work (Streeter and Saupe 1986); non-pecuniary benefits from off-farm work (N^M_m , N^F_m); exogenous variables such as human capital of the operator and spouse which is relevant to home work (E^M_h , E^F_h), and other household characteristics (Γ):

(5) $$U = U\left(T^M_h , T^F_h , Y , N^M_f , N^F_f , N^M_m , N^F_m ; E^M_h , E^F_h , \Gamma\right)$$
$$\partial U / \partial \Omega > 0$$

$$\partial^2 U/\partial\Omega^2 < 0$$
$$\Omega = T_h^M , T_h^F , Y$$

N_f^i is determined by time spent working on the farm $\left(T_f^i\right)$ and a vector of exogenous factors such as farm specific human capital $\left(E_f^i\right)$ and farm characteristics (ϕ); and N_m^i are determined by time spent working off-farm $\left(T_m^i\right)$ and a vector of exogenous factors such as market specific human capital (E_m^i) and local labor market characteristics (ψ^i):

(6) $$N_f^i = N_f^i \left(T_f^i \; ; \; E_f^i \; , \; \phi \right) ; i = M , F$$
$$N_m^i = N_m^i \left(T_m^i \; ; \; E_m^i \; , \; \psi^i \right) ; i = M , F$$

and

$$\partial N_f^i/\partial T_f^i > 0$$
$$\partial N_m^i/\partial T_m^i > 0$$

Hence, the "production" of non-pecuniary benefit depends on the attributes of the choice and the "consumption" of the benefit depends on the attributes of the individual and household.

It is also assumed that

$$\partial U/\partial N_f^i > 0 ; \quad i = M , F$$
$$\partial U/\partial N_m^i > 0 ; \; i = M , F$$

and N_f^i or N_m^i equal to zero do not imply U=0.

The distinctive feature of the model is that households are assumed to produce and consume not only pecuniary but also non-pecuniary benefits which are associated with farm and off-farm work time. The effect of non-pecuniary benefits should be differentiated from the externality effect.

Externality is a benefit exogenously given whereas the non-pecuniary benefit here is assumed to be a positive function of time worked on farm or off-farm.

The objective function can be defined as follows.

$$(6\text{-}1)\quad L = U(\cdot) + \lambda\left[W^M T^M_m + W^F T^F_m + P_q Q(\cdot) - P_x X + V - Py \cdot Y\right]$$

$$+ \gamma^M\left[T^M - T^M_m - T^M_f - T^M_h\right]$$

$$+ \gamma^F\left[T^F - T^F_m - T^F_f - T^F_h\right]$$

Then the first order conditions for a constrained maximum are:

$$(7)\qquad \lambda\left(P_q Q_x - P_x\right) = 0$$

$$(8)\qquad U_{N^i_f} N^i_{f T^i_f} + \lambda P_q Q_{T^i_f} - \gamma^i = 0\ ;\quad i = M, F$$

$$(9)\qquad U_{N^i_m} N^i_{m T^i_m} + \lambda W^i - \gamma^i \leq 0\ ;\ T^i_m\left[U_{N^i_m} N^i_{m T^i_m} + \lambda W^i - \gamma^i\right] = 0\ ;\ i = M, F$$

$$(10)\qquad U_{T^i_h} - \gamma^i = 0 \qquad ;\quad i = M, F$$

$$(11)\qquad U_y - \lambda P_y = 0$$

$$(12)\qquad T - T^i_f - T^i_m - T^i_h = 0\ ;\ i = M, F$$

$$(13)\qquad W^M T^M_m + W^F T^F_m + P_q Q - P_x X + V - P_y Y = 0$$

T^i_m are assumed to have corner solutions as well as interior solutions but the other endogenous variables are assumed to have only interior solutions.

The choice variables are

$$T^M_f, T^F_f, T^M_h, T^F_h, T^M_m, T^F_m, x, Y, \gamma^M, \gamma^F, \gamma$$

Combining equations (8)-(10) yields:

(14) $$\gamma^i = U_{T_h^i} = U_{N_f^i} N_{f\,T_f}^i + \lambda P_q Q_{T_f^i} = U_{N_m^i} N_{m\,T_m}^i + \lambda W^i \,;\, i = M\,,\, F$$

In other words, the allocation of time is such that, at the optimum, the marginal utility of farm work, off-farm work, and home time are set equal to each other and equal to the marginal utility of time. The marginal utility of farm work depends on both pecuniary and non-pecuniary sources and the marginal utility of off-farm work also depends on both pecuniary and non-pecuniary sources.

Here farm production decisions are not independent of the household consumption decisions because in equation (14),

$$\partial U / \partial N_f^i \,;\, i = M\,,\, F$$

are not independent of the exogenous variables on household characteristics.

Hence, the optimal values of the choice variables (designated by *) are obtained by simultaneously solving all the first order conditions. That is, when non-pecuniary benefits are considered, demand for farm purchased inputs, demand for farm work time, demand for home time, off-farm labor supply, farm output, pecuniary income and hence utility are expressed as functions of all exogenous variables including off-farm labor market conditions, farm and household characteristics, and price variables:

(15) $$\Omega = \Omega\ (Z)$$

where

$$\Omega = \left(X^*, T_f^{M*}, T_f^{F*}, T_h^{M*}, T_h^{F*}, T_m^{M*}, T_m^{F*}, Q^*, Y^*, U^*\right)$$

$$Z = \left(E_m^M, \psi^M, E_m^F, \psi^F, E_f^M, E_f^F, \phi, E_h^M, E_h^F, \Gamma, P_x, P_q, P_Y, V\right).$$

This result implies that, due to the non-pecuniary effects, time allocation of a farm household is a simultaneous system. Previous studies show a recursive system because farm work time is determined independently of the type of utility function. Farm work time depends also on the household characteristics and other price variables in our system.

Suppose

$$\tilde{M} = \left(E_m^M , \psi^M , E_m^F , \psi^F\right)$$

$$\tilde{F} = \left(E_f^M , E_f^F , \phi \right)$$

$$\tilde{H} = \left(E_h^M , E_h^F , \Gamma \right)$$

$$\tilde{P} = \left(P_x , P_q , P_Y, V\right)$$

then

$$Z = \left(\tilde{M} , \tilde{F} , \tilde{H}, \tilde{P}\right)$$

That is, exogenous variables can be grouped into four categories according to their source of impacts: labor market conditions $\left(\tilde{M}\right)$, farm-related characteristics $\left(\tilde{F}\right)$, household-related characteristics $\left(\tilde{H}\right)$, and prices $\left(\tilde{P}\right)$. Each group of exogenous variables represents the source of productivity for each choice variable.

Assuming that both husband and wife participate in farming, four general outcomes are possible for farm household labor behavior: both husband and wife work off-farm; husband only works off-farm; wife only works off-farm; neither husband nor wife work off-farm.

As in equation (2), off-farm wages are functions of market specific human capital and labor market conditions. Hence, equation (15) can be rewritten as

(15') $$\Omega = \Omega \left(W^{M} , W^{F} , \tilde{Z} \right)$$

where

$$\tilde{Z} = \left(\tilde{F} , \tilde{H}, \tilde{P} \right)$$

Hence the off-farm labor supply functions are:

(16) $$T_{m}^{i*} = T_{m}^{i*} \left(W^{M} , W^{F} , \tilde{Z} \right) ; i = M , F$$

The reservation wage for off-farm work of a farm household member (W^{iR}) is the marginal value of time when all of it is allocated to farm work and home time. Given equations (16), the equations for W^{iR} when both operator and spouse work off-farm are obtained by setting $T_{m}^{i*} = 0$:

(17) $$W^{iR} = W^{iR} \left(W^{j} , \tilde{Z} \right) \;\; ; (i , j) = \left\{ (M,F) , (F,M) \right\}$$

The reservation wage of a member is affected by one's spouse's wage and other exogenous variables except the market specific human capital and labor market conditions. In other words, given the spouse's market wage, a member's reservation wage depends on the exogenous variables of farm production and utility and price variables.

Farm labor demand when non-pecuniary benefits are not considered can be determined by estimating the agricultural production function assuming that agricultural production in every farm household is in equilibrium.

(18) $$Q^{*} = Q^{*} \left(T_{f}^{M*} , T_{f}^{F*} , X^{*} ; E_{f}^{M} , E_{f}^{F} , \phi \right)$$

The marginal value product of farm work of individual i is determined by;

(19) $$MVP^i = P_q \frac{\partial Q^*}{\partial T_f^{i*}} ; i = M , F$$

Here MVP^i should be theoretically the same as the off-farm wage when non-pecuniary benefits do not exist.

The off-farm labor supply function of individual i when non-pecuniary benefits exist is estimated by;

(20) $$T_m^{i*} = T_m^{i*} \left(W^i , MVP^j , \tilde{Z} \right) ; (i , j) = \left\{ (M , F) , (F, M) \right\}$$

where T_m^{i*} is the observed off-farm labor supply of individual i. Given the estimated function of equation (20) we can estimate the off-farm work time which an individual would have supplied if non-pecuniary benefits did not exist by applying the estimated marginal value product of farming to the above estimated equation:

(21) $$T_m^{i*} = T_m^{i2*} \left(MVP^i , MVP^j , \tilde{Z} \right) ; (i , j) = \left\{ (M , F) , (F, M) \right\}$$

The actual off-farm labor supply curve will be shifted either inward or outward from the original curve which didn't consider non-pecuniary benefits.

The difference in the off-farm labor supply between T_m^{i2*} and T_m^{i*} is expected to be affected by the exogenous variables which have non-pecuniary effects, that is, the variables which have effects on

$$\frac{\partial U}{\partial N_f^i}, \frac{\partial N_f^i}{\partial T_f^i}, \frac{\partial U}{\partial N_m^i}, \frac{\partial N_m^i}{\partial T_m^i}$$

in equation (14). Hence,

(22) $$\Delta T_m^{i*} = T_m^{i*} - T_m^{i2*} = \Delta T_m^{i*} \left(E_m^i , \psi^i , E_f^i , \phi , E_h^i , E_h^j , \Gamma \right) ; (i , j) = \left\{ (M,F),(F,M) \right\}$$

We expect that the above selected exogenous variables might have both pecuniary and non-pecuniary effects on the shift of the off-farm labor supply curve and the non-pecuniary effects can be estimated by the above equation. The pecuniary effects are estimated by the parameters of $\tilde{Z}$ of equation (20).

The Econometric Model

The model consists of the following equations: agricultural production function, off-farm wage function, off-farm labor supply function, and off-farm participation function. The off-farm participation function can be an object of interest itself, but here it is estimated for the correction of self-selection bias and the censored sampling problem.

Net revenue (NR) function is estimated instead of the physical production (Q) function as defined in equation (1) assuming that farm production is in equilibrium and that every farm household shares a common production function. The net revenue function is defined empirically as:

$$(23) \qquad NR = \alpha_0 + \alpha_1 T_f^{M*} + \alpha_2 \left(T_f^{M*}\right)^2 + \alpha_3 T_f^{F*} + \alpha_4 \left(T_f^{F*}\right)^2 + \alpha_5 DK^* + \alpha_6 \left(DK^*\right)^2 + \alpha_7 \left(T_f^{M*}\right)\left(T_f^{F*}\right) + \alpha_8 \left(T_f^{M*}\right)\left(DK^*\right) + \alpha_9 \left(T_f^{F*}\right)\left(DK^*\right) + \alpha_{10} \left(\tilde{F}\right) + e$$

where DK^* implies capital and land input which are assumed to be exogenously given. T_f^{F*} includes spouse and other unpaid family labor input and $\left(\tilde{F}\right)$ includes farm specific human capital and other farm characteristics except land and capital.

The net revenue (NR) is equal to total revenue less purchased input cost:

$$(23\text{-}1) \qquad NR = P_q Q^* \left(T_f^{M*},\ T_f^{F*},\ X^*\right) - P_X X^*$$

The marginal value product of operator and spouse is given as:

$$(23\text{-}2)\qquad MVP_M = P_q \frac{\partial Q^*}{\partial T_f^{M^*}}$$

$$MVP_F = P_q \frac{\partial Q^*}{\partial T_f^{F^*}}$$

The above marginal value products are also derived by the net revenue (NR) function:

$$(23\text{-}3)\qquad MVP_M = \frac{\partial NR^*}{\partial T_f^{M^*}} = P_q \frac{\partial Q^*}{\partial T_f^{M^*}}$$

$$MVP_F = \frac{\partial NR^*}{\partial T_f^{F^*}} = P_q \frac{\partial Q^*}{\partial T_f^{F^*}}$$

Therefore, we can estimate the net revenue function instead of the physical production function to obtain marginal value product of operator and spouse.

Then the marginal value product of farm labor input of a household member is estimated as follows given equation (23):

$$(24)\qquad MVP^M = \hat{\alpha}_1 + 2\,\hat{\alpha}_2\, T_f^{M^*} + \hat{\alpha}_7\, T_f^{F^*} + \hat{\alpha}_8\, DK^*$$

$$MVP^F = \hat{\alpha}_3 + 2\,\hat{\alpha}_4\, T_f^{F^*} + \hat{\alpha}_7\, T_f^{M^*} + \hat{\alpha}_9\, DK^*$$

That is, marginal value product of an individual depends on the farm work time of the individual and on the level of other farm input including spouse's labor.

The individual (i=M,F) chooses to work off-farm when the offered wage is larger than the reservation wage. The observed distribution of wages is a truncated distribution. It is the distribution of wage offers truncated by reservation wages. From equations (2) and (17), wage equations of individual i have the type

$$(25) \qquad W^i = x^i_1 \beta^i_1 + u^i_1$$
$$W^{iR} = x^i_2 \beta^i_2 + u^i_2$$

where

$$x^i_1 = [E^i \psi]$$
$$x^i_2 = [E^i \psi E^j \phi \Gamma P_x P_q P_y V]$$

and we observe

$$W = W^i \qquad \text{if } W^i \geq W^{iR}$$
$$W = 0 \qquad \text{Otherwise}$$

The equation (25) assumes that

$$E^M = E^M_m = E^M_f = E^M_h$$
$$E^F = E^F_m = E^F_f = E^F_h$$
$$\psi = \psi^M = \psi^F$$

which implies that the formal education represents all human capital effects on farm productivity, market wage and utility and that market condition is not actually clearly differentiable for the spouse and operator. For example, operator's wage depends on labor market conditions which are relevant to the operator (ψ^M) and spouse's wage depends on labor market conditions which are relevant to the spouse (ψ^F). Yet in empirical application labor market conditions are not differentiated and observed only as labor market condition (ψ).

We observe W^i if and only if $W^i \geq W^{iR}$. Otherwise $W^i=0$. If we estimate the first equation of the equations in (25) by OLS, based on the observations for which we have wages W^i, we obtain inconsistent estimates of the parameters.

Note that

$$E\left(u_1^i \mid W^i \geq W^{iR}\right) = -\sigma_u^i \frac{\phi\left(Z^i\right)}{\Phi\left(Z^i\right)} \tag{26}$$

where

$$Z^i = \frac{\left(x_1^i \beta_1^i - x_2^i \beta_2^i\right)}{\sigma}$$

and $\Phi(\bullet)$ and $\phi(\bullet)$ are, respectively, the cumulative density function and the probability distribution function of the standard normal evaluated at Z^i (Maddala 1983). This is the selectivity bias. Hence, we can write (25) as

$$W^i = x_1^i \beta_1^i - \sigma_u^i \frac{\phi(Z^i)}{\Phi(Z^i)} + v^i \tag{27}$$

where $E(v^i)=0$. A test for the selectivity bias is a test for $\sigma_u^i=0$. The unconditional expectation of W^i is

$$E(W^i) = \Phi x_1^i \beta^i{}_1 - \phi\sigma_u^i \tag{28}$$

Heckman (1976) suggested a two-stage estimation method for such models. First, obtain consistent estimates for the parameters in Z^i by the probit method applied to the dichotomous variable. From the probit model, we obtain consistent estimates of β_{1j}/σ and β_{2j}/σ for the elements of β_1 and β_2 corresponding to nonoverlapping variables in x_1 and x_2, and $\left(\beta_{1k} - \beta_{2k}\right)/\sigma$

corresponding to the common variables in x_1 and x_2. Then estimate equations (27) and (28) by OLS using the estimated $\hat{Z}^i$ for Z^i.

For those individuals who do not work off-farm, offered wages are estimated using equation (28).

The off-farm labor supply of individual i(=M,F) is defined as functions of predicted values of offered wages of operator and spouse and other exogenous variables:

$$(29) \qquad T^i_m = \hat{W}^M C^i_{11} + \hat{W}^F C^i_{12} + \tilde{Z}\gamma^i_1 + \varepsilon^i \qquad \text{if RHS>0}$$
$$T^i_m = 0 \qquad \text{otherwise}$$

where ε^i are residuals that are independently and normally distributed, with mean zero and a common variance σ^2.

Suppose

$$\beta^i = \begin{bmatrix} C^i_{11} & C^i_{12} & \gamma^i_1 \end{bmatrix}$$
$$X^i = \begin{bmatrix} \hat{W}^M & \hat{W}^F & \tilde{Z} \end{bmatrix}$$

then equation (29) can be rewritten as follows:

$$(29') \qquad T^i_m = \beta^i X^i + \varepsilon^i \qquad \text{if RHS>0}$$
$$T^i_m = 0 \qquad \text{otherwise}$$

The problem with the OLS estimation of equation (29') is that $E(\varepsilon^i)\neq 0$ because of the truncation. Considering only the nonzero observations we obtain

$$(30) \qquad E\left(T^i_m \mid T^i_m > 0\right) = \beta^i X^i + E\left(\varepsilon^i \mid \varepsilon^i > -\beta^i X^i\right) = \beta^i X^i + \sigma^i \frac{\phi^i}{\Phi^i}$$

where Φ^i and ϕ^i are the density function and distribution function, respectively, of the standard normal evaluated at $\beta^i X^i/\sigma^i$.

Heckman (1976) used the following procedure: because the likelihood function for the probit model is well behaved, we define a dummy variable

$$(31) \qquad I^i = 1 \quad \text{if} \quad T^i_m > 0$$
$$I^i = 0 \quad \text{otherwise}$$

Then using the probit model, we obtain consistent estimates of β^i/σ^i. Using these, we obtain estimated values of ϕ^i and Φ^i. Now we obtain consistent estimates of β^i and σ^i by estimating equation (30) by OLS, with

$$\frac{\hat{\phi}^i}{\hat{\Phi}^i}$$

as the explanatory variable in place of ϕ^i/Φ^i. Instead of using only the nonzero observations on T^i_m, we use all observations, and obtain

$$(32) \qquad E(T^i_m) = P(T^i_m>0) \cdot E(T^i_m \mid T^i_m>0) + P(T^i_m=0) \cdot E(T^i_m \mid T^i_m=0)$$
$$= \Phi^i\left(\beta^i X^i + \sigma^i \frac{\phi^i}{\Phi^i}\right) + 0$$
$$= \Phi^i \beta^i X^i + \sigma^i \phi^i$$

Thus, after obtaining estimates of ϕ^i and Φ^i, we estimate equation (32) by OLS. Tobin (1958) also suggested maximum likelihood procedure for this type of analysis.

Off-farm labor supply when only pecuniary benefits are considered is obtained by substituting the estimated marginal value product for off-farm wage given estimated equation (32):

$$(33) \qquad T^{i2}_m = MVP^M \hat{c}^i_{21} + MVP^F \hat{c}^i_{22} + \tilde{Z}\hat{\gamma}^i_2$$

This study hypothesizes that the difference in parameters estimated between equations (29) and (33) is explained by the impact of non-pecuniary effects:

(34) $\Delta T^{i}_{m} = T^{i}_{m} - T^{i2}_{m}$

We expect that a subset of Z which has non-pecuniary effects as in equation (22) will show significant changes in parameters. Each parameter will be tested if it is significantly different from zero using the t - test.

The probit procedure is used in the estimation of off-farm participation function and hence $\hat{\phi}^i$ and $\hat{\Phi}^i$ are estimated by applying $\hat{Z}^i$. The probit statistical model assumes that the error term of the choice model has standard normal distribution (Judge et al. 1988).

The predicted values of the probability density function $\hat{\phi}^i$ and the cumulative distribution function $\hat{\Phi}^i$ are used to correct the conditional nature of the wage function in equation (27) and the off-farm labor supply function as in equation (30). These predicted values are also applied to the calculation of unconditional predicted values of wage in equation (28) and off-farm labor supply in equation (32) for those who are not working off-farm as well as those who are working.

CHAPTER V

DATA AND MODEL DESCRIPTION

Summary of Data

Source of Data

The data used in this analysis are the 2,687 farm households of the Farm Operator Resource (FOR) Version of the 1991 USDA Farm Costs and Returns Survey (FCRS). The FCRS is composed of multiple versions, all of which collect consistent financial data on the farm business. Each version contains a different set of special questions designed to address a unique topic of interest (Mary C. Ahearn et al. 1993, p.5). Since the 1988 survey, the Farm Operator Resource (FOR) version has collected complete data on farm operator households. Access to the data are permitted by formal application to the United States Department of Agriculture, Economic Research Service. The analysis is done by joint agreement between Oklahoma State University and USDA.

In 1991, a total of 3,061 farm households were surveyed as the Farm Operator Resource (FOR) version (United States Department of Agriculture 1991). However, the study used only 2,687 observations where both operator and spouse existed. Earlier FOR surveys (particularly, 1988) showed an underestimation of operators and spouses working off-farm compared to the census of agriculture. The underestimation was presumably due to the undercounting of small farms in the sample. The FCRS is known to undercount farms by about 350,000-400,000. Most of these farms are in the sales classes of less than $10,000 annually. The FCRS is the only national annual data source with information on farm operator household characteristics and with the connection between total household income and net worth of farm businesses and households.

The data used by the study are basically sampled by the stratified cluster sampling procedure using a list and an area frame (Dillard 1993). The list frame includes all known large farms, and an area frame, stratified by land use, is used to capture small farms. Because the data are sampled by non-random sampling procedure the study weighted the data using a weighting variable. The weighting variable was calculated by the United States Department of Agriculture, National Agricultural Statistics Service. The weighting variable is the product of an expansion factor adjusted for nonresponse and a coverage adjustment. The expansion factor is the population count divided by the sample count. The square root value of each element of the expansion factor was calculated and both independent and dependent variables were multiplied by these values. The basic weighting procedure is the same as in the case of weighted least squares where the weights are expressed in a diagonal matrix.

Summary Description

All variables are described and defined in Table 2. Further description of the variables is given in the following section when defining functions of the model. The sample of households were grouped into four categories: operators only work off-farm; spouses only work off-farm; both work off-farm;

TABLE 2

VARIABLE IDENTIFICATION AND DESCRIPTION,
FARM OPERATOR HOUSEHOLDS

Variable	Unit	Description
Dependent and Related Variables		
OHR_O	hours/year	Operator's Hours of Work Off-Farm Per Year
OHR_S	hours/year	Spouse's Hours of Work Off-Farm Per Year
WAGE_O	$/hr.	Operator's Wage Per Hour for Off-Farm Work
WAGE_S	$/hr.	Spouse's Wage Per Hour for Off-Farm Work
INSURE_O	binary	1 If Operator Receives Insurance and Other Related Benefits; 0 Otherwise
INSURE_S	binary	1 If Spouse Receives Insurance and Other Related Benefits; 0 Otherwise
NETREV	$	Net Revenue in Farm Production
PARTI_O	binary	1 If Operator Participates in Off-Farm Work; 0 Otherwise
PARTI_S	binary	1 If Spouse Participates in Off-Farm Work; 0 Otherwise
DIFF_O	hours/year	Operator's Difference in Off-Farm Labor Supply
DIFF_S	hours/year	Spouse's Difference in Off-Farm Labor Supply
Labor Input (T_f)		
FHR_O	hours/year	Hours Worked on Farm by Operator
FHR_S	hours/year	Hours Worked on Farm by Spouse
FHR_3	hours/year	Hours Worked on Farm by Other Unpaid Workers in the Household
Land Input (Ld)		
ACRES	acres	Total Acres of Crop Planted
Capital Input (K)		
DEPR	$	Depreciation on Farm Business Assets
Farm Characteristics (ϕ)		
SAFETY	binary	1 If Farming Accident Occurred in 1991; 0 Otherwise
T_GRAIN	dummy	1 If Type of Farming is Cash Grains; 0 Otherwise
T_CROPS	dummy	0 If Type of Farming is Other Crops (Incorporated in Intercept Term)

TABLE 2 (Continued)

Variable	Unit	Description
Farm Characteristics (ϕ) (Continued)		
T_BEEF	dummy	1 If Type of Farming is Beef, Hog, and Sheep; 0 Otherwise
T_DAIRY	dummy	1 If Type of Farming is Dairy; 0 Otherwise
T_LIVST	dummy	1 If Type of Farming is Other Livestock and Poultry; 0 Otherwise
R_SOUTH	dummy	0 If Region is South (Incorporated in Intercept Term)
R_MIDWE	dummy	1 If Region is Midwest; 0 Otherwise
R_NOREA	dummy	1 If Region is Northeast; 0 Otherwise
R_WEST	dummy	1 If Region is West; 0 Otherwise
Human Capital (E_f, E_m, E_h)		
EDUC_O	years	Formal Education of Operator
EDUC_S	years	Formal Education of Spouse
EXPF_O	years	Operator's Experience in Farming
RAISE_O	binary	1 If Operator Raised on a Farm; 0 Otherwise
EXPOA_O	years	Off-Farm Experience of Operator
EXPOA_S	years	Off-Farm Experience of Spouse
HEALTH_O	binary	1 If Operator has Health Problem; 0 Otherwise
HEALTH_S	binary	1 If Spouse has Health Problem; 0 Otherwise
Life Cycle Effect		
AGE_O	years	Age of Operator
AGE_S	years	Age of Spouse
Labor Market Conditions (ψ^i)		
DIST_T	miles	Distance to the Nearest Town of at Least 50,000
FIND_O	binary	1 If Operator has Experienced Difficulty in Finding Off-Farm Job; 0 Otherwise
FIND_S	binary	1 If Spouse has Experienced Difficulty in Finding Off-Farm Job; 0 Otherwise
TIME_O	binary	1 If Operator has Off-Farm Work Time Constraint; 0 Otherwise
TIME_S	binary	1 If Spouse has Off-Farm Work Time Constraint; 0 Otherwise
COVER_O	binary	1 If Operator's Insurance Covers Other Members of Household; 0 Otherwise

TABLE 2 (Continued)

Variable	Unit	Description
Labor Market Conditions (ψ^i) (Continued)		
COVER_S	binary	Spouse's Insurance Covers Other Members of Household; 0 Otherwise
WAD_O	dummy	1 If Type of Work of Operator is Administrative/Professional; 0 Otherwise
WTE_O	dummy	1 If Type of Work of Operator is Technical; 0 Otherwise
WPD_O	dummy	1 If Type of Work of Operator is Production; 0 Otherwise
WSE_O	dummy	1 If Type of Work of Operator is Self-Employed; 0 Otherwise
WOT_O	dummy	0 If Type of Work of Operator is Other (Incorporated in Intercept Term)
WAD_S	dummy	1 If Type of Work of Spouse is Administrative/Professional; 0 Otherwise
WTE_S	dummy	1 If Type of Work of Spouse is Technical; 0 Otherwise
WPD_S	dummy	1 If Type of Work of Spouse is Production; 0 Otherwise
WSE_S	dummy	1 If Type of Work of Spouse is Self-Employed; 0 Otherwise
WOT_S	dummy	0 If Type of Work of Spouse is Other (Incorporated in Intercept Term)
NONWT_O	dummy	1 If Race of Operator is Non-White; 0 if white
NONWT_S	dummy	1 If Race of Spouse is Non-White; 0 if white
Household Characteristics (Γ)		
DEPEND	persons	Number of Dependents
OWNER	binary	1 If Farm Owned by Operator; 0 Otherwise
RESIDE	binary	1 If the Farm is in Town where populations over 50,000 Area; 0 Otherwise
Other Income (V)		
INCOME_O	$	Operator's Other Income
INCOME_S	$	Spouse's Other Income
LANBUIL	$	Total Value of Land and Buildings

TABLE 2 (Continued)

Variable	Unit	Description
Commuting Cost (τ^i)		
DISTJ_O	miles	Distance to the Operator's Job
DISTJ_S	miles	Distance to the Spouse's Job

and neither work off-farm. These groups are identified in Table 3 and summary data by group for all variables is given in Table 4.

Mean values for the variables are presented in Table 4 for each of the groups of households. The mean values are weighted by an expansion factor that represents the probability of that observation appearing in the total population of households. An example of applying the expansion factor and computing the cost per acre of an input is the following:

Farm Household	Cost per Acre	Expansion Factor	Expanded Cost
1	6	30	180
2	20	200	4,000
3	10	90	900
Total	NA	320	5,080

TABLE 3

FARM OPERATOR HOUSEHOLDS GROUPED BY OFF-FARM WORK, 1991 SAMPLE OF 2,687 HOUSEHOLDS

Group	Off-Farm Work Operator	Off-Farm Work Spouse	Number
A	No	No	927
B	No	Yes	507
C	Yes	No	476
D	Yes	Yes	777

TABLE 4

SUMMARY DATA BY FARM OPERATOR HOUSEHOLD GROUP AND VARIABLE (WEIGHTED MEANS)

	Farm Operator Household Group by Off-Farm Work					
Variable	Operator Spouse Unit	No No A	No Yes B	Yes No C	Yes Yes D	Total
Number of Observations		927	507	476	777	2,687
Dependent and Related Variables						
OHR_O	hour/yr.	0	0	1,830	1,913	N.A.
OHR_S	hour/yr.	0	1,606	0	1,664	N.A.
WAGE_O	$/hr.	0	0	16.9	37.5	N.A.
WAGE_S	$/hr.	0	9.05	0	10.2	N.A.
INSURE_O	%	0	0	84.2	86.3	N.A.
INSURE_S	%	0	95.9	0	93.2	N.A.
TOTREV	$	89,286	100,253	35,235	38,113	60,705
NETREV*	$	12,677	11,954	3,817	3,878	7,479

TABLE 4 (Continued)

Variable	Operator Spouse Unit	Farm Operator Household Group by Off-Farm Work No No A	 No Yes B	 Yes No C	 Yes Yes D	Total
Labor Input (T_f^i)						
FHR_O	hour/yr.	1,928	2,429	1,226	1,146	1,566
FHR_S	hour/yr.	626	375	438	242	410
FHR_3	hour/yr.	395	615	284	238	346
Land Input (Ld)						
CROPLAND ACRES	acres	183	313	119	115	163
Capital Input (K)						
DEPR	$	7,511	9,688	3,665	3,113	5,405
Farm Characteristics (ϕ)						
SAFETY	%	6.6	6.5	3.9	4.2	5.1
T_GRAIN	%	16.9	28.9	18.8	20.1	20.2
T_CROPS	%	27.4	18.5	26.5	22.9	24.3
T_BEEF	%	38.0	29.1	44.2	49.1	42.1
T_DAIRY	%	13.2	17.6	3.1	1.8	7.5
T_LIVST	%	4.4	5.8	7.3	6.1	5.8
R_MIDWE	%	34.8	55.2	34.8	37.7	38.8
R_NOREA	%	9.8	5.6	6.1	6.6	7.3
R_WEST	%	12.6	12.3	16.0	14.1	13.8
R_SOUTH	%	42.8	26.9	43.0	41.6	40.1
Human Capital $\left(E_f^i, E_m^i, E_h^i\right)$						
EDUC_O	years	11.7	12.4	12.4	13.1	12.4
EDUC_S	years	12.1	13.2	12.3	13.4	12.7
EXPF_O	years	39.7	32.4	28.3	23.6	30.4
RAISE_O	%	83.3	84.2	80.9	65.8	76.5

TABLE 4 (Continued)

Variable	Farm Operator Household Group by Off-Farm Work					
	Operator	No	No	Yes	Yes	
	Spouse	No	Yes	No	Yes	
	Unit	A	B	C	D	Total
Human Capital $\left(E^i_f, E^i_m, E^i_h\right)$ (Continued)						
EXPOA_O	years	13.9	8.9	24.1	20.9	17.9
EXPOA_S	years	5.3	15.4	4.5	15.1	10.1
HEALTH_O	%	32.1	21.1	8.3	9.7	17.3
HEALTH_S	%	20.6	6.1	14.1	9.5	13.1
Life Cycle Effect						
AGE_O	years	62.5	51.1	52.8	46.1	52.8
AGE_S	years	59.4	47.8	50.3	43.4	49.9
Labor Market Conditions (ψ^i)						
DIST_T	miles	23.7	28.9	23.3	21.7	23.6
FIND_O	%	0.8	5.6	3.9	6.7	4.3
FIND_S	%	0.3	8.4	2.9	7.4	4.6
TIME_O	%	2.6	10.3	10.3	16.4	10.4
TIME_S	%	3.5	13.4	8.3	11.1	8.7
COVER_O	%	1.2	3.6	47.5	48.4	28.6
COVER_S	%	0.4	38.4	2.6	32.8	18.1
WAD_O	%	0	0	13.3	20.8	N.A.
WTE_O	%	0	0	10.2	16.3	N.A.
WPD_O	%	0	0	20.2	23.3	N.A.
WSE_O	%	0	0	17.8	12.1	N.A.
WOT_O	%	0	0	38.5	27.5	N.A.
WAD_S	%	0	38.3	0	38.9	N.A.
WTE_S	%	0	19.1	0	11.8	N.A.
WPD_S	%	0	7.4	0	15.8	N.A.
WSE_S	%	0	6.7	0	5.5	N.A.
WOT_S	%	0	28.5	0	28.0	N.A.
NONWT_O	%	1.4	1.2	3.6	3.4	2.6
NONWT_S**	%	1.4	1.2	3.6	4.0	2.8
Household Characteristics (Γ)						
DEPEND	person	0.61	1.11	1.13	1.42	1.09
OWNER	%	96.0	91.3	93.7	92.5	93.5
RESIDE	%	15.7	10.5	13.5	12.1	13.2

TABLE 4 (Continued)

Variable	Operator Spouse Unit	No No A	No Yes B	Yes No C	Yes Yes D	Total
	Farm Operator Household Group by Off-Farm Work					
Other Income (V)						
INCOME_O*	$	33,010	33,602	13,862	31,434	28,405
INCOME_S*	$	33,009	20,890	39,479	45,571	37,200
LANBUIL*	$	367,427	276,330	245,281	188,264	263,091
Commuting Cost (τ^i)						
DISTJ_O	miles	0	0	15.0	18.7	N.A.
DISTJ_S	miles	0	14.0	0	11.7	N.A.

(Note) N.A. : Not Applicable
* : The unit used in the estimation of functions is thousand dollars.

The mean value for cost per acre is calculated as:

$$5,080 / 320 = 15.9$$

The calculation of the expansion factor is described in Dillard (1993).

Of the 2,687 households surveyed, 65.5 percent (1,760 households) reported off-farm work by the operator and/or spouse in 1991: 46.6 percent of the operators, and 47.8 percent of the spouses worked off-farm. The FOR survey of those reporting off-farm work compares to the national averages reported by the Census of Agriculture of 57.9 percent worked off-farm by the operator and/or spouse in 1988: 45.3 percent of the operators, and 36.3 percent of the spouses.

When both operator and spouse worked off-farm, hourly wage rates from off-farm work were $37.50 for operators and $10.20 for spouses in 1991. Off-farm hours of work per year were 1,913 hours for operators and 1,664 hours for spouses when both are working off-farm.

When both operator and spouse work off-farm, the operator works a total 3,059 hours a year in both farm and non-farm work which is 58.7 percent more time than operators where neither operator nor spouse are working off-farm. Group B, when operator doesn't work off-farm but spouse does, the spouse works a total of 1,981 hours a year which is 4.5 times the spouse's total work time in Group C where operator works off-farmbut spouse doesn't work off-farm. Unpaid family members of the household work more time on the farm when the operator doesn't work off-farm but the spouse does (Group B) compared to any of the other groups.

Group B has the largest gross revenue of farm production. Farm inputs of land, operator and other unpaid labor, and capital are also highest for this group.

Beef (hog and sheep) production is the most frequent farm type accounting for 42.1 percent of total farms. The beef farm type also has the greatest share of off-farm work participation: 49.1 percent of farms where both operator and spouse work off-farm. The south region has greatest share of total farms accounting for 40.1 percent of the total. Average formal education is 12.4 years for the operator and 12.7 years for the spouse. Those who work off-farm have more formal education than those who don't work off-farm for both operator and spouse. Average farm experience of operator is 30.4 year. About 76.5 percent of operators reported that they were raised on a farm. Off-farm experience is 17.9 years for the operator and 10.1 years for the spouse. Those who worked off-farm have more years of off-farm experience and less years of farm experience than those who didn't work off-farm. Average age was 52.8 years for the operator and 49.9 years for the spouse. Off-farm work groups were younger than those groups that didn't work off-farm for both operator and spouse.

About 17.3 percent of operators and 13.1 percent of spouses reported that they had some health problem. Off-farm work groups reported lower percentages of health problems compared to those groups who didn't work off-farm. About 10.4 percent of operators and 8.7 percent of spouses reported that they had off-farm work time constraints. The most frequent type of off-farm work for the operator was the "all other" which is work not categorized and administrative work was the most frequent type of work reported by spouses.

If operator and/or spouse were working off-farm, the number of dependents was greater. This is explainable considering that the age of those groups where operator or spouse do not work off-farm is higher than the groups where operator or spouse do work off-farm. Older age group is expected to have fewer number of children. Residence near town and ownership of the farm seemed to have little effect on the probability of off-farm work. The value of land and buildings was highest when the operator did not work off-farm and was lowest when both operator and spouse worked off-farm. Distance to the job for the operator was longer than that for the spouse. Many of the spouses are presumably working off-farm in the rural area.

About 94.2 percent of the spouses who worked off-farm were receiving health insurance and other fringe benefits whereas only 85.5 percent of operators who worked off-farm were receiving fringe benefits. This can be explained by the fact that spouses were more likely to work at administrative professions where fringe benefits are more frequently offered. Those farms where neither operator nor spouse worked off-farm earned the highest net revenue in farm production. The lowest net revenue was earned by those farms where operator worked off-farm but spouse didn't. Those farms where both operator and spouse worked off-farm earned higher total and net revenue than those farms where only the operator worked off-farm.

Special caution is required in interpreting the mean values of the variables. Even though the values reported are weighted means some of the values are unreasonably high or low. For example, mean value of operator's off-farm wage when both operator and spouse worked off-farm is 37.50 dollar per hour. It is 2.2 times the off-farm wage when only operator worked off-farm. This is caused by some outliers in the data. One operator earned $7,932 per hour and one spouse earned $448 per hour (Table 5). Even though the number of these outliers is small, it still has significant effects on estimated mean values.

Model Description

The variables used in the empirical equations of the model are described in this section. Statistical estimation of the equations follows in Chapter VI. The model of time allocation leading to the estimation of off-farm labor supply and non-pecuniary benefits of farm work are described by functions of farm production, wage and fringe benefits, farm labor demand, off-farm labor participation and labor supply, and the difference equation for non-pecuniary benefits. All functions are identified separately for farm operator and spouse except farm production. Net farm revenue is estimated in place of farm production because total farm production data are available only in value. Exact definition for each variable used in the estimation is described in the program for estimation of the functions (Appendix). The definitions used in the

TABLE 5

MINIMUM AND MAXIMUM VALUES FOR SELECTED VARIABLES

VARIABLE	UNIT	MINIMUM	MAXIMUM
OHR_O	hour/yr	0	4,506
OHR_S	hour/yr	0	6,240
WAGE_O	$/hr	-1.0	7,932
WAGE_S	$/hr	-2.6	448
TOTREV	$	-422,974	21,283,518
NETREV	$	-4,526,658	9,916,130
FHR_O	hour/yr	0	6,413
FHR_S	hour/yr	0	5,824
FHR_3	hour/yr	0	20,000
CROPLAND ACRES	acres	0	7,650
DEPR	$	0	700,000
EDUC_O	years	9	18
EDUC_S	years	9	18
EXPF_O	years	0	80
EXPOA_O	years	0	67
EXPOA_S	years	0	60
AGE_O	years	23	94
AGE_S	years	20	89
DIST_T	miles	0	280
INCOME_O	$	-1,572	11,122,500
INCOME_S	$	-1,572	11,122,500
LANBUIL	$	0	13,920,000
DISTJ_O	miles	0	650
DISTJ_S	miles	0	150
DEPEND	person	0	10

program are based on the farm survey questionnaire (United States Department of Agriculture, 1991).

Off-Farm Labor Participation Functions

The binary variable whether or not a farm operator/spouse works off-farm is used as the dependent variable for the off-farm labor participation function (Table 5.1). Farm operator or spouse participate in off-farm work if his/her market wage is greater than the reservation wage. Hence, all exogenous variables of the farm production function, the off-farm wage and fringe benefit function, and the utility function should be included in the estimation.

Age and age squared variables are included to incorporate life cycle effects on off-farm labor participation. Spouse's human capital stock presumably has effects on the operator's decision to work off-farm and operator's human capital has effects on the spouse's decision to work off-farm.

The human capital variables for farm production (E_f^i), human capital variables for market wage function (E_m^i) , farm characteristics (ϕ), and labor market conditions (ψ^i) which appear in the off-farm labor participation function reflect only the non-pecuniary effects of the variables. In case of human capital, formal education affects farm productivity and market wage, but it still affects the preference of the individual for farm and off-farm work. Farm work experience and being raised on a farm presumably have positive effects on farm productivity and hence will reduce off-farm labor supply by pecuniary effects. However, those variables may again affect utility in farming and have additional non-pecuniary effects on off-farm labor supply. Likewise, off-farm work experience presumably has positive effect on market wage, but may still create preference for off-farm work.

TABLE 5.1

OFF-FARM LABOR PARTICIPATION FUNCTION VARIABLES

Variable	Operator	Spouse
Dependent Variable		
Binary Variable	PARTI_O	PARTI_S
Independent Variables		
Life Cycle Effect		
Age	AGE_O	AGE_S
Age Squared	AGE2_O	AGE2_S
Human Capital (E_f^i, E_m^i, E_h^i)		
Education	EDUC_O	EDUC_S
Education Squared	EDUC_O^2	EDUC_S^2
Experience in Farming	EXPF_O	
Experience Squared	EXPF_O^2	
Raised on a Farm	RAISE_O	
Off-Farm Work Experience	EXPOA_O	EXPOA_S
Experience Squared	EXPOA_O^2	EXPOA_S^2
Health Condition	HEALTH_O	HEALTH_S
Farm Characteristics (ϕ)		
Safety of Farming	SAFETY	SAFETY
Total Acres of Crop Planted	ACRES	ACRES
Acres Squared	ACRES^2	ACRES^2
Capital	DEPR	DEPR
Capital Squared	DEPR^2	DEPR^2
Farm Type Dummy Variables	Farm Type	Farm Type
Region Dummy Variables	Regions	Regions
Labor Market Conditions (ψ^i)		
Distance to the Nearest Town	DIST_T	DIST_T
Distance Squared	DIST_T^2	DIST_T^2
Difficulty Finding Off-Farm Job	FIND_O	FIND_S
Race Dummy Variable	NONWT_O	NONWT_S

TABLE 5.1 (Continued)

Variable	Operator	Spouse
Household Characteristics (Γ)		
Number of Dependents	DEPEND	DEPEND
Ownership of Dwelling	OWNER	OWNER
Residence of Dwelling	RESIDE	RESIDE
Other Income (V)		
Other Income*	INCOME_O	INCOME_S
Total Value of Land & Buildings	LANBUIL	LANBUIL

(Note) * INCOME_O and INCOME_S include other non-wage off-farm income and governments payments.

Farm characteristics are also expected to have non-pecuniary effects. Safety of farming has effect on farm productivity, but it also may affect farmer's preference for farm work. Farm type also has non-pecuniary effects. For example, some people may prefer a certain type of farming, say, dairy farming. A region is assumed to have three types of effects. It has its own climate and hence affects farm productivity. It also has its own labor market conditions and hence affects market wage. A region again has its own "psychic" and "scenic" resources and hence affects time allocation of farmers.

Labor market conditions also have non-pecuniary effects. Distance to the nearest town has effect on wage by affecting regional labor demand faced by an operator. But if the wage effect is constant, then the distance may have an additional effect on off-farm labor supply because the operator may increase utility by enjoying the cultural facilities of the town. Other labor market conditions such as difficulty in finding off-farm job and off-farm work time constraint may also have non-pecuniary effects as well as wage effects. Types of work affect fringe benefits and hence have pecuniary effects. But the off-farm worker may have different non-pecuniary benefits by type of work. For example, some workers may prefer administrative work rather than production work. Race affects market wage by possible racial discrimination and hence has pecuniary effect. Race may also affect off-farm labor participation by the possible difference in work preference by race.

For the other variables such as household characteristics (Γ), other income (V), and variables incorporated for life cycle effect, the study doesn't differentiate non-pecuniary effects from pecuniary effects because they directly affect the utility function.

Spouses, most of them female, are expected to participate less in off-farm work as the number of dependents increase if the dependents represent mostly the number of children. However, the variable dependents actually includes parents and other relatives of the operator and hence off-farm work is expected to increase if the number of dependents increase. Ownership of dwelling, rented or owned, may affect time allocation of farmers. Residence of dwelling, whether or not the operator's dwelling is located on a lot in a town, city or suburban area, may also have effect on farmer's time allocation.

Operator's and spouse's off-farm participation are expected to decrease as other income and total value of land and buildings increases. Total value of land and buildings show the expectation on returns from the land in the future. Hence, if the value increases farmers are more likely to continue farming even though they have current negative returns.

The dependent variable for off-farm labor participation is measured as a binary variable. The total 2,687 FOR version data is used for the estimation of the off-farm labor participation functions of operators and spouses.

Wage Function

In the wage functions of operator and spouse, dependent variables are measured as market wages (Table 6). Market wage of an individual is obtained by total cash wages, salaries, tips, wages earned on other farms and ranches, military pay, commissions, piece rate payments, and cash bonuses divided by total off-farm work hours of the surveyed year.

Wage functions have only exogenous variables. The variable 'health insurance coverage' which represents whether the health insurance covered other household members may be endogenously determined. Yet this study treats the variable as exogenous.

Exogenous variables included are (1) human capital which represents attributes of the individual and (2) labor market conditions which represent attributes of the choice. Human capital variables included are formal education, education squared, work experience in any off-farm job, experience squared, and health condition. The experience squared variable is included to incorporate three possibilities: wage marginally increases, decreases, or remains constant as experience increases.

Regional labor market conditions are reflected as distance to the nearest town, difficulty finding off-farm job, existence of time constraint in off-farm work, health insurance coverage, types of work in off-farm, race, and region dummy variables. Distance to the nearest town is the mileage to the town with a population of at least 50,000. Difficulty finding off-farm job is dummy variable

TABLE 6

OFFERED WAGE FUNCTION VARIABLES

Variable	Operator	Spouse
Dependent Variable		
Market Wage (W^i)	WAGE_O	WAGE_S
Independent Variables		
Commuting Cost (τ^i)		
Distance to the Job	DISTJ_O	DISTJ_S
Human Capital ($E_m{}^i$)		
Education	EDUC_O	EDUC_S
Education Squared	EDUC_O^2	EDUC_S^2
Off-Farm Work Experience (Any)	EXPOA_O	EXPOA_S
Experience Squared	EXPOA2_O	EXPOA2_S
Health Condition	HEALTH_O	HEALTH_S
Labor Market Conditions (ψ^i)		
Distance to the Nearest Town	DIST_T	DIST_T
Distance Squared	DIST_T^2	DIST_T^2
Difficulty Finding Off-Farm Job	FIND_O	FIND_S
Off-Farm Work Time Constraint	TIME_O	TIME_S
Health Insurance Coverage	COVER_O	COVER_S
Type of Work Dummy Variables		
Administrative/Professional	WAD_O	WAD_S
Technical	WTE_O	WTE_S
Production	WPD_O	WPD_S
Self Employed	WSE_O	WSE_S
Other**		
Race Dummy Variable	NONWT_O	NONWT_S
Region Dummy Variables		
South**		
Midwest	R_Midwe	R_Midwe
Northeast	R_Norea	R_Norea
West	R_West	R_West

(Note) ** Incorporated in intercept term whether there were any times during the year when the operator/spouse searched for work off the farm but were unable to find suitable work. Existence of time constraint is the dummy variable which shows whether or not the individuals would work more hours at an off-farm job if they could.

Type of work dummy variables are included in the model because the study assumes imperfect labor mobility between professions. A worker is expected to receive different wage rate for certain professions even though his/her human capital stock and other conditions are the same. Race dummy variable is used to incorporate the possibility of race discrimination in wage determination. Two types of race categories are defined: (1) white; and (2) non-white which includes Spanish, Black, Asian, and American Indian. Regional dummy variables reflect other labor market conditions such as unemployment rate and industrial growth rate which are not reflected in the above variables.

Distance to the job variable is another type of exogenous variable which reflects the commuting cost. The study expects higher wage as distance to the job increases other things being equal because the reservation wage of off-farm work will increase as distance increases. The variable distance to the job is expected to have positive sign because farmers will only accept a higher wage as distance increases. Formal education and off-farm experience are expected to have positive sign in linear term and negative in quadratic term, reflecting that off-farm productivity marginally decrease as human capital input increases.

The variable health condition is expected to have negative sign because off-farm productivity will decrease if the operator or spouse has health problem. The variable distance to the nearest town is expected to have negative sign because off-farm labor demand will decrease as distance increases. Difficulty finding off-farm job is expected to have negative sign because the difficulty reflects less labor demand compared to supply. The variable off-farm work time constraint is expected to have negative sign because the existence of time constraint reflects less labor demand compared to supply. The variable health insurance coverage is expected to have negative sign because an operator or spouse will accept lower pecuniary wage if he/she is provided with the coverage.

The parameters on types of work are not expected to be the same because labor is not expected to be perfectly mobile between professions. The non-white dummy variable is expected to have negative sign because racial discrimination is expected to exist. The parameters of the regional dummy variables are not expected to be statistically identical because regional differences in labor market conditions are expected to exist.

The 2,687 household observations from the FOR version are grouped into four categories: operator only work off-farm; spouse only work off-farm; both work off-farm; neither work off-farm (see Table 2). Using Groups C and D data where operator works off-farm, the wage function of operator is estimated and applied to Group A and B to predict the market wage of operators who don't work off-farm. Again, using Groups B and D data where spouse works off-farm, the wage function of spouse is estimated and applied to Groups A and C to predict the market wage of spouses who don't work off-farm. A total of 1,253 observations is used for the operator's wage function and a total of 1,284 observations is used for the spouse's function. In each case the market wage function is estimated incorporating sample selection variables which are derived from the probit estimation of the off-farm labor participation function. Sample selection variables address the possible effects of unknown variables which are not reflected in the existing model.

Fringe Benefit Function

Nonwage fringe benefits are types of compensation and therefore are presumably functions of human capital stock of a worker and regional labor market conditions. Fringe benefits are defined as binary variables whether or not an off-farm worker receives fringe benefits. Fringe benefits include health insurance, worker's compensation, life insurance, pension or retirement, and paid vacation or sick leave. If any of these benefits is received, then the operator/spouse is defined to have fringe benefits.

Determination of fringe benefits is presumably less flexible than that of wage and hence the number of explanatory variables is more limited than the wage function (Table 7). Again, two types of exogenous variables are defined as in the wage function: human capital and labor market conditions. Education, off-farm work experience in any job which includes years worked part time or in military service, and experience squared variables are used to reflect the human capital stock of the worker.

Regional labor market conditions which affect fringe benefits are reflected in the following dummy variables: difficulty finding off-farm job; race which reflects possible race discrimination in supply of fringe benefits; and region which incorporates other regional labor market conditions.

Health insurance is assumed to be independent of the variables such as experience in current off-farm job, health condition, distance to the job or nearest town, and off-farm work time constraint. The education and off-farm experience variables are expected to have positive sign in linear term and negative in quadratic term because fringe benefits are considered as a compensation which reflects off-farm productivity. The variable difficulty finding

TABLE 7

FRINGE BENEFIT FUNCTION VARIABLES

Variable	Operator	Spouse
Dependent Variable		
Health Insurance (B)	INSUR_O	INSUR_S
Independent Variables		
Human Capital (E_m^i)		
Education	EDUC_O	EDUC_S
Education Squared	EDUC_O^2	EDUC_S^2
Off-Farm Work Experience (Any)	EXPOA_O	EXPOA_S
Experience Squared	EXPOA_O^2	EXPOA_S^2
Labor Market Conditions (ψ^i)		
Difficulty Finding Off-Farm Job	FIND_O	FIND_S
Race Dummy Variable	NONWT_O	NONWT_S
Region Dummy Variables		
South**		
Midwest	R_Midwe	R_Midwe
Northeast	R_Norea	R_Norea
West	R_West	R_West

(Note) ** Incorporated in intercept term

off-farm job is expected to have a negative sign as in the wage function. The race variable is expected to have a negative sign because racial discrimination is expected to exist. The regional dummy variables are not expected to have statistically identical parameters because regional difference in labor market conditions are expected to exist.

The same FOR version data are again grouped into four categories according to the reception of fringe benefits of operator and spouse. A total of 1,253 observations is used for the operator's benefit function and a total of 1,284 observations is used for the spouse's function. Sample selection bias is also considered as in the wage function by incorporating relevant variables derived from the off-farm labor participation function.

Farm Labor Demand Function

Farm labor demand, which is measured as total hours of farm work per year, is a function of household characteristics and other income variables as well as human capital, farm characteristics, and labor market conditions. Traditional farm labor demand functions have included only the latter three categories of variables because the production decision is assumed to be independent of the consumption decision. However, this study, due to the non-pecuniary effect, assumes that farm labor demand also is affected by household characteristics and other income variables.

Market wage is also included to see the effect of opportunity cost of off-farm work on farm labor demand. Wage is expected to have a negative effect on farm labor demand. Actual wages are used for those who work off-farm and predicted wages are used for those who don't work off-farm. A total of 2,687 observations is used in the estimation of the function.

Net Revenue Function

Net revenue is equal to total revenue less purchased input costs. Net revenue here is regarded as total returns to unpaid inputs.

Total revenue is obtained by summing total sales of crops, livestock, and poultry; net change in value of inventories of non-CCC crops, livestock, and poultry; and value of farm products used or consumed on the farm. Sales of crops include cash sales, marketing contracts, and net changes in CCC loans. Sales of livestock and poultry include cash sales and marketing contracts.

Purchased input costs include purchased feed expense; purchased livestock expense; livestock contractor expense; livestock leasing expense; custom feed, pasturing, and grazing expense; veterinary services and supplies expense; hired labor expense; contract labor expense; hired and contract labor fringe benefit expense; fertilizer, lime, and chemicals expense; seed and plant expense; tractor, auto/truck, other equipment, and structure leasing expense; fuel and oil expense; expense for repairs and replacement parts for vehicles; hand tools, supplies, and farm shop power equipment expense; land, farm, irrigation, building maintenance and repair expense; container expense; custom hired work expense; utilities; motor vehicle registration and licensing fees; other unrecorded expenses; general business expenses excluding insurance; real estate and property taxes; total interest paid; cash rent and AUM fee expense; and non-cash expenses for paid labor.

Independent variables of the net revenue function are categorized into two groups: endogenous and exogenous (Table 8). Endogenous variables include predicted values of operator's labor and spouse's labor assuming that those farm inputs are being used in equilibrium. Labor inputs include unpaid

TABLE 8

NET REVENUE FUNCTION VARIABLES

Variable	Name
Dependent Variable	
Net Revenue (NR)	NETREV
Independent Variables	
Labor Input (T_f^i)	
Hours Worked on Farm by	
Operator	FHR_O
Operator Squared	FHR_O^2
Operator Cubic	FHR_O^3
Spouse	FHR_S
Spouse Squared	FHR_S^2
Spouse Cubic	FHR_S^3
Other Unpaid Workers	FHR_3
Unpaid Workers Squared	FHR_3^2
Unpaid Cubic	FHR_3^3
Land Input (Ld)	
Total Acres of Crops Planted	ACRES
Acres Squared	$ACRES^2$
Capital Input (K)	
Depreciation on Farm Business Assets	DEPR
Depreciation Squared	$DEPR^2$
Interaction Terms	
Interactions between	
Operator and Spouse Labor	FHR_O * FHR_S
Operator and Unpaid Labor	FHR_O * FHR_3
Operator Labor and Land	FHR_O * ACRES
Operator Labor and Depreciation	FHR_O * DEPR
Spouse and Unpaid Labor	FHR_S * FHR_3
Spouse Labor and Land	FHR_S * ACRES
Spouse Labor and Depreciation	FHR_S * DEPR
Other Unpaid Labor and Land	FHR_3 * ACRES
Other Unpaid Labor and Depreciation	FHR_3 * DEPR
Land and Depreciation	ACRES * DEPR

TABLE 8 (Continued)

Variable	Name
Human Capital (E_f^i)	
Education (Operator)	EDUC_O
Education (Operator) Squared	EDUC_O^2
Experience in Farming (Operator)	EXPF_O
Experience Squared	EXPF_O^2
Raised on a Farm? (Operator)	RAISE_O
Health Condition (Operator)	HEALTH_O
Health Condition (Spouse)	HEALTH_S
Farm Characteristics (Γ)	
Safety of Farming	SAFETY
Farm Type Dummy Variables	
Other Crops**	
Cash Grains	T_GRAIN
Beef, Hog, Sheep	T_BEEF
Dairy	T_DAIRY
Other Livestock	T_LIVST
Region Dummy Variables	
South**	
Midwest	R_Midwe
Northeast	R_Norea
West	R_West

(Note) ** Incorporated in intercept term

farm and ranch work hours. Hired and contract labor are counted as purchased input costs in deriving net revenue. The other unpaid family labor is counted as an exogenous variable.

Exogenous variables of the net revenue function are of two types: human capital which represent attributes of the individuals and farm characteristics which represent physical and location attributes. Human capital variables included are formal education of operator, farming experience of operator, operator raised on farm, and health condition of operator and spouse. Spouse's education is not included because the variable is highly correlated with operator's. Hence, operator's education represents the overall education level of the family. Formal education and health condition are assumed to affect productivity of farm and off-farm work.

Farm characteristic variables include land and capital input, safety of farming which is obtained by summing the number of incidents from farm related work such as illness, injuries, and deaths. Land input is total acres of crops planted which excludes land used only for pasture, set-aside, land for various government programs, farmstead, woodland, roads, ponds, and wasteland. The total amount of depreciation claimed for all capital assets is used as a proxy for the capital stock variable. Interaction terms between inputs are included to capture the complementarity or substitutability between inputs. Farm types and region dummy variables are also used as farm characteristics variables.

Five categories of farm types are defined: (1) cash grains; (2) other crops; which include tobacco, cotton, other field crops, vegetables, melons, strawberries, fruits, nuts, nursery/greenhouse crops, christmas trees only farms, and conservation reserve program only farms; (3) beef, hogs, and sheep production; (4) dairy; and (5) other livestock which includes poultry and other livestock farms.

Four geographic regions are defined following Mary C. Ahearn et al. (p.20): (1) south region of 16 states: Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas, Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia; (2) midwest region of 12 states: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; (3) northeast region of 8 states: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont; and (4) west region of 11 states: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

All farm inputs are expected to have positive sign in linear term and negative sign in quadratic term reflecting that they have decreasing marginal returns. Interaction terms are generally expected to have negative sign because most of the inputs are substitutes for each other. Formal education and experience in farming are expected to have the same signs as physical inputs because human capital is also a kind of "capital" input. The variable operator raised on a farm is expected to have a positive sign because he/she is expected to have more experience in farming and thus to reflect increased productivity.

Health is expected to have a negative sign because a health problem should reduce farm productivity. Safety is expected to have a negative sign because a farm accident should reduce farm productivity. We have no a priori expectation on farm type variables. If other production conditions are the same then we expect the same net return from each farm type. If net return is not the same, then it implies that farm inputs are not perfectly mobile between farm types. Regions have no a priori expectation on the signs of the parameter estimates.

The equation is estimated by two stage least squares regression. Because the dependent variable of net revenue may be negative, various forms of the quadratic function are estimated. The 2,687 observations of the FOR version are used for the estimation of the equation.

Off-Farm Labor Supply Function

In the estimation of the off-farm labor supply function, which is measured as total hours of off-farm work, theoretically the same explanatory variables as in the off-farm labor participation function should be used. The same estimated net revenue function and estimated wage functions as in the participation function are also used. The censored sampling model is used in estimation of the function because those who don't participate in off-farm work are included in the sample. The off-farm labor participation function is used for the application of the correction of censored sampling problem. The total 2,687 observations are used for the operator's and spouse's off-farm labor supply functions. Actual wages are used for those who work off-farm and predicted wages are used for those who don't work off-farm.

The age variable is expected to have a negative sign for both the linear and quadratic terms because life cycle effect has presumably an inverted U-shape curve. Human capital variables are not a priori expected to have any certain direction because the parameters presumably reflect only non-pecuniary effects. The non-pecuniary effect depends on the type of utility function. Also, for the other variables, the parameters reflect only non-pecuniary effects which depend on the type of utility function. Therefore, the direction of signs cannot be determined a priori.

Difference Function

For estimation of the difference function of off-farm labor supply, which is derived by the difference between actual off-farm labor supply and expected labor supply when non-pecuniary effect is not considered, the exogenous variables of farm production (E_f^i, ϕ), market wage (E_m^i,ψ^j), and household characteristics (Γ) are used as explanatory variables because the variables are assumed to have non-pecuniary as well as pecuniary effects (Table 9). This difference function is estimated to certify the results of the off-farm labor participation and the off-farm labor supply because, if correctly estimated, the results of both estimations should be identical. The expected sign of the estimates are difficult to determine a priori because preference for farm or off-farm work depends on the individual's preference.

The total sample of 2,687 households from the FOR version is used for the estimation of the difference functions for operator and spouse.

TABLE 9

DIFFERENCE FUNCTION VARIABLES

Variable	Operator	Spouse
Dependent Variable		
Total Hours of Work	OHR_O	OHR_S
Independent Variables		
Life Cycle Effect		
Age	AGE_O	AGE_S
Age Squared	AGE_O^2	AGE_S^2
Human Capital (E_f^i, E_m^i, E_h^i)		
Education	EDUC_O	EDUC_S
Education Squared	$EDUC\_O^2$	$EDUC\_S^2$
Experience in Farming	EXPF_O	
Raised on a Farm	RAISE_O	
Off-Farm Work Experience	EXPOA_O	EXPOA_S
Health Condition	HEALTH_O	HEALTH_S
Farm Characteristics (ϕ)		
Safety of Farming	SAFETY	SAFETY
Cropping Acreage	ACRES	ACRES
Acreage Squared	$ACRES^2$	$ACRES^2$
Depreciation	DEPR	DEPR
Depreciation Squared	$DEPR^2$	$DEPR^2$
Farm Type Dummy Variables	Farm Type	Farm Type
Region Dummy Variables	Regions	Regions
Labor Market Conditions (ψ^i)		
Distance to the Nearest Town	DIST_T	DIST_T
Difficulty Finding Off-Farm Job	FIND_O	FIND_S
Race Dummy Variable	NONWT_O	NONWT_S
Household Characteristics (Γ)		
Number of Dependents	DEPEND	DEPEND
Ownership of Dwelling	OWNER	OWNER
Residence of Dwelling	RESIDE	RESIDE

CHAPTER VI

STATISTICAL ESTIMATION RESULTS

Estimation Procedure

A total of 15 equations were estimated using weighted least squares, probit procedure, two stage least squares procedure, and Heckman's two stage procedures. Two off-farm participation functions (operator and spouse) were estimated by the probit procedure and correction factors calculated. Four off-farm wage (offered wage) functions (operator and spouse) were estimated by Heckman's two stage procedure and the conditional nature of the wage functions for those who were working were modified by the correction factor. The first two off-farm wage equations included only human capital variables and labor market conditions following traditional human capital theory of offered wage determination. The second two equations included the additional household characteristics and other income variables to test the hypothesis that market wage is not exogenously given but is endogenously determined in the system. Two fringe benefit functions (operator and spouse) were estimated using the probit procedure.

Two farm labor demand functions (operator and spouse) were estimated by weighted least squares procedure and the independence of the farm labor demand from household characteristics was tested. The predicted values of farm labor demand for operator and spouse were calculated and used in estimating the net revenue function. One net revenue function, which represents the farm production function, was estimated by two stage least squares procedure using the predicted values of farm labor demand for operator and spouse. The two stage least squares was applied because the system is simultaneous. Two off-farm labor supply functions (operator and spouse) were estimated by Heckman's two stage procedure using actual wages of operator and spouse. Two 'difference' functions of operator and spouse were estimated by weighted least squares procedure. The dependent variable 'difference' was calculated as the difference between actual (but also predicted) off-farm labor supply and predicted off-farm labor supply when the marginal value product of farm labor was set equal to the off-farm wage rate. Generally, the total of 2,687 observations was used where both operator and spouse existed in the same household. Because of the interdependence between equations the following steps were followed in estimation as shown in Figure 14.1:

(1) Off-farm labor participation functions for operator and spouse using all observations were estimated using the probit procedure. The predicted probability distribution and cumulative density variables were derived to calculate Heckman's lambda for the operator and spouse. The procedure was applied for correction of the conditional nature of the offered wage and off-farm labor supply functions.

(2) Market wage (offered wage) functions for operator and spouse were estimated using Heckman's two stage procedure. The conditional nature of the offered wage was corrected using the participation function results to predict the offered wage for those who were not working.

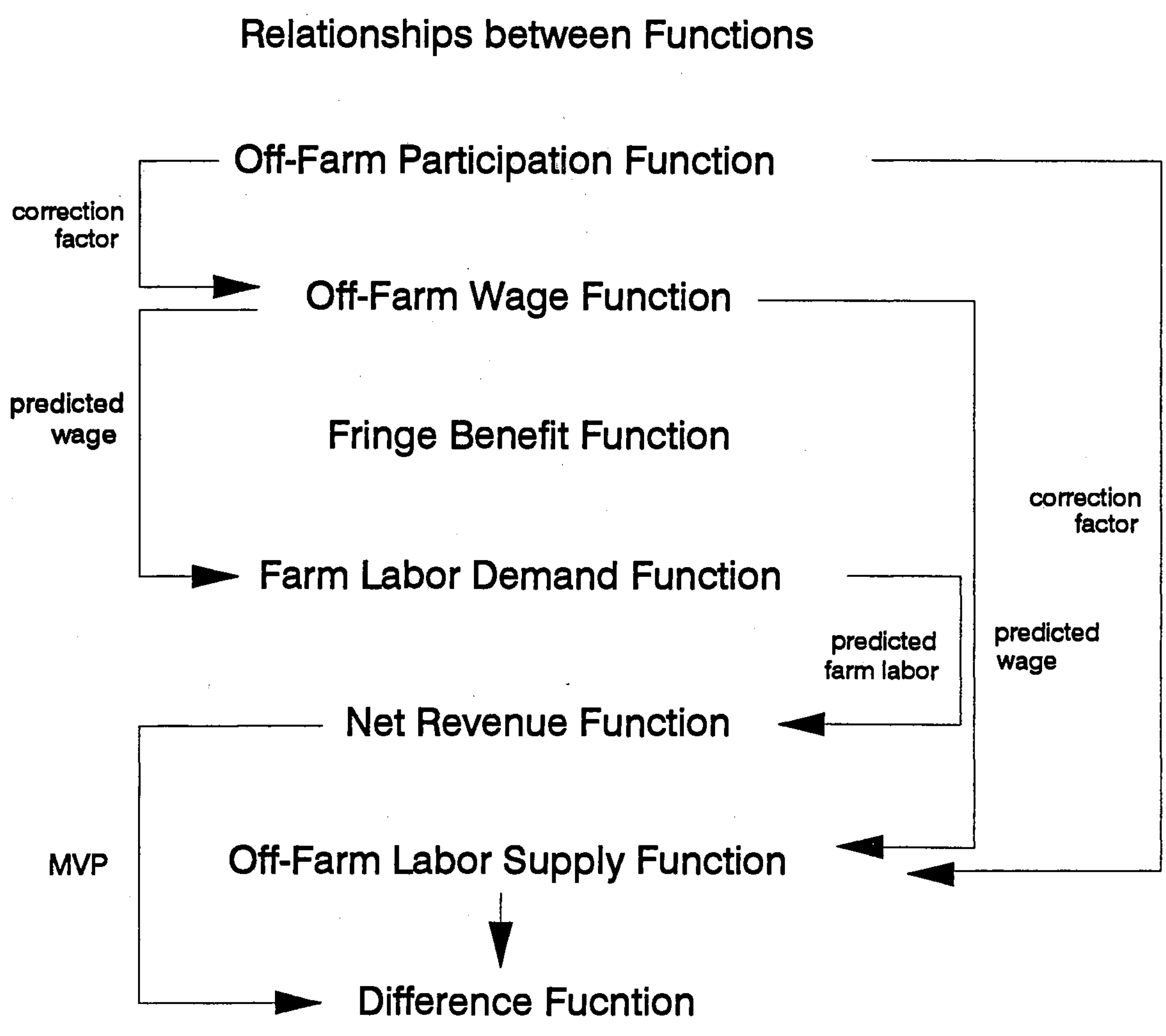

Figure 14.1. Relationships between Function.

(3) Fringe benefit functions for operator and spouse were estimated by the probit procedure using observations for only those who were working.

(4) Farm labor demand functions for operator and spouse were estimated by the weighted least squares procedure including off-farm market wage. The actual wage was used rather than predicted wage for those who were working in order not to eliminate important variation. Predicted wage was used for those who were not working off-farm.

(5) Net revenue function was estimated by two stage least squares procedure incorporating predicted values of farm labor demand for operator and spouse. For other unpaid labor, actual value was used. For other farm inputs such as land and capital, actual values were used because these inputs were assumed to be given exogenous. This implies that the time span of the system was assumed to be short-run. The marginal value products for operator and spouse labor were calculated from the estimated net revenue function.

(6) Off-farm labor supply functions for operator and spouse were estimated using Heckman's two stage procedure with actual values for offered wage. The actual offered wage was used rather than predicted offered wage as in the farm labor demand function in order to not eliminate important variation. The Heckman's correction procedure was applied to predict the offered wage for those who were not working.

(7) The 'difference' functions for operator and spouse were estimated by the weighted least squares procedure. The dependent variable

'difference' was calculated as the difference between actual off-farm labor supply and the predicted off-farm labor supply where the marginal value product of farm labor was set equal to the off-farm offered wage.

The weighted least squares procedure used is as follows: (1) The square root value of the weighting variable (Chapter V) was calculated, (2) each observation of the data was multiplied by this square root value, and (3) ordinary least squares procedure was applied to this transformed data. Special attention is required in interpreting the estimates of the weighted least squares procedure. Depending on the scale of the weighting values, the estimated value of the intercept term varies.

Hidiroglou et al. (1977) showed that weighted least squares method can be applied to the multistage stratified samples using the weighting variable when measurement error variance is known. However, the weighting procedure does not necessarily account for the complex sample design. Reliance on standard statistical techniques leads to biased estimates of the standard errors, and hence, may compromise the reliability of the statistical tests of significance (Bagi et al. 1988). An appropriate weighting procedure is not yet developed and, to my knowledge, no software exists that can correct for sample design bias in the limited dependent variable models such as logit and Tobit analysis. The ratio of the correct standard error to the standard error computed assuming a simple random sample is known as the design effect (Perry 1990). Design effects which can be applied to limited dependent variable models cannot be constructed. However, a large number of observations of the data is believed to lessen the design effect and, if weighted, the properties of the data nearly approach those of a random sample.

The simple t tests are applied to test (1) if the parameter estimates of the correction factor in off-farm wage and off-farm labor supply functions are equal to zero, (2) if wage is determined independently of the household and other income variables, and (3) if the parameters of the explanatory variables of the difference functions are equal to zero, that is, if there exist any non-pecuniary effects.

Off-Farm Labor Participation Functions

Off-farm labor participation functions for operator and spouse were estimated using only exogenous variables of the utility function, market wage function, and farm production function as explanatory variables (Table 10).

Life Cycle Effect

The off-farm labor participation for operator and spouse follows the inverted U-shape with age, implying that off-farm labor participation follows the standard life cycle hypothesis (Figure 15 panel 1). The maximum probability of off-farm labor participation occurs when the operator is 30.8 years old and then the probability of off-farm labor participation decreases. Considering that the average age of the operator is 52.8 years, off-farm labor participation for most operators has a negative relationship with age. The average value of the independent variable is located by an *. Spouse's probability of off-farm labor participation also follows the life cycle hypothesis. The maximum probability occurs when the spouse is 29.8 years old implying that, at the average age of 49.9, spouses decrease their off-farm labor participation as age increases. All of the coefficients for the life cycle variables are statistically significant at the 5 percent probability level.

TABLE 10

PROBIT RESULTS OF OFF-FARM LABOR PARTICIPATION FOR OPERATOR AND SPOUSE

Parameter	Operator			Spouse		
	Coefficients	t-value		Coefficients	t-value	
Constant	-0.2033	-3.47	**	-0.0516	-0.86	
Life Cycle Effect						
AGE	0.1020	4.01	**	0.1214	4.43	**
AGE^2	-0.0016	-6.33	**	-0.0020	-6.93	**
Human Capital $\left(E_m^i, E_f^i, E_h^i\right)$						
EDUC_O	-0.2459	-2.63	**			
$EDUC\_O^2$	0.0126	3.25	**			
EDUC_S				-0.3981	-3.96	**
$EDUC\_S^2$				0.0182	4.38	**
EXPF_O	-0.0189	-1.56				
$EXPF\_O^2$	0.0004	2.13	**			
RAISE_O	0.2399	1.81	*			
EXPOA	0.1022	10.03	**	0.2055	16.25	**
$EXPOA^2$	-0.0011	-4.73	**	-0.0031	-8.79	**
HEALTH	-0.7163	-5.56	**	-0.3819	-2.41	**
Farm Characteristics (ϕ)						
SAFETY	0.3544	1.60		0.3530	1.63	
ACRES	-0.0009081	-3.51	**	0.0002875	1.14	
$ACRES^2$	0.0000003	4.03	**	-0.000000078	-1.13	
DEPR	-0.0206615	-3.94	**	-0.0127188	-2.43	**
$DEPR^2$	0.0000231	2.03	**	0.0000150	1.28	
T-GRAIN	0.2556	1.63		0.5849	3.46	**
T-BEEF	0.1728	1.44		0.2868	2.29	**
T-DAIRY	-0.9845	-4.84	**	0.1511	0.78	
T-LIVST	-0.0873	-0.43		-0.0608	-0.26	
R-MIDWE	-0.0445	-0.37		0.1521	1.20	
R-NOREA	0.0409	0.22		-0.0963	-0.50	
R-WEST	-0.0877	-0.62		-0.3886	-2.68	**
Labor Market Conditions (ψ^i)						
DIST_T	-0.0000134	-0.01		-0.008404	-1.97	**
$DIST\_T^2$	0.0000144	0.65		0.0000804	2.26	**
FIND	0.2041	0.84		0.7714	3.08	**
NONWT	-0.0505	-0.16		-0.6887	-2.27	**

TABLE 10 (Continued)

Parameter	Operator		Spouse	
	Coefficients	t-value	Coefficients	t-value
Household Characteristics (Γ)				
DEPEND	0.0474	1.22	-0.0543	-1.39
OWNER	-0.1985	-1.07	-0.1140	-0.61
RESIDE	0.0211	0.15	0.0981	0.66
Other Income (v)				
INCOME	-0.0001447	-0.32	0.0003090	0.83
LANBUIL	0.0000683	0.72	-0.0001200	-1.10
Number of Observations	2.687		2.687	
Dependent Variable	PARTI_O		PARTI_S	

** Significant at 5 percent level.
* Significant at 10 percent level.

<u>Human Capital</u>

The formal education of operator is positively related with the probability of off-farm work. The minimum probability of off-farm labor participation occurs when the operator's formal education is 9.7 years (Figure 15 panel 2). Considering that average formal education for operators is 12.4 years, the formal education has a positive effect on the probability of off-farm work for most operators.

The formal education of spouse is also positively related with the probability of off-farm work. The minimum probability of off-farm labor

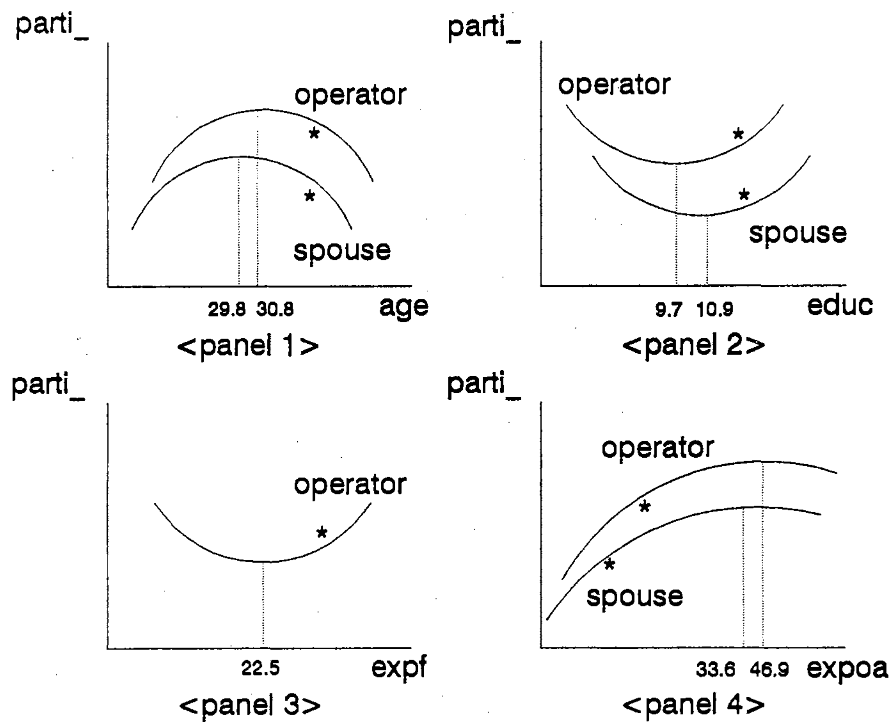

Figure 15. Relationships Between Probability of Off-Farm Labor Participation of Operator and Spouse and Selected Life Cycle and Human Capital Variables.

participation occurs when the spouse's formal education is 10.9 years. Considering that the average years of formal education is 12.7 years, the variable has a positive effect on the probability of off-farm work for most spouses. All formal education variables are significant at the 5 percent probability level.

Farming experience of the operator has a U-shaped effect on the probability of off-farm work (Figure 15 panel 3). The minimum probability occurs when experience is 22.5 years. That is, the probability of off-farm work decreases until the operator has 22.5 years of farm work experience but the probability increases beyond that point. Considering that the average farming experience is 30.4 years, many of the operators are distributed on the increasing side of the U-shaped curve. Why the probability of off-farm labor participation increases after 22.5 years of farming experience is not readily explainable.

Off-farm work experience of operator has a positive relationship with the probability of off-farm labor participation. The maximum probability of participation occurs when the off-farm work experience is 46.9 years (Figure 15 panel 4). Considering that the average off-farm work experience of operator is 17.9 years, most of the operators are on the increasing side of the inverted U-shaped curve. Spouse's off-farm work experience also has the same relationship with the probability of off-farm labor participation as for farm operator. The maximum probability occurs when the spouse's experience is 33.6 years. Considering that the average off-farm work experience for the spouse is 10.1 years, most of the spouses are on the increasing side of the inverted U-shaped curve. All the off-farm work experience parameter estimates are significant at the 5 percent probability level.

If the operator had a health problem then the probability of off-farm labor participation decreased. The same result holds for the spouse. All the coefficients are significant at the 5 percent probability level. If the operator was raised on a farm then the probability of off-farm labor participation increased. The parameter estimate is significant at the 10 percent probability level. This result is the reverse of what was expected. If the operator is raised on a farm then it presumably increases the farm specific human capital of the operator and hence should decrease the probability of off-farm labor participation.

Farm Characteristics

The cropping acreage and the amount of capital (depreciation) were considered as fixed farm inputs and hence as exogenous farm characteristics. As cropping acreage increased operator's off-farm labor participation decreased (Figure 16 panel 1). The minimum probability of off-farm labor participation occurs when the acreage is 1,498. Considering that the average cropping acreage is 163, most of the operators are on the decreasing side of the U-shaped curve. All the parameter estimates are significant at the 5 percent probability level. However, the spouse's off-farm labor participation has a positive relationship with the cropping acreage although the parameter estimates are not significant. The maximum probability occurs at 1,843 acres implying that most of the spouses are on the increasing side of the inverted U-shaped curve. Spouse's farm labor is presumably substituted by hired labor as cropping acreage increases and this increases the spouse's probability of off-farm labor participation.

The amount of capital in farming has a positive relationship with the operator's probability of off-farm labor participation. The minimum probability occurs when the amount of capital depreciation is $445. Considering that the average amount of capital depreciation is $5,405, most of the operators are on the increasing side of the U-shaped curve. Spouse's off-farm labor participation has the same relationship with the amount of capital in farming. The minimum probability occurs when the amount of capital depreciation is $423 implying that most of spouses are on the increasing side of the U-shaped curve. The increasing relationships of the amount of capital in farming with probabilities of

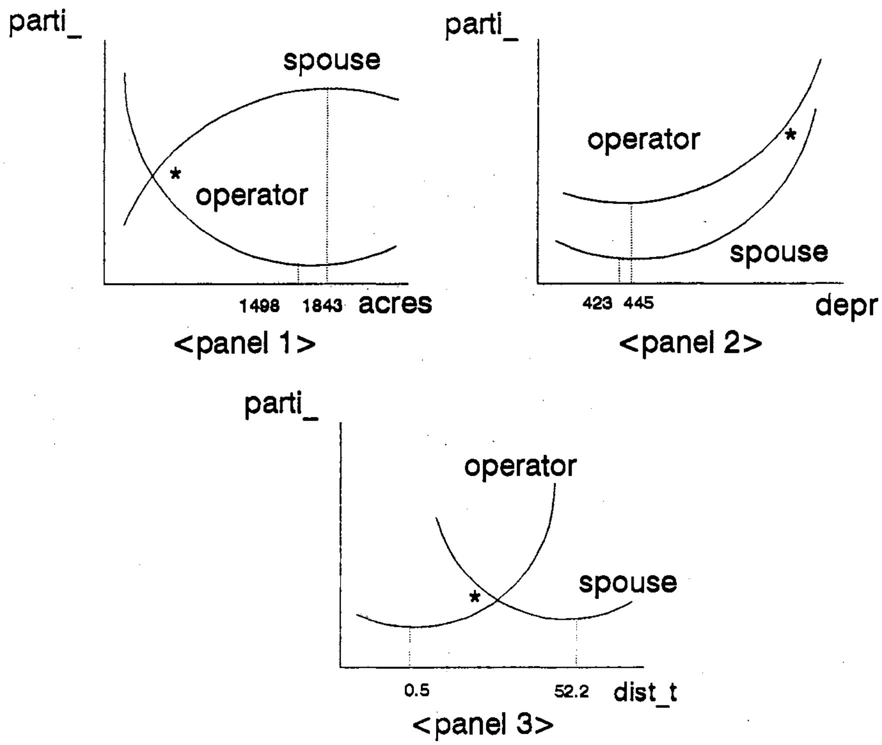

Figure 16. Relationships Between Probability of Off-Farm Labor Participation of Operator and Spouse and Selected Farm Characteristic and Labor Market Variables.

off-farm work for operator and spouse imply that capital is a substitute for operator and spouse farm labor.

If a farming accident occurred the probability of off-farm labor participation increased for both operator and spouse although the parameter estimates are not significant at the 10 percent probability level. The result is as expected.

Types of farming were found to have significant effects on the operator's probability of off-farm labor participation. If the type of farming was cash grains or beef, hog, or sheep production then the operator's probability of off-farm labor participation increased compared to "other" crop framing (intercept) although the parameter estimates are not significant. If the type of farming was dairy production then the probability of off-farm labor participation decreased significantly compared to "other" crop farming. Types of farming had similar effects on the spouse's probability of off-farm labor participation. Cash grains and beef, hog, or sheep production significantly increased spouse's probability of off-farm work compared to "other" crop farming. Dairy farming has no significant effect on the spouse's off-farm labor participation implying that dairy production is more male-labor-intensive farming. Most of the operators are believed to be "male." The results indicate that, in general, cash grains and beef, hog, or sheep production are labor extensive farming and dairy production is labor intensive farming.

Regional dummy variables reflect regional differences in farming conditions such as temperature and precipitation as well as differences in local labor market conditions such as employment rate and industry mix. Hence the parameter estimates of these regional dummy variables reflect the comprehensive effects of these differences. Operators have a higher probability of off-farm work in the Northeast region compared to the other regions although the parameter estimate is not statistically significant. Regional conditions have different effects on the spouse's probability of off-farm work compared to operators. Spouses have significantly less probability of off-farm labor participation in the West region. Although statistically not significant, spouses have a higher probability of off-farm labor participation in the Midwest region and a lesser probability in the Northeast region. The West region was found to be commonly unfavorable to both operator and spouse off-farm labor participation. A possible hypothesis is that the West region has a higher proportion of labor intensive farming and hence more demand for farm work than for off-farm work.

Labor Market Conditions

The effects of regional labor markets are reflected in the regional dummy variables. Distance to the nearest town also reflects the effects of regional labor market conditions. The study hypothesizes that demand for off-farm labor decreases as the distance to the nearest town increases. The empirical results indicate that the operator's probability of off-farm work increases as the distance increases although the parameter estimates are not statistically significant. However, distance has a statistically significant negative effect on the spouse's probability of off-farm labor participation as hypothesized. The minimum probability occurs when the distance is 52.2 miles. Considering that the average distance to the nearest town is 23.6 miles, most of the spouses are on the decreasing side of the U-shaped curve.

If the operator had difficulty in finding an off-farm job then the operator has a higher probability of off-farm labor participation although the parameter estimate is not statistically significant. However, the same variable has a significant positive effect on the spouse's off-farm labor participation. The results are the reverse of what was expected because difficulty in finding an off-farm job is presumably reflected by a low probability of being employed in off-farm work. A possible hypothesis is that those who are working off-farm have more chances of looking for off-farm jobs and hence are more sensitive in reporting difficulty in finding jobs.

If the operator is non-white then there is a lower probability of off-farm labor participation although the parameter estimate is not statistically significant.

If the spouse is non-white then there is a lower probability of off-farm work and the result is statistically significant. The results reflect either the possibility of racial discrimination in employment or less of a preference for off-farm work by non-whites.

Household Characteristics

The number of dependents increases the operator's probability of off-farm labor participation although the parameter estimate is not statistically significant. Two possible explanations are possible for this phenomenon. First, the number of dependents includes parents and relatives of the operator and hence they substitute for operator's farm work. Second, the number of dependents represents mostly the number of children and the operator receives more pressure to work off-farm as the number of children increases. Spouse's probability of off-farm labor participation decreases as the number of dependents increases. The number of dependents is believed to reflect the number of children and hence spouses need to spend more time on home work as the number of children increases.

If the farm was owned by the household then the operator and spouse have a lower probability of off-farm participation although the parameter estimates are not statistically significant. If the household residence was located in a town area then both operator and spouse have a higher probability of off-farm work although the parameter estimates are not statistically significant. Household members are expected to have more chances of being employed in off-farm work if they resided in a town area.

Other Income

Other income decreases the operator's probability of off-farm labor participation as theory suggests although the parameter estimate is not statistically significant. Spouse's probability of off-farm labor participation increases as other income increases although the parameter estimate is not statistically significant. A possible explanation for the spouse's behavior is that leisure (or home time) substitutes for farm work faster than for off-farm work as other income increases.

The value of land and buildings represents the asset effect on the off-farm labor participation. The variable also reflects people's expectations in general on returns to farming or returns to the asset. Hence, the variable is expected to have a negative effect on off-farm participation. Operator's probability of off-farm work increases as the value of land and buildings increases although the parameter estimate is not statistically significant. Spouse's probability of off-farm labor participation decreases as asset value increases as expected although the parameter estimate is not statistically significant.

Off-Farm Wage Determination Functions

Two types of off-farm wage (offered wage) functions for operator and spouse were estimated by Heckman's two stage procedure. The first equation used only human capital and labor market condition variables following traditional human capital theory in wage determination (Table 11). The second equation included farm and household characteristics and other income variables to test the effects of those variables on wage determination (Table 12).

TABLE 11

HECKMAN'S TWO STAGE RESULTS FOR OFF-FARM WAGE DETERMINATION FOR OPERATOR AND SPOUSE (WITH ONLY HUMAN CAPITAL AND LABOR MARKET VARIABLES)

Parameter	Operator			Spouse		
	Coefficients	t-value		Coefficients	t-value	
CONSTANT	0.7632	1.09		-0.8972	-2.81	**
Commuting Cost (τ^i)						
DISTJ	0.0209	4.27	**	0.0078	0.78	
Human Capital (E^i_m)						
EDUC	1.3491	7.49	**	0.6080	5.88	**
EDUC^2	-0.0321	-3.23	**	0.00099	0.17	
EXPOA	-0.1610	-2.45	**	0.0410	0.79	
EXPOA^2	0.0048	3.75	**	0.00054	0.45	
HEALTH	0.6963	0.81		-0.3697	-0.78	
Labor Market Conditions (ψ^i)						
DIST_T	-0.0921	-3.88	**	-0.0192	-2.06	**
DIST_T	0.00049	2.28	**	0.000038	0.69	
FIND	-1.7466	-1.51		-0.1871	-0.33	
TIME	-0.0545	-0.07		-1.6873	-3.64	**
COVER	2.2058	3.91	**	2.0884	7.13	**
WAD	4.7634	5.69	**	0.2858	0.77	
WTE	1.7617	2.07	**	-0.8034	-1.79	*
WPD	0.5066	0.68		0.4083	0.90	
WSE	5.3837	6.70	**	-0.8047	-1.34	
NONWT	-0.9331	-0.69		-0.6320	-0.85	
R_MIDWE	0.4135	1.91	*	0.6627	2.22	**
R_WEST	0.3396	0.60		0.1407	0.33	
R_NOREA	1.2819	1.25		-0.1209	-0.21	
Correction Factor						
LAMBDA	-0.4025	-0.63		1.0397	2.97	**
Adjusted R^2	0.4821			0.5736		
Number of Observations	1,253			1,284		
Dependent Variable	WAGE_O			WAGE_S		

** Significant at 5 percent level
* Significant at 10 percent level

TABLE 12

HECKMAN'S TWO STAGE RESULTS FOR OFF-FARM WAGE DETERMINATION FOR OPERATOR AND SPOUSE (WITH ALL EXOGENOUS VARIABLES)

Parameter	Operator			Spouse		
	Coefficients	t-value		Coefficients	t-value	
CONSTANT	2.2285	2.95	**	-0.0335	-0.11	
Human Capital (E_m^i)						
EDUC	0.6961	9.16	**	0.5837	14.31	**
EXPF_O	-0.0265	-1.28				
RAISE_O	-1.0138	-1.69	*			
EXPOA	0.0892	3.67	*	0.0287	1.88	*
HEALTH	1.5920	1.77	*	-0.6690	-1.39	
Farm Characteristics (ϕ)						
SAFETY	-1.2724	-0.98		-0.1229	-0.20	
ACRES	-0.000198	-0.11		-0.0032	-3.95	**
ACRES^2	-0.00000054	-1.20		0.00000658	2.45	**
DEPR	-0.060467	-1.09		0.0124285	0.52	
DEPR^2	0.000396	1.15		-0.0000365	-0.23	
T_GRAIN	1.2775	1.52		1.8537	4.18	**
T_BEEF	1.6605	2.78	**	0.5605	1.67	*
T_DAIRY	1.8239	0.99		1.0919	1.80	*
T_LIVST	1.3269	1.26		1.5930	2.68	**
Labor Market Conditions (ψ^i)						
R_MIDWE	-0.2189	-0.35		-0.4511	-1.06	
R_NOREA	-0.2030	-0.19		0.0498	0.15	
R_WEST	0.8996	1.21		-0.4801	-0.84	
DIST_T	-0.0447	-4.07	**	-0.0128	-2.52	**
FIND	-2.1862	-2.04	**	-1.5498	-3.24	**
NONWT	-1.5646	-1.16		-0.7035	-0.94	
Household Characteristics (Γ)						
DEPEND	0.3198	1.68	*	-0.2437	-2.41	**
OWNER	1.5127	1.72	*	1.0999	2.44	**
RESIDE	0.4612	0.61		-0.4353	-1.06	

TABLE 12 (Continued)

Parameter	Operator Coefficients	Operator t-value		Spouse Coefficients	Spouse t-value	
Other Income (V)						
INCOME	0.0621	8.00	**	0.0231	8.72	**
LANBUIL	0.0041	4.81	**	0.00012	0.27	
Correction Factor						
LAMBDA	-2.3201	-2.98	**	-0.1164	-0.39	
Adjusted R^2	0.4862			0.5852		
Number of Observations	1,253			1,284		
Dependent Variable	WAGE_O			WAGE_S		

** Significant at 5 percent level
* Significant at 10 percent level

Human capital theory suggests that offered wage is determined by productivity of an individual and that productivity depends on the human capital stock of the individual. Therefore, in the short run, an individual's wage is determined by his/her human capital stock and local labor market conditions. That is, human capital is evaluated by an employer and a wage is "offered" to the individual. However, the study found that the observed wage is not just an 'offered' wage. Farm and household characteristics and other income characteristics also affect wage determination. This implies that the observed wage is not just exogenously 'offered' but is endogenously determined within the system. Considering that off-farm market wage is observed only when the offered wage is greater than the reservation wage, the observed wage also depends on those variables which affect reservation wage. Therefore, parameter estimates of farm and household characteristics and other income variables reflect the effects on reservation wage.

Human Capital

Formal education has a positive relationship with offered wage of operators (Figure 17 panel 1). The maximum wage occurs when formal education is 20.9 years. Considering that the average formal education of operator is 12.4 years, most operators are on the increasing side of the inverted U-shaped curve. Spouse's formal education also has a positive relationship with offered wage. The parameter estimates are statistically significant except for the spouse's quadratic term.

Off-farm work experience has a U-shaped relationship with operator's offered wage (Figure 17 panel 2). The minimum wage occurs when experience is 16.6 years. Considering that the average experience is 17.9 years, most of the operators are on the increasing side of the U shaped curve. Why offered wage decreases until experience is 16.6 years? The study does not find a clear explanation for this result. Off-farm work experience was expected to have a positive relationship with offered wage because off-farm work experience increases the amount of human capital. People generally begin their career with a given stock of human capital (formal education) and hence the initial offered wage is determined by this initial stock of capital. Yet the stock of human capital is also expected to increase as the years of work experience increases. The parameter estimates of operator's off-farm work experience are all statistically significant. Off-farm work experience also has a positive relationship with spouse's offered wage although the parameter estimates are not statistically significant except for the linear term in Table 12.

If the operator has a health problem then his/her offered wage is higher although the parameter estimate is not statistically significant. If spouse has a health problem then his/her offered wage is lower than those who have no health problem. The parameter estimate is not statistically significant. If one has a health problem then one's productivity is expected to be lower and hence a negative relationship is expected.

Labor Market Conditions

As distance to the nearest town increases the offered wage for the operator decreases (Figure 17 panel 3). The minimum wage occurs when the distance is 93.6 miles. Considering that the average distance to the nearest town is 23.6 miles, most operators are on the decreasing side of the U-shaped curve. Distance also has a negative relationship with spouse's offered wage. This may be interpreted that as distance to the nearest town increases, availability of jobs decreases and hence operators and spouses accept lower offered wage rates. Parameter estimates are statistically significant except for spouse's squared term in Table 11.

If operator or spouse had experienced difficulty in finding an off-farm job then his/her offered wage was lower than those who had not experienced such difficulties although the parameter estimates are not statistically significant except for spouse in Table 12. The result is as expected because difficulty presumably reflects labor demand in local labor markets.

If operator had a time constraint in off-farm work then his/her offered wage is lower than those who had no time constraint but the parameter estimate

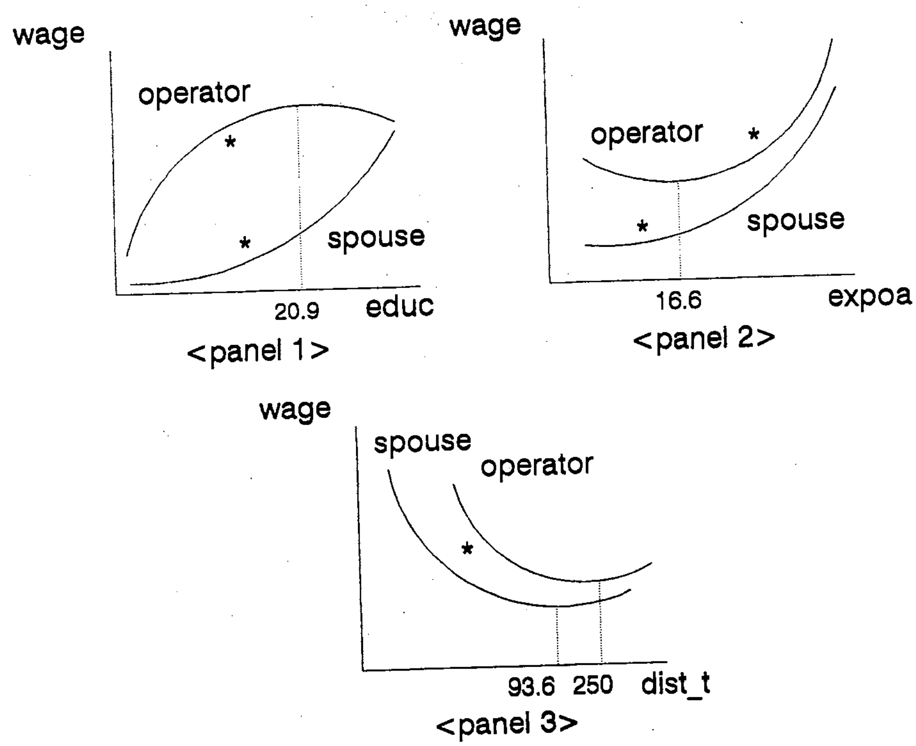

Figure 17. Relationships Between Off-Farm Market Wage of Operator and Spouse and Selected Human Capital and Labor Market Variables.

is not statistically significant. If spouse had a time constraint then his/her offered wage is lower and the parameter estimate is statistically significant. The results are as expected because off-farm time constraints are considered to reflect the lower labor demand in local labor markets.

If operator's or spouse's health insurance covered other household members, then his/her market wage was higher than those whose insurance did not cover other members and the parameter estimates are statistically significant. Considering that insurance coverage is similar to a wage compensation the result seems unacceptable because people are expected to accept a lower wage if additional insurance coverage is offered. However, this may be due to the fact that insurance coverage is highly correlated with type of work such as administrative/professional work where the average wage is much higher than for other types of work.

Market wage of operator in administrative/professional, technical, and service types of work is higher than the wage in "other" type of work and the parameter estimates are statistically significant. Market wage of operator in administrative/professional type work is higher than offered wage in "other" type of work by $4.76 per hour. Market wage in service type work is $5.38 higher and in technical type work is $1.76 higher than the wage in "other" type of work. Market wage in production type work is $0.50 higher than the wage in "other" type but the parameter estimate is not statistically significant. For spouses, market wage in technical type of work is $0.80 lower than "other" type of work and the parameter estimate is statistically significant. Market wage in administrative/professional type work is $0.28 higher, production type work is $0.40 higher, and service type work is $0.80 lower than the market wage in "other" type of work but parameter estimates are not statistically significant. Two explanations are possible for these differences in market wages between professions. First, labor is not perfectly mobile between professions. Second, people have different preferences for professions and hence they accept different pecuniary wages.

If operator's race is non-white then his/her market wage is lower than white people and the same relationship is true for spouses but the parameter estimates are not statistically significant. This indicates that no significant racial discrimination exists in wage determination for operators and spouses.

Regional dummy variables reflect differences in local labor market conditions such as unemployment rate or industry mix. Operators in the Midwest region (Table 11) received $0.41 higher wages than operators in the South region (intercept) and the parameter estimate is significant. Operators in the West region received $0.34 higher and operators in the Northeast region received $1.28 higher wages than operators in the South region but the parameter estimates are not statistically significant. Spouses in the Midwest region received $0.66 higher wages than spouses in the South region and the parameter estimate is statistically significant. Spouses in the West region received $0.14 higher wages and spouses in Northeast region received $0.12 lower wages than spouses in South region but the parameter estimates are not statistically significant. Two explanations are also possible for these regional differences in market wages as in the case of wage differences between professions. First, labor is not perfectly mobile between regions. If labor market conditions are different between regions market wage can be equalized only if labor is perfectly mobile. Second, there exist differences in non-pecuniary benefits such as scenic or psychic benefits between regions and people accept different pecuniary wages according to the level of these non-pecuniary benefits.

The correction variable was calculated which addresses the conditional nature of the market wage function. The correction factor basically reflects those variables which are not included in the model explaining wage determination. The parameter estimate for the correction factor for operators is not statistically significant reflecting that operators who were working had no differentiable characteristics from operators who were not working. However, the parameter estimate for spouses is statistically significant and positive. This implies that if market wage is predicted for those spouses who are not working then they are expected to receive a higher wage than those spouses who are working if other conditions are equal.

Commuting Cost

Commuting cost is reflected in the distance to the off-farm job. Farmers choose to work off-farm when the offered wage is greater than the shadow price for farm labor. Here the offered wage should be evaluated at the farm gate. In other words, farm operators compare shadow price of farm labor and the offered off-farm wage with commuting cost subtracted. Farm operators accept a higher wage as distance to the job increases if other conditions are equal. Hence, distance to the job actually affects the reservation wage rather than the offered wage. The study expects reservation wage to increase as distance to job increases. The signs of the coefficients are as expected for both operator and spouse although the parameter estimate for the spouse is not statistically significant. Offered wage for operator should be $0.02 higher per mile to the job if other conditions are equal.

Farm Characteristics

Cash grain farming; beef, hog, and sheep production; dairy farming; and other livestock production have increased reservation wages for the operator compared to other types of farming but only the parameter estimate of beef, hog, and sheep production is statistically significant (Table 12). The same relationship is true for the spouse but all parameter estimates are statistically significant. Operator's and spouse's reservation wage decreases as the size of cropland increases although the parameter estimates are statistically significant only for spouses. Results are mixed for capital (depreciation) but none of the parameters are statistically significant.

Household Characteristics

Operator's reservation wage increases but spouse's reservation wage decreases as the number of dependents increases. Reservation wage was expected to increase as the number of dependents increases because the value of home time should increase. If the farm was owned by the household then both operator's and spouse's reservation wage increases. Location of residence shows opposite signs for operator and spouse but neither coefficient is statistically significant.

Other Income Variables

Reservation wage for both operator and spouse increases as other income increases and the parameter estimates are statistically significant. The result is as expected because the value of home time increases as other income increases. Reservation wage for both operator and spouse increases as the value of land and buildings increases but the parameter estimate is significant for operator but not for spouse. The results are as expected because asset value has the same effect as other income.

As with the wage functions for operator and spouse, observed wages depend on farm characteristics, household characteristics, and other income variables. The results imply that wage is endogenously determined by the system and not exogenously given. Hence, time allocation of a household is a simultaneous system and not a recursive system.

Fringe Benefit Function

Human Capital

Fringe benefits are regarded as a kind of wage compensation and hence are a function of human capital and regional labor market conditions (Table 13). Human capital variables are shown to be the main determinants of the fringe benefit function for both the operator and spouse. Operator's probability of receiving fringe benefits has a U-shaped relationship with operator's formal education (Figure 18 panel 1). The parameter estimates are statistically significant. Minimum probability occurs when operator's formal education is 13.3 years. Considering that operator's average formal education is 12.4 years, most operator's are on the decreasing side of the U-shaped curve. Spouse's probability of receiving fringe benefits also has a U-shaped relationship with spouse's formal education. Minimum probability occurs when spouse's formal education is 9.5 years. Considering that average formal education of spouse is 12.7 years, most spouses are on the increasing side of the U-shaped curve.

Operator's probability of receiving fringe benefits has an inverted U-shaped relationship with operator's off-farm work experience. Maximum probability occurs when operator's experience is 31.0 years. Considering that average off-farm work experience of operator is 17.8 years, most operators are on the increasing side of the inverted U-shaped curve. Spouse's probability of receiving fringe benefits has the same relationship with spouse's off-farm work experience. These results are generally what was expected except that operator's probability generally has a negative relationship with formal education.

TABLE 13

PROBIT RESULTS OF FRINGE BENEFIT FUNCTIONS
FOR OPERATOR AND SPOUSE

Parameter	Operator			Spouse		
	Coefficients	t-value		Coefficients	t-value	
CONSTANT	0.2761	3.09	**	1.0460	8.67	**
Human Capital (E_m^i)						
EDUC	-0.1439	-3.37	**	-0.2828	-4.77	**
$EDUC^2$	0.0054	2.10	**	0.0148	3.76	**
EXPOA	0.1922	12.48	**	0.2948	8.69	**
$EXPOA^2$	-0.0031	-9.74	**	-0.0058	-7.12	**
Labor Market Conditions (ψ^i)						
FIND	0.4041	1.15		0.8687	1.83	*
NONWT	0.3307	0.61				
R_MIDWE	-0.2744	-1.61		0.3128	1.27	
R_NOREA	0.1281	0.43		-0.4953	-1.38	
R_WEST	0.0911	0.41		-0.4682	-1.52	
Number of Observations	1,253			1,284		
Dependent Variable	INSURE_O			INSURE_S		

** Significant at 5 percent level
* Significant at 10 percent level

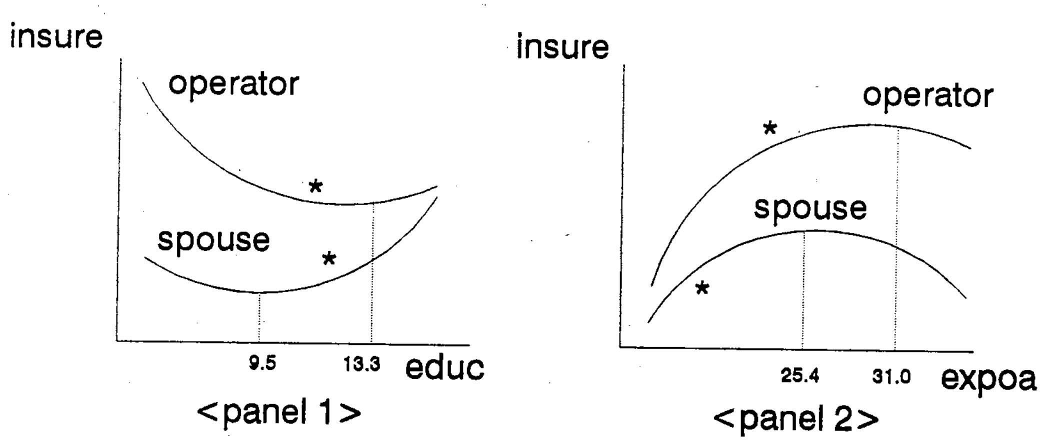

Figure 18. Relationships Between Probability of Receiving Fringe Benefits and Human Capital Variables.

Labor Market Conditions

If operator or spouse has experienced difficulty in finding an off-farm job then he/she has a higher probability of receiving fringe benefits. The parameter estimate is statistically significant for spouses but not for operators. This is presumably due to the fact that those who are working have more experience in finding off-farm jobs and thus may be more prone to indicate difficulty in finding a "better" job. The results are the reverse of those found with the wage functions.

The probability of receiving fringe benefits are not statistically different between regions. Operators in the West and Northeast regions have a higher probability and in the Midwest region have a lower probability of receiving fringe benefits compared to operators in the South region but none of the parameter estimates are statistically significant. Spouses in the Midwest region have a higher probability and spouses in the West and Northeast regions have a lower probability of receiving fringe benefits compared to spouses in the South region but none of the parameter estimates are statistically significant. No a priori expectation exists on regional differences in receiving fringe benefits. Race has no statistically significant effects on receiving fringe benefits for operators.

Farm Labor Demand Functions

Farm labor demand functions are estimated for operator and spouse (Table 14). Predicted values of operator's and spouse's farm labor demand are used in the net revenue function. Because the farm production decision is not independent of the household consumption decision when non-pecuniary benefits are considered, the arguments of farm labor demand are theoretically identical to the arguments of off-farm labor supply. Farm labor is either affected by demand conditions for farm production or affected by the operator's willingness to supply farm labor. This is caused by the fact farm work time affects directly the level of utility by non-pecuniary effects.

Life Cycle Effects

Operators' farm work hours have an inverted U-shaped relationship with operator's age (Figure 19 panel 2). The age parameter estimates are highly significant (Table 14). This coincides with the general life cycle effect. The maximum hours of farm work occurs when operator's age is 45.3. Operators

TABLE 14

WEIGHTED LEAST SQUARES RESULTS FOR
THE FARM LABOR DEMAND FOR
OPERATOR AND SPOUSE

Parameter	Operator			Spouse		
	Coefficients	t-value		Coefficients	t-value	
CONSTANT	0.47473	6.09	**	1.20151	10.83	**
Life Cycle Effect						
AGE	37.7850	7.49	**	26.1631	6.71	**
AGE^2	-0.4171	-7.63	**	-0.3226	-7.42	**
Human Capital $\left(E_f^i, E_m^i, E_h^i\right)$						
EDUC_O	20.3389	2.85	**			
EDUC_S				-12.8537	-2.13	**
EXPF_O	4.7395	3.20	**			
RAISE_O	-9.5409	-0.21				
EXPOA	-13.3760	-9.02	**	-2.7430	-1.80	*
HEALTH	1.2028	0.02		-19.8349	-0.49	
Farm Characteristics (ϕ)						
SAFETY	156.7662	1.90	*	221.5594	3.63	**
ACRES	1.4625	14.13	**	0.0212	0.27	
ACRES^2	-0.000318	-10.73	**	-0.0000218	-0.96	
DEPR	13.6456	6.31	**	9.0282	5.45	**
DEPR	-0.0233	-5.42	**	-0.0138	-4.17	**
T_GRAIN	-30.2156	-0.51		-169.6672	-3.69	**
T_BEEF	122.7771	2.73	**	0.5024	0.01	
T_DAIRY	1385.3884	17.43	**	386.2183	6.49	**
T_LIVST	323.9086	4.05	**	183.5533	2.98	**
Labor Market Characteristics (Ψ^i)						
R_MIDWE	156.4801	3.51	**	153.2067	4.46	**
R_NOREA	49.8423	0.69		39.8937	0.72	
R_WEST	-82.6141	-1.49		67.0387	1.56	
DIST_T	1.9247	2.58	**	2.5809	4.53**	
FIND	-59.6415	-0.69		-14.0016	-0.22	
NONWT	-271.9651	-2.44	**	-82.8395	-1.01	

TABLE 14 (Continued)

Parameter	Operator Coefficients	Operator t-value		Spouse Coefficients	Spouse t-value	
Household Characteristics (Γ)						
DEPEND	-33.9179	-2.32	**	-47.3245	-4.18	**
OWNER	75.8785	1.04		82.9015	1.48	
RESIDE	-894.5066	-1.61		-119.8154	-2.96	**
Other Income (V)						
INCOME	-0.1491	-0.83		-0.1707	-1.29	
LANBUIL	-0.0061	-0.14		-0.0539	-1.68	*
Off-Farm Market Wage						
WAGE	-16.2601	-3.25	**	-21.6131	-3.62	**
$WAGE^2$	0.2188	2.01	**	-0.000157	-0.01	
Adjusted R^2	0.5154			0.1556		
Number of Observations	2,687			2,687		
Dependent Variable	FHR_O			FHR_S		

** Significant at 5 percent level
* Significant at 10 percent level

increase farm work until his/her age reaches 45.3 years and decrease farm work time beyond that point. Considering that the average age of operator is 52.8, most operators are on the decreasing side of the inverted U-shaped curve. Spouse's farm work time has the same relationship with age as for the operator and the parameter estimates are also statistically significant. The maximum farm work time occurs when spouse's age is 40.5. Considering that the average age of spouse is 50.0, most spouses are on the decreasing side of the inverted U-shaped curve.

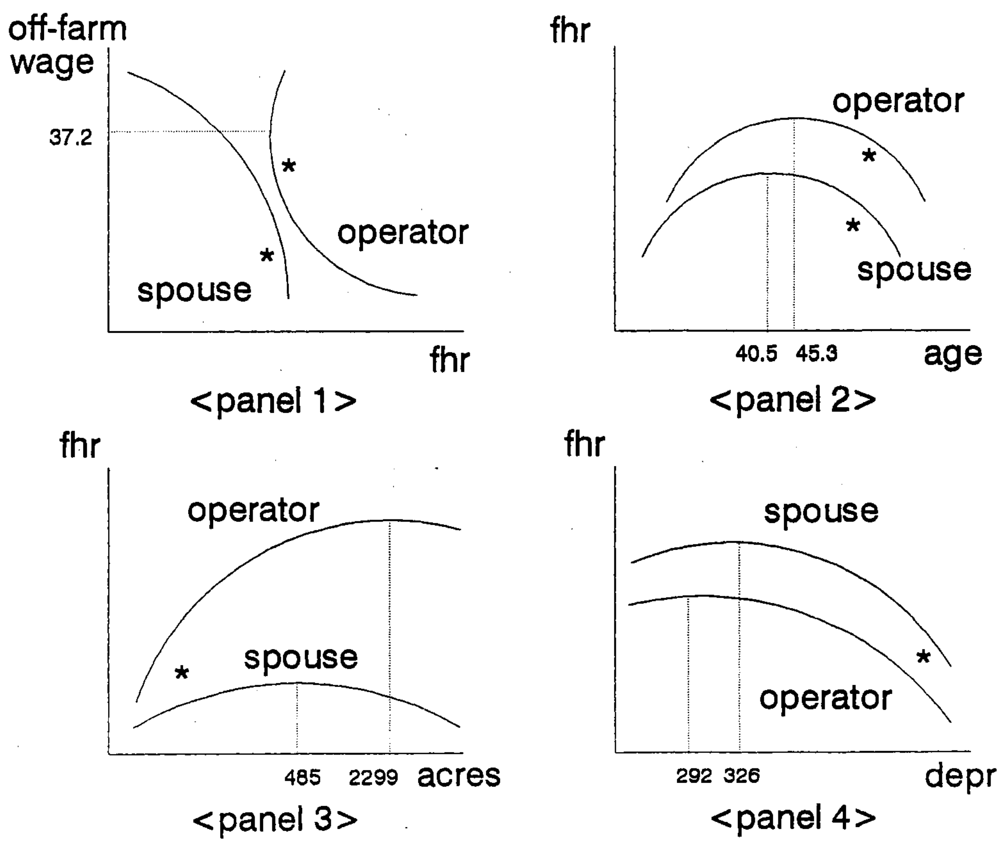

Figure 19. Relationships Between Farm Labor Demand of Operator and Spouse and Age, Off-Farm Wage, Cropping Acreage, and Amount of Capital.

Human Capital

Operators increased their farm work time as their formal education increased and the parameter estimate is statistically significant. Each year of formal education increased annual farm work time by 20.3 hours. However, spouses decreased farm work time as formal education increased and the parameter estimate is statistically significant. Each year of formal education decreased spouse's annual farm work time by 12.8 hours.

Operators and spouses decreased their farm work time as their off-farm work experience increased and the parameter estimates are statistically significant. The results are as expected. Off-farm work experience presumably increases the value of time in off-farm work and hence the expected decrease in farm work time.

Operators increased their farm work time as their farming experience increased. The parameter estimate is statistically significant. The result is as expected. Farming experience increases farm specific human capital and hence the value of time in farm work. If the operator was raised on a farm then he/she decreased farm work time although the parameter estimate is not statistically significant. This was the reverse of what was expected because an operator was expected to have higher farm specific human capital if he/she was raised on a farm. Remembering that operators who were raised on a farm increased off-farm labor participation, this result is quite consistent.

If an operator has health problems then he/she increases farm work time but spouses decrease farm work time if he/she has health problems. The parameter estimates are not statistically significant. Remembering that both operators and spouses decreased off-farm labor participation, it is clear that operators decrease off-farm labor participation and increased farm work time and spouses decrease farm work time and increase home time if they have health problems.

<u>Farm Characteristics</u>

Both operator and spouse increase their farm work time as cropping acreage increases (Figure 19 panel 3). The parameter estimates are significant for operators but not for spouses. Maximum farm work hours for operators occur when crop acreage is 2,299. Considering that the average crop acreage is 163, most of the operators are on the increasing side of the inverted U-shaped curve. Maximum farm work hours for spouses occur when crop acreage is 485, and hence most spouses are on the increasing side of the inverted U-shaped curve. The results coincide with the hypothesis that operator's and spouse's labor are complements to crop land. That is, farm labor demand increases as cropland acreage increases.

However, farm work hours of operators and spouses decrease as the amount of capital increases (Figure 19 panel 4). Maximum farm work hours of operators occurs when the amount of capital (depreciation) is 292. Considering that the average amount of capital (in value of annual depreciation) was 5,405, most operators are on the decreasing side of the inverted U-shaped curve. The same relationship is true for the spouses. The results are consistent with the hypothesis that capital is a substitute for the operator's and spouse's farm labor.

Those operators and spouses whose farming was not safe worked more time on farm than those whose farming was safe. The parameter estimates are statistically significant. These results seem quite contradictory to the fact that both operators and spouses increased their off-farm labor participation when a farming accident occurred. Yet it is explainable when we consider that farming accidents increase as more time is devoted to farm work and hence the positive relationship with farm work time. Increased work time on farm was not the effect but the cause of unsafety of farming.

Operator's and spouse's farm work time have similar relationships with types of farming. Cash grain farming uses less amounts of farm work time compared to other types of farming for both operator and spouse. The parameter estimate is significant for spouses but not significant for operators. Cash grain farming uses 30 hours less of operator labor and 169 hours less of spouse labor than for "other crops" farming. Beef, hog, and sheep production, dairy farming, and other livestock farming use more operator and spouse labor compared to "other crops" farming. Most of the parameter estimates are statistically significant. Beef, hog, and sheep production uses 123 more hours of operator labor but about the same amount of spouse labor compared to "other crops" farming. Dairy farming uses 1,385 more hours of operator labor and 386 more hours of spouse labor compared to "other crops" farming. Other livestock production uses 324 more hours of operator labor and 184 more hours of spouse labor compared to "other crops" farming. The results reflect that cash grain farming is land intensive and hence labor extensive farming and that beef, hog, and sheep production, dairy farming, and other livestock production are more labor intensive and hence land extensive farming.

Regional dummy variables reflect differences in farming conditions such as the annual amount of precipitation or temperature. Regional dummy variables also reflect differences in local labor market conditions. For example, if a region has high labor demand and hence has a higher wage level than another region, then farmers in that region will use less time in farming and more time off-farm. Farming in the Midwestern region uses more labor of operator and spouse compared to the South. The parameter estimates are statistically significant. Operators in the Midwest region use 156 hours of operator labor and 153 hours of spouse labor on farming more than in the South region. One possible hypothesis is that the opportunity cost of farm work, that is the off-farm wage, is lower in the Midwest region compared to the South region. The West region useless of operator's labor and more of spouse's labor compared to the South but the parameter estimates are not significant. The Northeast region uses more operator and spouse labor compared to the South but the parameter estimates are also not significant.

Labor Market Conditions

As distance to the nearest town (population greater than 50,000) increases both operators and spouses use more farm labor and the parameter estimates are statistically significant. Operators increase 1.9 hours and spouses increase 2.5 hours of farm work time as distance to the town increases by one mile. The result is as expected. Distance to the nearest town presumably reduces off-farm labor demand and hence the opportunity cost of farm work decreases.

If operator or spouse had experience of difficulty in finding off-farm job, then he/she uses less time in farm work. The result is the reverse of what was expected but the result is consistent with the fact that operators and spouses increased off-farm labor participation when they had the same experience. Farm operators and spouses who work more time off-farm and hence less time on-farm would have more perceptions in determining difficulty of finding off-farm jobs.

If the operator was non-white then he/she worked less time on farm work and the parameter estimate is statistically significant. Non-white operators worked 272 hours less on farm than white operators. Spouses also worked less amount of time in farm work if he/she was non-white but the parameter estimate is not significant. Two explanations are possible. First, non-whites have higher productivity in off-farm work compared to farm work and hence they allocate more time to off-farm work and less to farm work. Second, non-whites have higher preference for off-farm work compared to farm work than do whites.

Household Characteristics

If operator or spouse has more dependents then he/she worked less amount of time in farm work. The parameter estimates are statistically significant. Operators worked 34 hours less and spouses worked 47 hours less on farm work for each additional dependent. Two interpretations are possible. If the number of dependents represents the number of grown-ups such as parents and relatives then they substitute for the operator's and spouse's farm work and hence make it possible for them to work more time off-farm. If the variable represents the number of children then operators presumably need to work off-farm to make additional income and spouses are believed to spend more time on home time.

If the farm was owned by the household then the operator and spouse worked more time on farm but the parameter estimates are not significant. Ownership presumably increases the non-pecuniary benefits from farm work and therefore is believed to increase farm work time.

If the operator and spouse resided in town then both decreased farm work time. The parameter estimate was significant for the spouse but not for the operator. Spouses worked 120 hours less on farm if he/she resided in town. The results are as expected because farm operators and spouses are expected to have more opportunity for off-farm work if they reside in town. These results coincide with the fact that the probability of off-farm labor participation increases when they reside in town.

Other Income

If other income increases, both operator and spouse reduce their farm work time although the parameter estimates are not significant. The results are as expected. Farm operators and spouses are expected to reduce total work time when other sources of income increase and hence farm work time is also expected to decrease.

The variable total value of land and buildings presumably represents people's general expectation on the future returns to farming or returns to the asset. Two opposing effects are expected. First, if farmers expect increases in future returns then they are expected to decrease total work time and hence farm work time is also expected to decrease. This is the income effect. Second, if farmers expect increases in returns to farm assets then they allocate more time to farm work and less to off-farm work. This is the substitution effect. The results indicate that the income effect dominates the substitution effect although the parameter estimates are significant only for the spouse.

Off-farm Wage

Actual observed off-farm wage was used if the operator or spouse was working off-farm and the predicted offered wage was used if the individual was not working off-farm. Operator's farm work time has the U-shape relationship with off-farm wage and the parameter estimates are statistically significant. The minimum farm work time occurs when the off-farm wage is $37.20 per hour (Figure 19 panel 1). Considering that the average off-farm wage of operator is $29.60 per hour, most operators are on the decreasing side of the U-shaped curve. Spouse's farm work time also has a negative relationship with off-farm wage and the parameter estimates are significant for the linear term but not for the squared term implying that spouse's farm work time has a strong linear relationship with off-farm wage. The results are as expected. Farm operators and spouses are expected to decrease their farm work time as their opportunity cost increases.

Net Revenue Function

Labor, Land, and Capital

Net revenue shows a positive relationship with operator's farm work time. Excluding the interaction terms, parameter estimates with operator labor are statistically significant only in the linear term (Table 15). The relationship of operator's farm work time with net revenue, hence the productivity of operator's labor, depends on the level of other inputs such as spouse's labor, other unpaid labor, land, and capital:

$$\begin{aligned} NETREV = C & + (0.0272 - 0.000003962 * FHR\_S - 0.000002706 * FHR\_3 \\ & + 0.000027645 * ACRES + 0.000563137 * DEPR) * FHR\_O \\ & - 0.000009273 * FHR\_O^2 + 0.000000001\ FHR\_O^3 \end{aligned}$$

where C represents mean values of other inputs. The net revenue has the following relationship with operator's farm work hours:

$$\begin{aligned} NETREV = C & + 0.032189 * FHR\_O - 0.000009273 * FHR\_O^2 \\ & + 0.000000001 * FFHR\_O^3 \end{aligned}$$

TABLE 15

TWO-STAGE LEAST SQAURES RESULTS
FOR THE NET REVENUE FUNCTION

Parameter	Coefficients	t-value	
CONSTANT	-12.866633613	-2.00	**
Labor Input (T_f^i)			
(Predicted)			
FHR_O	0.027209722	1.72	*
FHR_O^2	-0.000009273	-1.15	
FHR_O^3	0.000000001	0.85	
FHR_S	0.015756325	0.66	
FHR_S^2	-0.000030665	-0.63	
FHR_S^3	0.000000003	0.09	
(Observed)			
FHR_3	0.002851691	0.47	
FHR_3^2	0.000000917	0.69	
FHR_3^3	-0.000000001	-1.83	*
Land Input (Ld)			
ACRES	-0.099117755	-3.62	**
ACRES^2	0.000000934	0.17	
Capital Input (k)			
DEPR	-1.461782288	-2.45	**
DEPR^2	-0.002608461	-3.10	**
Interaction of Inputs (With predicted farm operator and spouse labor)			
FHR_O * FHR_S	-0.000003962	-3.80	**
FHR_O * FHR_3	-0.000002706	-1.48	
FHR_O * ACRES	0.000027645	3.60	**
FHR_O * DEPR	0.000563137	2.77	**
FHR_S * FHR_3	0.000002143	1.00	
FHR_S * ACRES	0.000010931	1.20	
FHR_S * DEPR	0.000855003	3.81	**
FHR_3 * ACRES	0.000015704	5.22	**
FHR_3 * DEPR	-0.000100854	-1.43	
ACRES * DEPR	0.000337300	8.46	**

TABLE 15 (Continued)

Parameter	Coefficients	t-value	
Human Capital (E_f^i)			
EDUC_O	-1.3571	-0.86	
EDUC_O^2	0.0806	1.01	
EXPF_O	0.4974	1.21	
EXPF_O^2	-0.0050	-0.83	
RAISE_O	-0.2333	-0.04	
HEALTH_O	-4.3274	-0.81	
HEALTH_S	1.6496	0.28	
Farm Characteristics (ϕ)			
SAFETY	-0.7794	-0.08	
T_GRAIN	-7.4354	-1.06	
T_BEEF (Hogs, Sheep)	-8.5058	-1.77	*
T_DAIRY	2.1982	0.14	
T_LIVST (Other)	-10.4787	-1.15	
R_MIDWE	0.6663	0.12	
R_NOREA	0.5219	0.06	
R_WEST	-1.2367	-0.20	
Adjusted R^2	0.1718		
Number of Observations	2,867		
Dependent Variable	NETREV		

** Significant at 5 percent level
* Significant at 10 percent level

Maximum net revenue occurs when operator's farm work time is around 2,400 hours (Figure 20 panel 1). Considering that the average farm work hours of operator was 1,566 hours per year, most of the operators were in the 'second stage' of the traditional production function. We remember that, in the B group of farm households where spouse only work off-farm, operators work 2,429 hours on farm per year. This does not mean that they are in the third stage of production. Considering that the B group has the greatest level of crop land and capital, the maximum net revenue occurs when operator's labor is greater than 2,400 hours implying that most operators in that group are believed to be in the second stage of production. Net revenue has a negative relationship with spouse's farm work time but none of the parameter estimates are statistically significant. Following the same procedure as above, the relationships of farm work time of spouse and other unpaid workers with net revenue are given as follows:

$$NETREV = C + 0.016696 * FHR\_S - 0000030665 * FHR\_S^2 + 0.000000003 * FHR\_S^3$$

$$NETREV = C + 0.001507 * FHR\_3 + 0.000000917 * FHR\_3^2 - 0.000000001 * FHR\_3^3$$

Maximum net revenue occurs when spouse's farm work time is around 250 hours. Considering that the average farm work hours of spouse was 410 hours per year, most of the spouses are on the decreasing side of the production function. The result is consistent with the fact that 39.5 percent of spouses (1,061 out of 2,687) made negative marginal value product in farming while only 0.6 percent of operators (17 out of 2,687) made negative marginal value product in farming. Net revenue has a positive relationship with farm work time of other unpaid labor but none of the parameter estimates are statistically significant. Maximum net revenue occurs when farm work time of other unpaid labor is around 1,400 hours per year. Considering that the average farm work hours of other unpaid labor was 346 hours per year, most of the other unpaid labor is in the 'second stage' of the traditional production function.

Why were many of the spouses working on the decreasing side of the production function? They were working more time than was required in terms of profit maximization level. One possible hypothesis is that spouse's labor demand is not independent of the consumption decision. That is, spouse's farm work time depends more on the household characteristics as well as farm characteristics than does operator's farm labor.

Net revenue was found to have a positive relationship with cropping acreage and most of the parameter estimates are statistically significant. If we don't consider interaction terms between farm land and other farm inputs, then net revenue seems to have a negative relationship with cropping acreage. However, the relationship of net revenue with cropping acreage depends on the level of other inputs:

$$\begin{aligned} NETREV \;=\; C &+ (-\,0.09911 + 0.0000276 * FHR\_O + 0.0000109 * FHR\_S \\ &+ 0.0000157 * FHR\_3 + 0.000337*DEPR) *ACRES \\ &+ 0.000000934*ACRES^{\wedge}2 \end{aligned}$$

where C represents other inputs which is constant. When the mean values of other inputs are applied the net revenue has the following relationship with cropping acreage:

$$NETREV = C + 1.77557\ ACRES + 0.000000934\ ACRES^{\wedge}2$$

The above equation implies that net revenue has a positive relationship with cropping acreage and the marginal value product of crop land is on the increasing side of the U-shaped curve (Figure 20 panel 2). In other words, crop land is being used in the first stage of the production function.

Net revenue has a negative relationship with the amount of capital in farm production and most of the capital related parameter estimates are statistically significant. The relationship of net revenue with the amount of capital also depends on the amount of other inputs used:

$$NETREV = C + (-1.46178 + 0.000563*FHR\_O + 0.000855*FHR\_S - 0.0001*FHR\_3 + 0.000337*ACRES)*DEPR - 0.0026*DEPR^2$$

When the mean values of other inputs are applied, the net revenue has the following relationship with the amount of capital input:

$$NETREV = C - 0.20903 * DEPR - 0.0026 * DEPR^2$$

The above equation indicates that net revenue has a negative relationship with the amount of capital when the mean values are applied for other input use (Figure 20 panel 3). On average, capital is believed to be used in the third stage of production. In other words, farm capital is excessively supplied for the average U.S. farm household.

Signs of parameter estimates for interaction terms show whether the two farm inputs are substitutes or complements. Crop land is a complement to all other inputs including all types of labor. Capital is a complement to operator's and spouse's labor but is a substitute for other unpaid labor. Operator's labor is a substitute for spouse's and other unpaid labor. Crop land and capital are complements.

<u>Human Capital</u>

Net revenue has a U-shaped relationship with formal education of operators but the parameter estimates are not statistically significant (Table 15 and Figure 20 panel 4). Spouse's formal education was not used because the variable is highly correlated with operator's formal education. Hence, operator's formal education represents the common education level of the family in general. Minimum net revenue occurs when operator's formal education is 8.4 years. Considering that average formal education is 12.4 years for operators and 12.7 years for spouse, most farm operators and spouses are on the increasing side of the U-shaped curve. These results are as expected.

Net revenue has an inverted U-shape relationship with farming experience of operator but the parameter estimates are not statistically significant (Figure 20 panel 5). Maximum net revenue occurs when farming experience is 49.2 years. Considering that average farming experience of operator is 30.3 years, most operators were on the increasing side of the inverted U-shaped curve. The results are as expected because farming experience is expected to increase farm specific human capital stock.

If operator was raised on a farm then net revenue is smaller than for those who were not raised on a farm but the parameter estimate is not statistically significant. The result is the reverse of what was expected but is consistent with the result that those who were raised on a farm worked less amount of time on farm.

If operator had health problems then net revenue decreased but net revenue increased if spouse had health problems. The parameter estimates, however, are not statistically significant. Net revenue is expected to have a negative relationship with health problems because health problems decrease farm specific human capital.

Farm Characteristics

Types of farming represent differences in productivity in terms of net revenue between farm types when other conditions are equal. Other livestock;

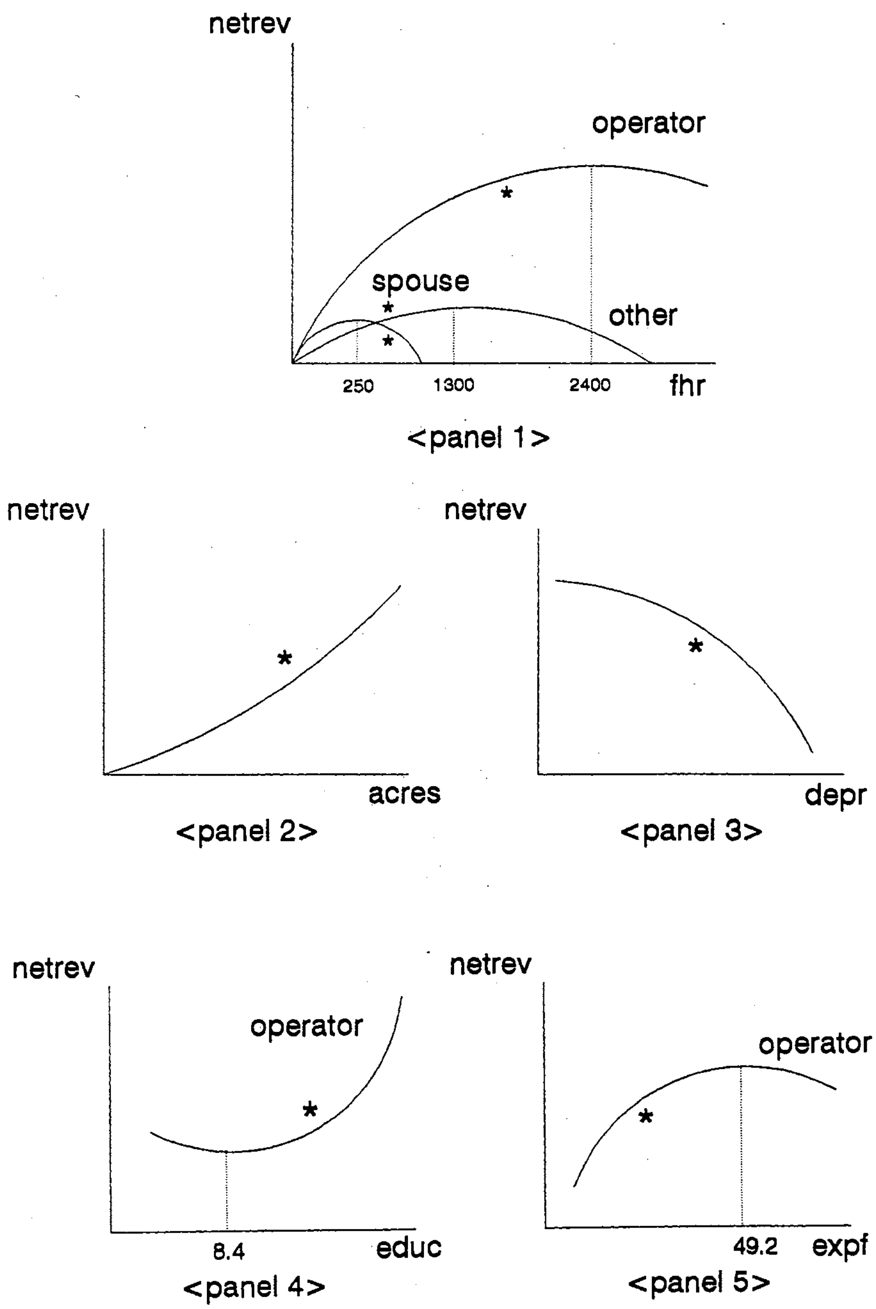

Figure 20. Relationships Between Net Revenue and Farm Input Variables.

beef, hogs, and sheep production; and cash grains all have lower net revenues compared to "other crops" farming but only beef, hogs, and sheep production is statistically significant. Dairy has higher net revenue compared to "other crops" farming but the parameter estimate is not statistically significant. Differences in net revenue between farm types reflect that resources are not perfectly mobile between types of farm.

Regional differences in farm characteristics such as climate and precipitation have no statistically significant effects on net farm revenue. This reflects that farm production does not wholly depend on natural conditions in the U.S. and hence regional differences matter little. The incidence of farm safety is not statistically significant in effecting net farm returns.

Off-Farm Labor Supply Functions

Heckman's two stage procedure was used in the estimation of off-farm labor supply functions for operator and spouse to address the non-negativity of the dependent variable (Table 16). Actual values for off-farm market wage were included in the estimation.

Life Cycle Effect

Off-farm labor supply for both operator and spouse have an inverted U-shape relationship with age (Figure 21 panel 2). The parameter estimates are highly significant. Maximum hours of off-farm labor supply for the operator occur at age 37.8 years and for the spouse at 37.1 years. Considering that the average ages were 52.8 for operator and 50.0 for spouse, both operator and spouse are on the decreasing side of the inverted U-shaped curve. The results coincide with the general life cycle hypothesis. Remembering that farm work

TABLE 16

HECKMAN'S TWO STAGE RESULTS FOR THE OFF-FARM LABOR SUPPLY FUNCTIONS FOR OPERATOR AND SPOUSE

Parameter	Operator			Spouse		
	Coefficients	t-value		Coefficients	t-value	
CONSTANT	-495.1310	-4.88	**	-184.6637	-3.24	**
Life Cycle Effect						
AGE	106.9203	16.87	**	87.3381	13.61	**
AGE^2	-1.4116	-15.36	**	-1.1784	-13.61	**
Human Capital (E_f^i, E_m^i, E_h^i)						
EDUC_O	26.6717	3.23	**			
EDUC_S				-18.9495	-2.14	**
EXPF_O	-1.3390	-0.76				
RAISE_O	67.0337	1.37				
EXPOA	20.1069	5.26	**	22.0637	6.69	**
HEALTH	-515.7500	-6.59	**	188.2867	2.66	**
Farm Characteristics (ϕ)						
SAFETY	371.1928	3.60	**	-151.5441	-1.69	*
$ACRES^2$	-0.9652	-6.80	**	0.3058	2.53	**
ACRES	0.000206	5.34	**	-0.000048	-1.23	
DEPR	-17.7775	-3.93	**	-12.4645	-3.56	**
$DEPR^2$	0.0603	2.21	**	0.0539	2.38	**
T_GRAIN	37.8064	0.55		-40.3993	-0.61	
T_BEEF	93.4006	1.88	*	-40.8222	-0.80	
T_DAIRY	-765.0687	-4.76	**	-165.6479	-1.85	*
T_LIVST	-10.1371	-0.11		-28.3563	-0.32	
Labor Market conditions (ψ^i)						
R_MIDWE	43.1055	0.86		26.2220	0.54	
R_NOREA	81.5729	0.97		70.8050	0.84	
R_WEST	-89.9401	-1.51		113.2830	1.82	*
DIST_T	-0.7505	-0.83		0.4846	0.64	
FIND	-258.5102	-3.01	**	-315.9950	-4.48	**
NONWT	92.1831	0.85		-93.5961	-0.85	
Household Characteristics (Γ)						
DEPEND	-66.0191	-4.22	**	-44.5033	-2.74	**
OWNER	-57.8938	-0.73		368.7047	5.10	**
RESIDE	12.2566	0.20		38.8871	0.64	

TABLE 16 (Continued)

Parameter	Operator			Spouse		
	Coefficients	t-value		Coefficients	t-value	
Other Income (V)						
INCOME	-0.4098	-0.63		0.6037	1.48	
LANBUIL	0.2257	3.26	**	-0.0128	-0.19	
Market Wage						
WAGE	-2.1626	-0.45		7.6467	0.99	
$WAGE^2$	-0.2609	-2.57		-0.4383	-1.59	
Correction Factor						
LAMBDA	573.83	4.92	**	129.7444	2.11	**
Adjusted R^2	0.7311			0.6855		
Number of Observations	1,253			1,284		
Dependent Variable	OHR_O			OHR_S		

** Significant at 5 percent level
* Significant at 10 percent level

time also followed an inverted U-shape curve and that maximum hours of farm work occurred when operator was 45.3 years and spouse was 40.5 years, the turning points for off-farm work are at younger ages than for farm work.

Human Capital

Operator's off-farm work time has a positive relationship with operator's formal education and the parameter estimate is statistically significant. However, spouse's off-farm work has a negative relationship with spouse's formal education and the parameter estimate is also significant. Remembering

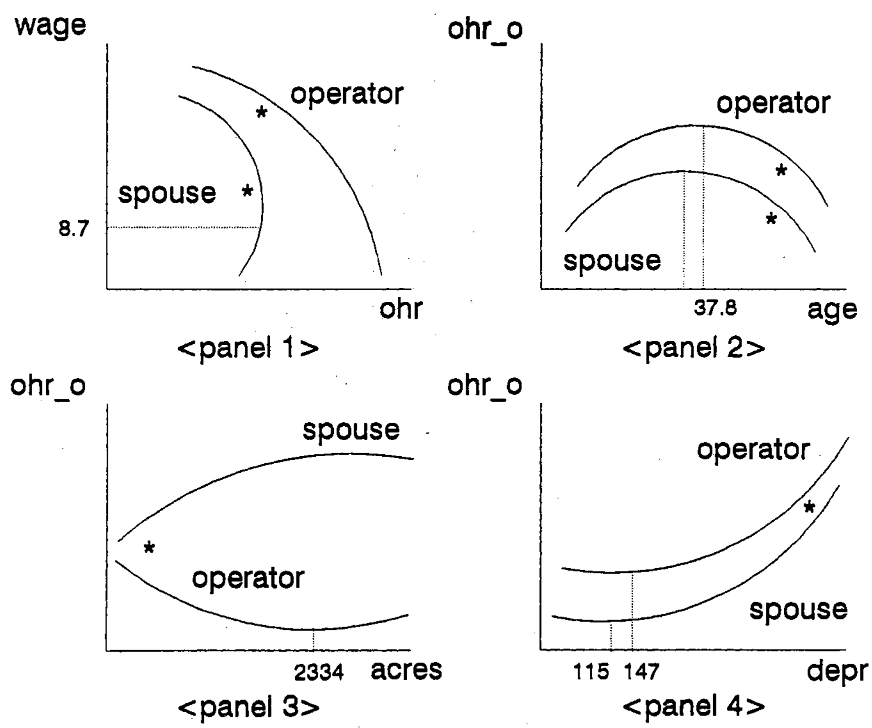

Figure 21. Relationships Between Off-Farm Work Time and Age, Acreage, Capital, and Market Wage.

that operator's farm work time had a positive relationship with operator's formal education and spouse's farm work time had a negative relationship with spouse's formal education, we can conclude that operators increase farm and off-farm work time (and hence total work time) as their formal education increases and spouses decrease farm and off-farm work time (and hence total work time) as their formal education increases. Operators increased 20.3 hours of annual farm work time and 26.6 hours of off-farm annual work time for each additional year of formal education. Spouses decreased 12.8 hours of annual farm work time and 18.9 hours of annual off-farm work time for each additional year of formal education.

Operator's off-farm work time has a negative relationship with operator's experience in farm work but the parameter estimate is not statistically significant. The result is as expected and consistent with the fact that operator's farm work time has a positive relationship with operator's experience in farm work.

If an operator is raised on a farm then he/she worked more time on off-farm although the parameter estimate is not statistically significant. The result is the reverse of what was expected but consistent with the fact that farm work time decreased when an operator was raised on a farm.

Both operator's and spouse's off-farm work time have positive and significant relationships with off-farm work experience. These results are as expected because off-farm experience is expected to increase off-farm specific human capital and hence increase the value of off-farm work time. The results are also consistent with the fact that farm work time for both operator and spouse have negative relationships with off-farm work experience. Operators decreased annual farm work time by 13.3 hours and increased annual off-farm work time by 20.1 hours for each additional year of off-farm work experience.

Spouses decreased annual farm work time by 2.7 hours and increased annual off-farm work time by 22.0 hours for each additional year of off-farm work experience.

Operators decreased off-farm work time when they had health problems. The parameter estimate is statistically significant. However, spouses increased off-farm work time when they had health problems and the parameter estimate is also statistically significant. Considering the results from the farm labor demand functions, we can conclude that operators increase farm work and decrease off-farm work time when they have health problems and spouses decrease farm work time and increase off-farm work time when they have health problems. Operators with health problems on average worked 516 fewer hours per year in off-farm work and spouses with health problems worked 188 hours more per year in off-farm work. Both operators and spouses are expected to decrease both farm and off-farm work time and to increase home time if they have health problems. Why do spouses increase off-farm work time when they have health problems? One possible hypothesis is that spouses are not healthy because they work more time. Increased work time off-farm is not the effect but the cause of health problems. They are not healthy because they work 188 more hours off-farm.

Farm Characteristics

Operator's off-farm work time has a U-shape relationship with cropping acreage and the parameter estimates are statistically significant. Minimum off-farm work occurs when crop acreage is 2,334 (Figure 21 panel 3). Considering that the average acreage is 163, most operators are on the decreasing side of the U-shaped curve. However, spouse's off-farm work time has an inverted U-shape relationship with acreage and the parameter estimates are statistically significant in the linear term. Maximum off-farm work time occurs when crop acreage is 3,146 which implies that most of the spouses are on the increasing side of the inverted U-shaped curve. Remembering the results for farm labor demand, we can conclude that operators increase farm work time and decrease off-farm work time and spouses increase both farm and off-farm work time as acreage increases. The results are as expected for the operators but why do spouses increase off-farm work time when acreage increases? One possible hypothesis is that hired labor substitutes for spouse's labor as crop acreage increases.

Both operator's and spouse's off-farm work time have U-shaped relationships with the amount of capital in farming and all parameter estimates are statistically significant . Minimum off-farm work time occurs when the amount of capital depreciation is $147 for the operators and $115 for the spouses (Figure 21 panel 4). Considering that the average amount of capital depreciation is $5,405 (in annual depreciation value), most of the operators and spouses are on the increasing side of the U-shaped curve. Remembering the results for farm labor demand, we can conclude that both operators and spouses decrease farm work time and increase off-farm work time as the amount of capital increases in farming. This implies that capital is a substitute for both operator's and spouse's farm labor.

If farm accidents occurred, then operators worked more time but spouses worked less time off-farm. The parameter estimates are statistically significant. The results are as expected for operators but not for spouses. Farm operators are expected to work less time on farm and more time off-farm if farming accidents occurred. However, operators spend more time on-farm if farm accidents occurred. One possible hypothesis is that operators have more accidents in farming when they work more amount of time in farming. For example, those operators who experienced at least one accident in farming worked 156 hours more on farm work and 371 hours more on off-farm work than those who did not experience an accident in farming. Safety in farm work is the result of and not the cause of additional farm work.

Type of farming also has significant effects on time allocation of farmers. Operators worked more off-farm when the type of farming was cash grains and beef, hog, and sheep production and they worked less off-farm when the type of farming was dairy or other livestock production. Parameter estimates are significant for dairy production and beef, hog, and sheep production but are not sifnificant for cash grains and other livestock production. Spouses worked less off-farm for all types of farming when compared to "other crop" farming (which is reflected in the intercept term). The parameter estimates are significant only for dairy farming.

Considering the results of both farm and off-farm labor demand, we can conclude that (1) dairy production and other livestock farming are the most labor intensive farming for both operator and spouse; (2) seasonallity of beef, hog, and sheep production make it possible for operators to work more time both on and off-farm; and (3) cash grain farming used less operator and spouse labor compared to "other crops" farming which is reflected in the intercept term. Operators in dairy farming worked 1,385 more hours on farm and 765 fewer hours off-farm compared to "other crops" farming. Spouses in dairy farming worked 386 more hours on farm and 165 fewer hours off-farm compared to "other crops" farming. Operators in beef, hog, and sheep production worked 122 more hours on farm and also worked 93 more hours off-farm.

Regional dummy variables reflect differences in farm characteristics and local labor market conditions. Operators in the West region worked fewer hours off-farm compared to the South region but the parameter estimate is not statistically significant. Operators in the Midwest and Northeast regions worked more hours off-farm compared to the South region and parameter estimates are also not statistically significant. Considering the results for both farm and off-farm labor demand, we can conclude that operators in the West region worked fewer hours both on-farm and off-farm compared to operators in the South region and operators in the Midwest and Northeast regions worked more hours both on farm and off-farm compared to operators in South region. Spouses in the West, Midwest, and Northeast regions worked more hours off-farm compared to spouses in the South region but none of the parameter estimates are statistically significant. Considering the results of both farm and off-farm labor demand, we can conclude that spouses in the West, Midwest, and Northeast regions worked more hours both on-farm and off-farm compared to spouses in the South region. Spouses in the West region worked 113 more hours off-farm than spouses in the South region. Total work time of spouses in the South was the lowest of all regions and total work time of operators in the West was the lowest for all regions, other conditions equal.

Labor Market Conditions

As distance to the nearest town increases operators worked fewer hours off-farm and spouses worked more hours off-farm but the parameter estimates are not statistically significant. Off-farm work time is expected to decrease as distance to the nearest town increases because labor demand for off-farm work is expected to decrease as distance increases.

If operator or spouse experienced difficulty in finding an off-farm job then he/she worked fewer hours off-farm. The parameter estimates are statistically significant. The results are as expected. Operators who had such an experience worked 259 fewer hours off-farm and spouses who had such an experience worked 316 fewer hours off-farm.

If the operator was non-white then he/she worked more hours off-farm and if spouse was non-white then he/she worked fewer hours off-farm but the parameter estimates are not statistically significant. No a priori expectation exists on the effect of race on off-farm labor supply.

Household Characteristics

Both operator's and spouse's off-farm work time have negative relationships with the number of dependents and the parameter estimates are statistically significant. Considering the results of both farm and off-farm labor demand, we can conclude that both operator and spouse decrease farm and off-farm work time (hence total work time) and hence increase home time as the number of dependents increase. Therefore, the dependents are believed to represent more the number of children rather than number of grown-ups such as parents and relatives.

If a farm is owned by the household then the operator worked less time off-farm but the parameter estimate is not statistically significant. Yet spouse worked more off-farm if the farm is owned by the household and the parameter estimate is statistically significant. No a priori expectation exists on the effect of ownership on off-farm work time.

If the housheold residence is located in town then both operator and spouse worked more time off-farm but the parameter estimates are not statistically significant. Considering the results of both farm and off-farm labor demand, we can conclude that operators and spouses decrease farm work time and increase off-farm work time if the household residence is located in town. The results are as expected because household members are expected to have more opportunities to work off-farm.

Other Income

Operators work fewer hours off-farm and spouses work more hours off-farm if other income increases but the parameter estimates are not statistically significant. Considering the results of both farm and off-farm labor demand, we can conclude that operators decrease farm and off-farm work time (hence total work time) and spouses decrease farm work time but increase off-farm work time as other income increases. Total work time is expected to have a negative relationship with other income because home time (leisure) is expected to be a normal good.

Operators work more hours off-farm as the value of land and buildings increases and the parameter estimate is statistically significant. However, spouses work fewer hours off-farm as the value of land and buildings increases but the parameter estimate is not statistically significant. Farm operators are expected to decrease work time (especially off-farm work time) as the value of land and buildings increases because the variable presumably represents future returns to farming or returns to the asset.

Off-farm Wage

Off-farm work time of operator has a negative relationship with off-farm wage rate. The parameter estimate for the quadratic term is statistically significant. However, off-farm work time of spouse has an inverted U-shape relationship with off-farm wage rate but the parameter estimates are not statistically significant. Maximum off-farm work of spouse occurs when the off-farm wage is $8.70 per hour (Figure 21 panel 1). Considering that the average off-farm wage for spouse is $5.00 per hour, most spouses are on the increasing side of the inverted U-shaped curve. Off-farm work time of operator and spouse is expected to have a positive relationship with off-farm wage rate. Then why does the operator's off-farm work time have a negative relationship with off-farm wage rate? One possible hypothesis is in the approach to calculating the off-farm wage. The off-farm wage was not directly surveyed but was indirectly calculated based on information on total off-farm work time and total off-farm labor income. Off-farm wage is calculated by:

Off-farm wage rate of operator(spouse) = Off-farm labor income of operator(spouse) /total annual off-farm work time of operator (spouse). Therefore, off-farm wage calculated could show the propensity of inverse relationship with off-farm work time. The second hypothesis is that farmer's off-farm labor supply is on the backward bending curve. If off-farm work time and off-farm labor income as surveyed are assumed to be unbiased, then the estimated inverse relationship between off-farm wage rate and off-farm work time reflects a backward bending off-farm labor supply curve.

Correction Factor

The correction factors for both operator and spouse are positive and significantly different from zero which implies that selectivity bias exists. The positiveness of the parameter estimates imply that, if off-farm work time is predicted for those who are not working off-farm, they will work more time than those who are working if other measured conditions are equal.

Difference Function

The difference function is estimated to capture the non-pecuniary effect of labor supply from changes in exogenous variables. The dependent variable is the difference between actual (but also predicted) off-farm labor supply and predicted off-farm labor supply when the off-farm wage rate (offered wage) is set equal to the marginal value product of farm labor. The dependent variable 'difference' is calculated by the following steps:

(1) Off-farm labor supply of operator and spouse is predicted using the parameter estimates for off-farm wage rate and other exogenous variables as shown in Table 16. The estimated equations for operator and spouse can be expressed as follows:

$$OHR\_O = C_1X - 2.1626*WAGE\_O - 0.2609*WAGE\_O^2$$
$$OHR\_S = C_2X + 7.6467*WAGE\_S - 0.4383*WAGE\_S^2$$

where X denotes a vector of exogenous variables and C_1 and C_2 denote vectors of estimated coefficients. If we apply actual operator and spouse values for the off-farm wage rate and the other exogenous variables to the above estimated equations, then we obtain predicted values of actual off-farm labor supply for all observations. Therefore, OHR_O and OHR_S in the above equations imply the predicted values because error terms are omitted.

(2) The farm net revenue function from Table 15 is used to set up the marginal value product of farm labor equations for operator and spouse:

$$MVP\_O = (0.0272 - 0.000003962*FHR\_S - 0.0000002706*FHR\_3 + 0.000027645*ACRES + 0.000563137*DEPR) - 0.000018546*FHR\_O + 0.000000003*FHR\_O^2$$

$MVP\_S = (0.015756 - 0.000003962*FHR\_O + 0.000002143*FHR\_3 + 0.000010931*ACRES + 0.000855003*DEPR) - 0.00006133*FHR\_S + 0.000000009*FHR\_S^2$

As we see from the above equations, the marginal value product of the operator's (spouse's) farm labor depends on the levels of the spouse's and operator's farm labor and other farm inputs but it is independent of the other exogenous variables. Applying the actual values for farm work time of operator and spouse and other input levels we calculate the marginal value product of operator and spouse farm labor for all observations.

(3) The off-farm wage rate in the off-farm labor supply functions for operator and spouse are set equal to the calculated marginal value product of operator and spouse farm labor and a new off-farm labor supply is calculated:

$OHR\_O' = C_1X - 2.1626*(WAGE\_O-MVP\_O) - 0.2609*(WAGE\_O-MVP\_O)^2$

$OHR\_S' = C_2X + 7.6467*(WAGE\_S-MVP\_S) - 0.4383*(WAGE\_S-MVP\_S)^2$

(4) The difference between the actual (but also predicted) off-farm labor supply and the new (pecuniary) off-farm labor supply becomes the 'difference' variable:

$DIFF\_O = OHR\_O - OHR\_O'$

$DIFF\_S = OHR\_S - OHR\_S'$

(5) If the operator's or spouse's marginal value product of labor in farming is negative then the total farm work time is regarded as the 'difference' because operators and spouses are expected not to work on-farm if their marginal value product is negative:

DIFF_O = FHR_O if MVP_O < 0

DIFF_S = FHR_S if MVP_S < 0

What does the value of the 'difference' variable imply? Special attention is required for interpretation because the backward bending off-farm labor supply curve for operators adds to the complexity.

First, let's consider the case when the off-farm labor supply curve is positively sloped. As discussed in Chapter III, we estimate the off-farm labor supply function S_N (Figure 22 panel 3) using observed off-farm wage rate W and off-farm work time T_m in the estimation. However, this is the shifted S_p function including non-pecuniary effects. Farmers should work OT_m'' time at off-farm wage rate W if only pecuniary effects are considered. Then the difference between T_m and T_m'' is caused by the non-pecuniary effects. However, information on the S_p curve is not directly available from survey data. If we equate the off-farm wage rate with the estimated marginal value product of farm work (MVP) and insert this into the estimated off-farm labor supply function (step 3 above), then we obtain T_m'. Hence, we are calculating the difference $T_m'T_m$ instead of T_mT_m'' assuming that they are equal. If the estimated difference T_m-T_m' is positive, as in panel (3) of Figure 22, farm operators and/or spouses are increasing farm work and decreasing off-farm work because of net non-pecuniary effects of farming.

However, the reverse is true when the off-farm labor supply curve is backward bending. As shown in Figure 22 panel (5), T_m' will be greater than actual off-farm labor supply T_m when the farm labor demand curve shifts to the right because of net non-pecuniary effects of farming. Therefore, if the estimated difference T_m-T_m' is negative, as in panel (5) of Figure 22, operators and/or spouses are working more time on farm and less time off-farm than required for only pecuniary terms.

If the 'difference' variable is zero, then operators and/or spouses are optimally allocating time according to pecuniary benefits and they have no net non-pecuniary effects from work time allocations. If the difference variable is negative for operators and spouses (because of their backward bending off-farm labor supply curve) then they are allocating too much labor to farming and too little labor to off-farm work in terms of maximizing pecuniary benefits and hence net non-pecuniary benefits are in the direction of farm labor.

The same set of exogenous variables derived in Chapter IV were regressed against the 'difference' variable with results reported in Table 17. The parameter estimates interpret the amount of change in the 'difference' variable for a one unit change in any of the independent variables. The parameter estimates show how many hours the off-farrm labor supply curve (Figure 22 panels 3 and 5) shifts horizontally because of net non-peucniary effects of labor supply. If a parameter estimate has a positive value then an increase in the variable increases the preference for off-farm work even though the present state may be a preference for farm work. Likewise, if a parameter estimate has a negative value then an increase in the variable increases the preference for farm work. The parameter estimates represent the extent of change in preference for a unit change in the variable.

No a priori expectation exists on the non-pecuniary effect of exogenous variables or preference for farm or off-farm work. The parameter estimates show the average response for the sample of farm operators and spouses.

TABLE 17

WEIGHTED LEAST SQUARES RESULTS FOR DIFFERENCE FUNCTIONS FOR OPERATOR AND SPOUSE

Parameter	Operator			Spouse		
	Coefficients	t-value		Coefficients	t-value	
CONSTANT	71.8131	6.05	**	45.3692	2.48	**
Life Cycle Effect						
AGE	-2.8473	-1.24		-25.0364	-6.94	**
AGE^2	0.0397	1.63		0.2908	7.32	**
Human Capital $\left(E_f^i, E_m^i, E_h^i\right)$						
EDUC_O	-17.4961	-5.45	**			
EDUC_S				22.7475	4.24	**
EXPF_O	1.1583	1.70	*			
RAISE_O	9.4163	0.44				
EXPOA	0.4550	0.73		8.4510	7.22	**
HEALTH	42.9722	1.91	*	12.5019	0.33	
Farm Characteristics (ϕ)						
SAFETY	-25.4431	-0.67		-290.7186	-5.12	**
ACRES	0.0965	2.04	**	0.0838	1.15	
$ACRES^2$	-0.000026	-1.91	*	0.0000128	0.61	
DEPR	1.6141	1.70	*	-3.1112	-2.11	**
$DEPR^2$	-0.0026	-1.37		0.0054	1.77	*
T_GRAIN	40.1831	1.46		224.3175	5.27	**
T_BEEF	0.7364	0.03		16.3615	0.51	
T_DAIRY	-54.7046	-1.51		-530.2190	-9.58	**
T_LIVST	2.1618	0.05		-240.9316	-4.21	**
Labor Market Conditions (ψ^i)						
R_MIDWE	-9.4304	-0.46		-185.6566	-5.83	**
R_NOREA	27.2371	0.82		-8.5196	-0.16	
R_WEST	66.4487	2.62	**	-48.1418	-1.21	
DIST_T	-0.9663	-2.84	**	-3.7359	-7.09	**
FIND	102.0642	2.58	**	28.1414	0.47	
NONWT	59.8975	1.17		59.6513	0.78	

TABLE 17 (Continued)

Parameter	Operator		Spouse		
	Coefficients	t-value	Coefficients	t-value	
Household Characteristics (Γ)					
DEPEND	6.5304	0.97	57.8539	5.52	**
OWNER	-43.8616	-1.32	-168.2866	-3.26	**
RESIDE	3.1723	0.13	108.4594	2.89	**
Adjusted R2	0.1075		0.2138		
Number of Observations	2,687		2.687		
Dependent Variable	DIFF_O		DIFF_S		

** Significant at 5 percent level
* Significant at 10 percent level

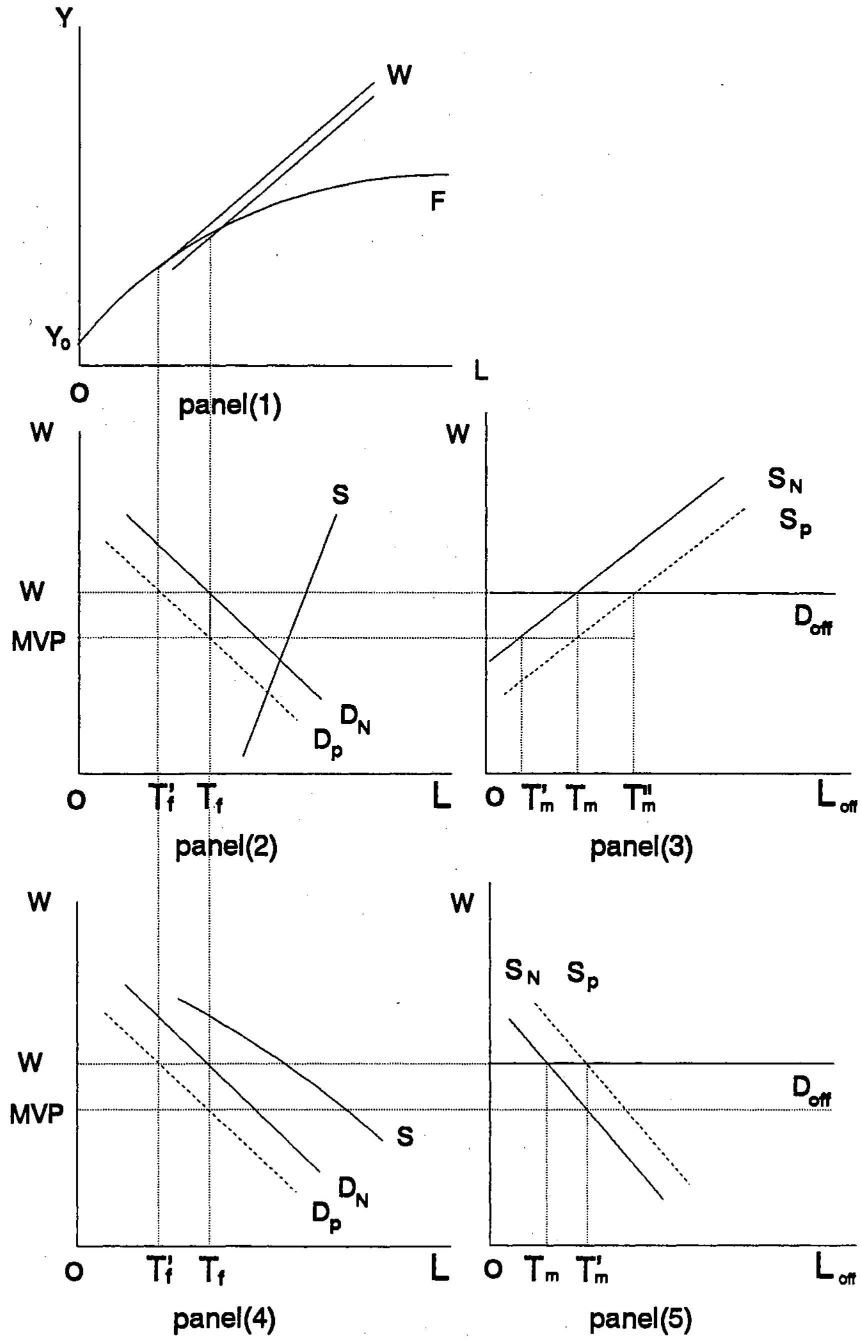

Figure 22. The Effect of Non-Pecuniary Benefits on Off-Farm Labor Supply When Off-Farm Labor Supply Curve is Positively or Negatively Sloped.

Life Cycle Effects

Both operator's and spouse's 'difference' variable have a U-shaped relationship with age (Figure 23). The parameter estimates are statistically significant for the spouse. The value of the 'difference' variable for most operators and spouses is negative implying that most are working more farm work than required in pecuniary terms (recall from the earlier section that the off-farm labor supply curve is backward bending). That is most of the operators and spouses have higher preference for farm work than off-farm work. Operator's extent of preference for farm work increases at first and then begins to decrease when he/she is 35.8 years old. That is, operators on average have a maximum preference for farm work when he/she are 35.8 years old and have worked around 150 hours per year more on farm than is required in pecuniary terms. Considering that the average age of operators is 52.8, most of the operators are on the increasing side of the U-shape curve implying that the preference for off-farm work increases as age increases although most still have a high preference for farm work (the curve is below the zero value for the 'difference' variable).

Spouse's preference for farm work also increases at first with age and then decreases when the spouse reaches 43.0 years although the preference is for farm work for the entire range of the variable. Spouses worked about 380 hours per year more time on farm at age 43 than required for maximizing pecuniary benefits. Considering that the average age for spouses is 50.0, most of the spouses are also on the increasing side of the U-shape curve implying that the preference for off-farm work increases as age increases although most of them still have a high preference for farm work. The life cycle result for

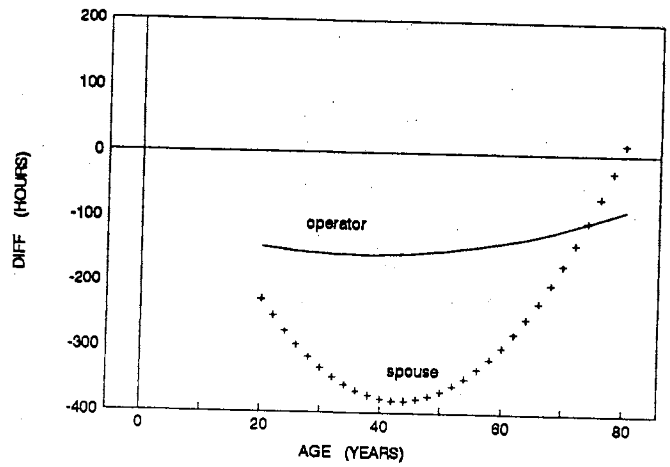

Figure 23. Relationship between the 'Difference' Vsriable and Age of Operator and Spouse

spouse implies that the off-farm labor supply curve S_N in Figure 22 panel 5 shifts leftward as age increases and then begins to shift rightward when the spouse's age is 43.0 years but is always to the left of S_P.

Human Capital

Human capital has pecuniary effects on farm production and off-farm wage determination but here (Table 17) only non-pecuniary effects of human capital on off-farm labor supply are shown. As formal education increases operator's preference for farm work increases (hence preference for off-farm work decreases) and most operators have a net preference for farm work.

However, spouse's preference for off-farm work increases (hence preference for farm work decreases) as age increases although most spouses have a net preference for farm work. Operator's preference for off-farm work time decreases by 17.5 hours per year but spouse's off-farm work time increases by 22.7 hours per year as formal education increases by one year. All the parameter estimates are statistically significant.

As farming experience increases operators preference for off-farm work increases (hence preference for farm work decreases) and the parameter estimate is statistically significant. Operator's preference for off-farm work time increases by 1.2 hours per year as farming experience increases by one year. If the operator was raised on a farm then he/she has 'comparatively' more preference for off-farm work than those who were not raised on a farm. Those who were raised on a farm worked 9.4 more hours per year on off-farm than those who were not raised on a farm but the parameter estimate is not statistically significant. In either case, operators still had a net preference for farm work.

As operator's or spouse's off-farm work experience increased his/her preference for off-farm work increased. The parameter estimate is statistically significant for spouse but not for operator. Spouse's off-farm work time increased by 8.4 hours per year as off-farm work experience increased by one year. If operator or spouse had a health problem then he/she had comparatively more preference for off-farm work (hence less preference for farm work) than those who did not have a health problem. The parameter estimate is statistically significant for operators but not for spouses. Those operators who had a health problem worked 43 more hours per year off-farm than those who did not have a health problem. Even with health problems both operators and spouses still have a net preference for farm work.

Farm Characteristics

If a farming accident was reported then both operator and spouse have comparatively more preference for farm work (hence less preference for off-farm work) than those who reported no farming accident. The parameter estimate is significant for spouses but not for operators. Those spouses who reported a farming accident worked 290 hours per year less off-farm than the pecuniary optimum (hence 290 hours more on farm because the study assumed fixed total labor supply) than those who reported no farming accident. Though it looks somewhat paradoxical, the probability of a farming accident increases with a higher preference for farm work. Farm operators and spouses presumably work more time on-farm because of their preference for more farm work and hence have more accidents.

Operator's and spouse's preference for off-farm work increases comparatively as the size of crop land acreage increases although most still have a higher net preference for farm work (Figure 24). At the average acreage of 163, operators worked about 150 hours more per year on-farm work and spouses worked about 370 hours more per year on-farm work than required for maximum pecuniary benefits. The parameter estimates are significant for operators but not for spouses. The result implies that operator's and spouse's farm work time decreases (hence off-farm work time increases) and moves toward the profit maximizing level as farm size increases.

Operator's preference for off-farm work increases and spouse's preference for farm work increases as the amount of farm capital increases (Figure 25). The parameter estimates are statistically significant except for the operator's quadratic term. The results imply that operators work more time

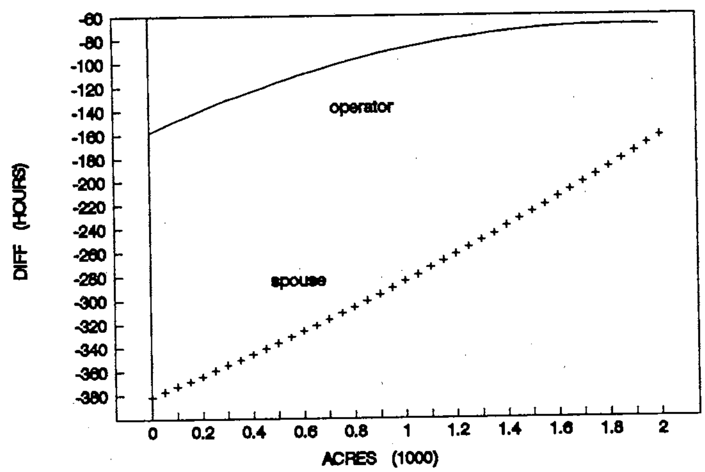

Figure 24. Relationship Between the 'Difference' Variable and Crop Land Acreage.

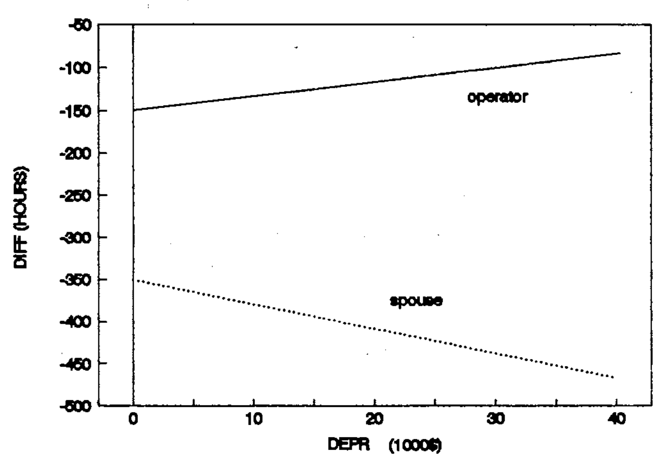

Figure 25. Relationship Between the 'Difference' Variable and Amount of Capital.

off-farm (hence less time on-farm) and spouses work less time off-farm (hence more time on farm) than required for maximum pecuniary benefits as the amount of capital increases. At the average level of capital depreciation of $5,405, operators worked about 140 hours more per year and spouses worked about 360 hours more per year on-farm than required for maximizing pecuniary benefits.

Operators have a comparatively higher preference for off-farm work (hence less preference for farm work) in cash grains, beef, hog, and sheep production, and other livestock farming than operators in "other crops" farming which is reflected in the intercept term but none of the parameters are statistically significant. Operators in dairy farming have a comparatively less preference for off-farm work (and hence more preference for farm work) than operators in "other crops" farming but the parameter is not statistically significant.

However, spouse's preferences are dependent on the types of farming. Spouses in cash grain farming worked 224 hours more off-farm (reflecting a comparatively higher preference for off-farm work) than spouses in "other crops" farming and the parameter estimate is statistically significant. Spouses in beef, hog, and sheep production farming have comparatively more preference for off-farm work than spouses in "other crops" farming but the parameter estimate is not statistically significant. Spouses in dairy and other livestock farming have comparatively less preference for off-farm work (hence more preference for farm work) than spouses in "other crops" farming and the parameter estimates are statistically significant.

Labor Market Conditions

Preferences of operators and spouses are different between regions. The regional dummy variables reflect the differences of farming conditions as well as local labor market conditions. Hence the parameter estimates of these dummy variables reflect the comprehensive effect of these conditions. Operators in the West region worked 66 hours more per year off-farm (reflecting comparatively more preference for off-farm work) than operators in the South region and the parameter estimate is statistically significant. Operators in the Midwest region had comparatively less preference for off-farm work and operators in the Northeast region had more preference for off-farm work than operators in the South region but the parameter estimates are not statistically significant. Spouses in the Midwest region worked 185 hours less off-farm (reflecting comparatively less preference for off-farm work) than spouses in the South region and the parameter estimate is statistically significant. Spouses in the West and the Northeast regions had less preference for off-farm work than spouses in the South region but the parameter estimates are not statistically significant.

As distance to the nearest town increases the preference for off-farm work decreases (and preference for farm work increases) for both operators and spouses. All of the parameter estimates are statistically significant. As distance to the town increases by one mile, operators worked about 1.0 hour per year less and spouses worked about 3.7 hours per year less off-farm. The results are as expected if psychic or scenic benefits increase as distance to the nearest town increases.

If operator or spouse had experienced difficulty in finding an off-farm job then he/she has a comparatively higher preference for off-farm work. The parameter estimate is significant for operators but not for spouses. Operators who reported that they had difficulty in finding an off-farm job worked 102 hours per year more off-farm than operators who didn't report the difficulty. The 'difficulty' is presumably the result of 'trying' to find off-farm work and the try reflects a farmers preference for off-farm work. Therefore, it is natural for those farm operators and spouses who have comparatively more preference for off-farm work to have more experience in job search and hence report having more difficulty in finding off-farm work.

If an operator or spouse is non-white then he/she has comparatively more preference for off-farm work (hence less preference for farm work) but the parameter estimates are not statistically significant.

Household Characteristics

Operator's and spouse's preference for off-farm work increases as the number of dependents increases, The parameter estimate is statistically significant for spouses but not for operators. Spouse's off-farm work time increases by 57 hours per year as the number of dependents increases by one.

Operator and spouse whose farm is owned by the household have comparatively higher preference for farm work. The parameter estimate is statistically significant for spouse but not for operator. Spouses whose farm is owned by the household worked 168 hours less per year off-farm than spouses whose farm is rented.

If household residence is in town then both operator and spouse have comparatively higher preference for off-farm work. The parameter estimate is statistically significant for spouses but not for operators. Spouses whose residence is in town worked 108 hours per year more off-farm than those whose residence was not in town.

In general, operator's time allocation followed more the pecuniary principle than the non-pecuniary principle when compared to the spouse's time allocation. The result reflects that spouse's time allocation is more flexible than operator's time and that operators have more of an obligation for supporting the household economically (pecuniarily) and hence have less flexibility in time allocation for non-pecuniary benefits.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

American agriculture has experienced rapid technology development and inelastic demand for commodity output. Agriculture has continually adjusted resource use in response to these conditions. Results in labor markets have appeared in two ways: out-migration and multiple job-holding. Therefore, agricultural households have become more susceptible to changes in the non-farm sector and farm household income has become more variable. In addition, a considerable share of farm operator households are found to be farming with marginal value products for operator and spouse farm labor below the off-farm offered wage rate. Thus farm operator households are not maximizing pecuniary benefits through allocation of labor between farm and off-farm work.

Various reasons provide possible rationale for the discrepancy in work time allocation: time constraints on off-farm work; existence of searching cost and management cost for hired labor; imperfect mobility of labor between industries and regions; expected utility includes pecuniary and non-pecuniary benefits of work-time allocations; and expected increase in farm asset income. The study hypothesizes that a major component in the discrepancy is caused by the difference in preference between farm and off-farm work.

The major objective of this study was to measure the impact of non-pecuniary benefits on farm and off-farm labor supply behavior for farm operators and their spouses acknowledging that the non-pecuniary effect is not the only source of discrepancy between the off-farm offered wage and the marginal value product of operator and spouse farm labor.

Optimal allocation of time in a farm household is determined when marginal value of time in each use is identical. If non-pecuniary effects are not considered, marginal value product of farm labor should be equal to the market wage rate in optimal allocation. However, if farm work or off-farm work has non-pecuniary effects, the net effect of these non-pecuniary effects may be the reason for discrepancy between the pecuniary marginal value product of farm labor and the off-farm offered wage rate. A set of exogenous variables is expected to have non-pecuniary effects as well as pecuniary effects on the time allocation of farm household members. The non-pecuniary effect is assumed to be produced and consumed within a farm household.

For the measurement of this discrepancy, a difference function of off-farm labor supply was estimated which is the difference between the actual off-farm labor supply and the predicted off-farm labor supply when the marginal value product of farm labor is equal to the off-farm offered wage rate. A non-pecuniary effect from farm work will shift the off-farm labor supply function to the left and a non-pecuniary effect from off-farm work will shift the off-farm labor supply function to the right. The observed shift is the net non-pecuniary effect from farm work and off-farm work. For calculation of the marginal value product of farm work a net revenue function for farming was estimated. Market wage functions for operators and spouses working off-farm were estimated and used to predict the market wage for those who were not working off-farm. The predicted market wage was applied in estimation of the off-farm labor supply functions for operator and spouse using all household observations. To correct for the conditional nature of the wage functions, off-farm labor participation functions for operator and spouse were estimated using a probit procedure and Heckman's two stage procedure was used in the estimation of off-farm labor supply functions to address the non-negativity of the dependent variable.

The empirical results showed that age of both operator and spouse had inverted U-shaped relationships for the probability of off-farm labor participation and time allocations for farm work and off-farm work. The result implies that farm operator's and spouse's allocation of time follows the life cycle hypothesis. At the average age, both operator's and spouse's probability of off-farm labor participation and allocations of farm work time and off-farm work time decreased as age increased.

Formal education variables for both operator and spouse were statistically significant in all functions estimated. Operators increased both farm work time and off-farm work time (hence total work time) as formal education increased but spouses decreased both farm and off-farm work time (hence total work time) as formal education increased. The probability of off-farm labor participation increased for both operator and spouse as formal education increased. As farming experience increased, operators increased farm work time and decreased off-farm work time but the probability of off-farm labor participation increased. If operator was raised on a farm then he/she worked less time on-farm and more time off-farm and the probability of off-farm labor participation was greater than for those who were not raised on a farm. As off-farm work experience increased, both operator and spouse increased off-farm work time and decreased farm work time and the probability of off-farm labor participation increased. If operator had any health problem then off-farm work time decreased and farm work time increased and the probability of off-farm labor participation decreased. However, spouse increased off-farm work time and decreased farm work time and the probability of off-farm labor participation decreased if he/she had any health problem.

If a farm accident was reported, both operator and spouse worked more time on-farm than those reporting no accidents. The result perhaps is related to increased labor supply to farming rather than safety of farm work. As cropping acreage increased, operators increased farm work time and decreased off-farm work time and the probability of off-farm labor participation decreased. However, spouses increased both farm and off-farm work time and the probability of off-farm labor participation increased as cropping acreage increased. As the amount of capital increased, both operator and spouse decreased farm work time and increased off-farm work time and the probability of off-farm labor participation increased. The result indicates that capital is a substitute for farm labor. Operators worked more time off-farm if type of farming was beef, hog, and sheep production. Both operator and spouse worked more time on farm (hence less time off-farm) if type of farming was dairy and other livestock production. Operators and spouses in cash grain farming and beef, hog, and sheep production had greater probability of off-farm labor participation.

Operators in the Midwest and Northeast regions worked more time both on and off-farm than those in the South region. However, operators in the West region worked less time both on and off-farm than operators in the South region. However, spouses in the South region worked less time both on and off-farm than spouses in all other regions. As distance to the nearest town (population over 50,000) increased, operators decreased off-farm work time and increased farm work time but spouses increased both farm and off-farm work time and spouse's probability of off-farm labor participation decreased.

Operators and spouses who experienced difficulty in finding off-farm jobs worked less time off-farm than those who had not experienced such difficulty but the probability of off-farm labor participation increased. Non-white operators worked less time on farm and non-white spouses had lower probabilities of off-farm labor participation.

As the number of dependents increased, operators and spouses decreased both farm and off-farm work time (hence total work time). If the farm was owned by the farm household then the spouse worked more time off-farm. If the farm residence was located in town then the spouse worked less time on-farm.

Other income decreased operator's farm and off-farm work time but increased spouse's off-farm work time but the effects were not statistically significant. The total value of land and buildings increased operator's off-farm work time and decreased spouse's farm work time.

Operator's and spouse's observed wage depended on farm and household characteristics as well as human capital and labor market conditions. This implies that the observed wage is the offered wage and is conditioned by the reservation wage. Market wage is observed when the offered wage is greater than the reservation wage. Therefore, the observed market wage reflects reservation wage as well as offered wage. Formal education increased offered wage rate. Farming experience and being raised on a farm had negative relationship with offered wage rate. Off-farm work experience was positively related with offered wage rate. Operator's good health was positively related with offered wage rate. If a farming accident occurred then both operator and spouse accepted lower offered wage. That is, the reservation wage decreased when a farm accident was reported. If cropping acreage and amount of capital increased then both operator and spouse accepted lower offered wage. Both operator and spouse accepted the lowest offered wage when classified in "other" type of farming. Offered wage rates were not statistically different between regions. Both operator and spouse accepted lower offered wage as distance to the nearest town increased. If there was difficulty in finding an off-farm job then both operator and spouse accepted lower offered wage. Race had no significant effect on wage determination. As the number of dependents increased, operators accepted higher offered wage but spouses accepted lower offered wage. If the farm was owned by the household then it increased the reservation wage of operator and spouse. Residence of household in town had no significant effect on wage determination. Operator's and spouse's reservation wage increased as other income increased. Operator's reservation wage increased as the value of land and buildings increased.

The difference functions for operators and spouses showed that most of the exogenous variables had statistically significant effects on non-pecuniary benefits. Spouses' time allocations depended more upon non-pecuniary effects compared to operators' time allocations. This implies that operators' time allocations are less flexible than spouses'. Both operator's and spouse's preference for off-farm work increased as age increased. As formal education increased operator's preference for farm work increased but spouse's preference for off-farm work increased. Farming experience and being raised on a farm increased operator's preference for off-farm work. Off-farm experience increased preference for off-farm work for both operator and spouse. If operator and spouse had any health problem then preference for off-farm work increased. If a farming accident occurred then preference for farm work increased. This result presumably reflected that the farmers preference for farm work increased the farm work time and thus the probability of an accident occurring.

Operators and spouses had greater preference for off-farm work as cropping acreage increased. As the amount of capital increased, preference for farm work increased for operator but preference for off-farm work increased for spouse. Operator and spouse had greater preference for off-farm work if type of farming was cash grain and beef, hog, and sheep production. Spouses had more preference for farm work if type of farming was dairy and other livestock production. Operators in the West region had greater preference for off-farm work and spouses in the Midwest region had greater preference for farm work. Preference for farm work increased for both operator and spouse as distance to nearest town increased. If operator and spouse had difficulty in finding an off-farm job then they had more preference for off-farm work. The difficulty presumably reflects the preference for off-farm work. Farm operators and spouses who have preference for off-farm work will more likely seek off-farm jobs and hence will have more opportunities to experience difficulty in finding off-farm jobs. Race had no significant effect on work preference. As the number of dependents increased spouse's preference for off-farm work increased. If the farm was owned by the household then spouse had more preference for farm work. If the household residence was located in town then the spouse had more preference for off-farm work.

Both operator and spouse were found to have self-selectivity bias in wage determination. When only human capital and labor market variables were included in wage determination, spouse's selectivity bias was positive. When all exogenous variables were included, the operator's selectivity bias was positive. Both operator and spouse were found to have positive selectivity bias in off-farm labor supply. These results imply that, if we predict off-farm wage and off-farm labor supply with given exogenous variables, those who didn't work off-farm would show a lower predicted offered wage rate but for a given wage rate they would show a predicted higher off-farm labor supply if other conditions are equal.

Conclusions

Most of the operators (99.4 percent) were predicted to have a positive marginal value product for work time in farming but a considerable share of spouses (39.5 percent) were predicted to have a negative marginal value product for work time in farming. Many of the spouses were believed to operate in the third stage of the traditional farm production function when only considering pecuniary benefits. However, most of the operators and other unpaid farm workers were operating in the second stage of the production function.

The time allocation and wage (hence income) determination of farm operator and spouse were found to be a simultaneously determined system. Observed wage of farm operator and spouse was not exogenously determined but simultaneously determined within the system. In other words, observed wage was a function of farm and household characteristics and other income variables as well as a function of human capital variables and local labor market conditions.

However, the main source of simultaneity of the system was the non-pecuniary effect. Farm operator and spouse had different preferences between farm and off-farm work and this caused the simultaneity of the system. For example, farm work time is not determined independently of the household characteristics and other income variables.

The study hypothesized that the difference between the marginal value product of farm work and the off-farm wage was mainly caused by non-pecuniary effects and that this 'difference', in part, was explained by the same set of exogenous variables that explained pecuniary effects of work time allocations. However, only 10.8 percent of the variance of the operator's 'difference' and 21.4 percent of the variance of the spouse's 'difference' was explained by the exogenous variables. This implies that the 'difference' variable depends on pecuniary and non-pecuniary effects that are not measured by these exogenous variables. However, most of the parameter estimates of the identified variables were statistically significant (especially for spouse) providing strong evidence of the existence of pecuniary and non-pecuniary effects of these variables. As was shown, spouses are more sensitive and have more flexibility with respect to the effects of non-pecuniary benefits.

These results imply a need to differentiate the pecuniary and non-pecuniary effects when analyzing the effects of policy variables or external conditions of farming on work time allocations and farm household incomes. Policy analyses which assume that farmers' behavior depends only on pecuniary benefits may lead to wrong conclusions if non-pecuniary effects are not distinguished from pecuniary effects.

Both operator and spouse were found to have self-selectivity bias in determination of off-farm wage and off-farm labor supply.

Limitations and Implications for Further Research

The major limitation of the study is in the properties of the data used. The Farm Costs and Returns Survey data used in the study was sampled by the stratified cluster sampling procedure. Special programs have been developed to carry out various analyses on the multistage stratified samples which also can be used to estimate regression equations. However, the programs which can be applied to limited dependent variable models such as used in this study have not been fully developed. The study basically used weighted regression procedures. Original data were weighted by a weighting variable provided by the United States Department of Agriculture, Economic Research Service. The same weighted data were also applied to the limited dependent variable models. Hence, we have no strong theoretical rationale for the reliability and significance of the parameter and standard errors estimated. However, considering that more than 2,600 observations were used, we have strong reason to believe that, when weighted, the sample has properties of random samples. Moreover, even if the actual standard errors are twice the estimated ones, most of the estimates would still be "significant".

Further research should be devoted to the development of the estimating procedure of the limited dependent variable models when non-random sampling procedures are used.

The distinctive feature of the study is in the estimation of the 'difference' function for operators and spouses. The study tries to find the sources of the shift of the off-farm labor supply function and attributes the shift only to the effect of non-pecuniary benefits. There are other possible sources for this shift including measurement errors in the data. Farm costs may be overestimated or farm revenues underestimated. Other explanations are also possible and were discussed in Chapter I. Further studies are required to establish sources responsible for shifting the labor supply functions.

References

Ahearn, M. and H. S. El-Osta. (August 1992). The Role of Off-Farm Employment: Permanent or Transitional State? Economic Research Service. USDA. Paper Presented at the American Agricultural Economics Association Meetings, Baltimore, Maryland.

Ahearn, Mary A. and John E. Lee, Jr. (1991). Multiple Job-Holding Among Farm Operator Households in the United States in Multiple Job-Holding Among Farm Families, ed. M. C. Hallberg, Jill L. Findeis, and Daniel A. Lass. Ames: Iowa University Press: 3-30.

Ahearn, Mary.C.,Janet.E. Perry. (1992). and H. S. El-Osta. The Economic Well-Being of Farm Operator Households, 1988-90.

Bagi F. S., H. S. El-Osta, and M. C. Ahearn. Size Distribution of Income Among the Farm Operator Households in the United States in 1988. Agriculture and Rural Economy Division, Economic Research Service, U. S. Department of Agriculture, Washington, D.C.

Barros, Geraldo S. D. C. (1976). Asking Wages, Market Wages, and the Off-Farm Labor Supply by Farm Operators. Ph.D.Thesis North Carolina State University.

Becker, G. S. (1965). A Theory of the Allocation of Time. Economic Journal, 75,492-517.

Becker, Gary S. (1981). A Treatise on the Family. Cambridge: Harvard University Press.

Bishop, Charles E. (May 1956) Programming Farm-Nonfarm Allocation of Farm Family Resources. Journal of Farm Economics, 38, p. 401.

Bishop, C. E. (1955). Part-Time Farming and the Low-Income Farm Problem. Journal of Farm Economics, XXXVII, Proceedings Number, December.

Bollman, R. D. (1973). Off-farm work by operators of Canadian census farms-1971. Canadian Farm Economics, 8(6), 1-5.

Bollman, Ray D. (1979). Off-Farm Work by Farmers: An application of the kinked demand curve for labor. Canadian Journal of Agricultural Economics, 27(1), 37-60.

Bollman, Ray D. (1991). Efficiency Aspects of Part-Time Farming. in Multiple Job-Holding among Farm Families, ed. M. C. Hallberg, Jill L. Findeis, and Daniel A. Lass. Ames: Iowa University Press: 112-139.

Buttel, Frederick H. (1982). The Political Economy of Part-Time Farming. GeoJournal, 6(4), 293-300.

Buttel, Frederick H., Bruce F.Hall, Oscar W.Larson III, and Jack Kloppenburg. (1982). Manpower implications of part-time farming in New York State. Unpublished report prepared for the Employment and Training Administration, U.S. Department of Labor,.Ithaca, N.Y.: Cornell University.

Carlin, Thomas A. and Susan Bentley. (1991). Modelling On-Farm Enterprise Adjustments. in Multiple Job-Holding Among Farm Families, ed. M. C. Hallberg, Jill L. Findeis, and Daniel A. Lass. Ames: Iowa University Press: 140-148.

Chapman, S. J. Hours of Labor. Economic Journal, XIX, 353-73.

Cochrane, Willard W. (1987). Saving the modest-sized farm or,the case for part-time farming. Choices, Second quarter, 4-7.

Dickens, Willian T., and Kevin Lang. (1985). A Test of Dual Labor Market Theory. American Economic Rev., 75, 792-805.

Dillard, D. (July 1993). Sample and Summary Documentation for the Farm Costs and Returns Survey. Statistical Methods Branch, National Agricultural Statistics Service.

E.R.S. U.S. Department of Agriculture. (January 1993). Agricultural Economic Report. Number 666.

Findeis, J. L. and D. A. Lass. (August 1992). Farm Operator Off-farm Labor Supply and Hired Labor Use on Pennsyvania Farms. Paper presented at the American Agricultural Economics Association meeting, Baltmore, MD.

Fuguitt, Glen V. Part-Time Farming and the Push-Pull Hypothesis. American Journal of Sociology, 23, 392-397.

Furtan, William H., G. C. van Kooten, and S. J. Thompson. (1985). The Estimation of Off-Farm Supply Functions of Saskatchewan. Journal of Agricultural Economics, 36, 211-20.

Gisser, Micha. (1965). Schooling and the Farm Problem. Econometrica, 33(3), 582-592.

Goddeeris, J. H. (1988). Compensating differentials and self-selection: An application to lawyers. Journal of Political Economy, 96, 411-27.

Goetz, S. J. (1992). A Selectivity Model of Household Food Marketing Behavior in Subsaharan Africa. American Journal of Agricultural Economics, 74(2), 444-52.

Gould, Brian W.,and William E. Saupe. (1989). Off-Farm Labor Market Entry and Exit, American Journal Agricultural Economics, 71, 960-969.

Gunter, Lewell F. (1990) Off-farm employment and earnings of Grgia farm operators. Georgia Agricultural Experimental Stations, College of Agriculture, The University of Georgia, Athens, Georgia.

Hanson, R. J., and R. G. F. Spitze. (1974). Increasing Incomes of Farm Families Through Dual Employment. Agricultural Finance Review, 35, 59-64.

Hanson, R. J. and R. G. F. Spitze. (January 1976). Economic Analysis of Off-farm Income in the Improvement of Illinois Farm Family Income. Department Agricultural Economics, AERR 139, Agricultural Experiment Station, University of Illinois.

Heckman, J. (1976) The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models. Annals of Economic and Social Measurement, 5, 475-92.

Heckman, James J. and Thomas E. MaCurdy. (1980). A life-cycle model of female labor supply. Rev.Economic Studies, 47, 47-74.

Heckman, James J. (1979) Sample Selection Bias as a Specification Error. Econometrica, 47, 153-61.

Hidiroglou, M. A., W. A. Fuller, R. D. Hickman. (August 1977). SUPER CARP. Survey Section Statistical Laboratory Iowa State University.

Hoover, Herbert and John Crecink. (August 1961). Part-Time Farming-Its Role and Prospects in the Clay-Hills Area of Mississippi, Bul.627, Mississippi Agricultural Experiment Station.

Huffman, W. E. (1974). Decision making:the role of education," American Journal of Agricultural Economics, 56(1), 85-97.

Huffman, Wallace E. (January 1976). A Cross-Sectional Analysis of Nonfarm Work of Farm Family Members (Springfield,Virginia:National Technical Information Service Report No.DLMA 91-19-75-18-1.

Huffman, Wallace E. (1976). The Productive Value of Human Time in U.S. Agriculture," American Journal of Agricultural Economics, 58, 672-683.

Huffman, Wallace E. (December 1976). The Value of the Productive Time of Farm Wives: Iowa,North Carolina, and Oklahoma. American Journal of Agricultural Economics, 58, 836-841.

Huffman, Wallace E. (1980). Farm and Off-Farm Decisions: The Role of Human Capital. Rev. Economics and Statistics, 62, 14-23.

Huffman, Wallace E. (1977). Interactions between Farm and Nonfarm Labor Markets." American Journal of Agricultural Economics, 59, 1054-61.

Huffman, Wallace E., and Mark D. Lange. (1989). Off-farm work decisions of husbands and wives:Joint Decision making. Review of Economics and Statistics, 71(3):471-80.

Huffman, Wallace E. (1991). Agricultural Household Models: Survey and Critique. in Multiple Job-Holding Among Farm Families, ed. M.C. Hallberg, Jill L. Findeis, and Daniel A. Lass. Ames: Iowa University Press: 79-111.

Jensen, Helen H., and Priscilla Salant. (1985). The Role of Fringe Benefits in Operator Off-Farm Labor Supply. American Journal of Agricultural Economics, 67, 1095-1099.

Johnson, Thomas G. (1991). The Market for Farm Family Labor. in Multiple Job-Holding Among Farm Families, ed. M. C. Hallberg, Jill L. Findeis, and Daniel A. Lass. Ames: Iowa University Press: 277-284.

Judge, George G., R. Carter Hill, William E. Griffiths, Helmut Lütkepohl, and Tsoung-Choao Lee. (1988). Introduction to the Theory and Practice of Econometrics. 2nd ed. New York: John Wiley and Sons Press.

Kada, Ryohei. (1980). Part-Time Farming: Off-Farm Employment and Farm Adjustments in the United States and Japan. Tokyo, Japan: Center ofr Academic Publications.

Kerachsky, S. H. (1977). Labor supply decisions of farm families. American Journal of Agricultural Economics, 59, 869-73.

Lange, M. D. (1979). An Economic Analysis of Time Allocation and Capital-Labor Ratios in Household Production of Farm Families in Iowa. Ph.D. thesis, Iowa State University.

Larson, Donald, and Hung Yu Hu. (August 1979). Factors Affecting the Supply of Off-farm Labor Among Small Farmers in Taiwan. American Journal of Agricultural Economics, 59(3), 549-53.

Lass, Daniel A.,and Conrado M. Gempesaw II. (1992). The supply of off-farm Labor: A Random Coefficients Approach. American Journal of Agricultural Economics, 74, 400-411.

Lass,D. A., J. L. Findeis,and M.C.Hallberg. (1989). Off-farm employment Decisions by Massachusetts Farm Households. Northeastern Journal of Agricultural and Res.Economics. 18, 149-159.

Lass, Daniel A., Jill L. Findeis, and Milton C. Hallberg. (1991). Factors Affecting the Supply of Off-Farm Labor: A Review of Empirical Evidence. in Multiple Job-Holding Among Farm Families, ed. M. C. Hallberg, Jill L. Findeis, and Daniel A. Lass. Ames: Iowa University Press: 239-262.

Lee, John E. Jr. (1965). Allocating Farm Resources Between Farm and Nonfarm Uses. Journal Farm Economics. 47, 83-92.

Leistritz, F. L., H. G. Vreugdenhil, B. L. Ekstrom, and A. G. Leholm. (1985). Off-Farm Income and Employment of North Dakota Farm Families. Agricultural Economics Miscellaneous Report No.88, Fargo, N.D.:Agricultural Experiment Station, North Dakota State University.

Lopez, Ramon E. (1984). Estimating Labor Supply and Production Decisions of Self-Employed Farm Producers. European Economics. Rev., 24, 61-82.

Maddala, G. S. (1983). Limited-dependent and qualitative variables in econometrics. Cambridge: Cambridge University Press.

Mage, J. A. A Typology of Part-Time Farming. Part-Time Farming: Proceedings of the First Rural Geography Symposium. Anthony M, Fuller and J. A. Mage, (eds). Norwich, England: Geo Abstracts, Ltd. pp.6-37.

Martin, J. H. and John H. Southern. (January 1961). Part-Time Farming in Northeast Texas, Bul.970, Texas Agricultural Experiment Station, p.23.

McCarthy, M. R., P.Salant, and W. Saupe. (1988). Off-farm labor Allocation by Married Farm Women: Research Review and New Evidence from Wisconsin. Women and Farming: Changing Roles,Changing Structures, pp.135-52. Boulder Co:Westview Press.

Mincer, Jacob. (August 1958). Investment in Human Capital and Personal Income Distribution. Journal of Political Economy, LXVI.

Misawa, Takeo. (1969). An Analysis of Part-Time Farming in the Post-war Period. Agricultural and Economic Growth:Japan's Experience,eds. Kazushi Ohkawa, Bruce F. Johnston, and Hiromitsu aneda, pp.250-69.Tokyo:University of Tokyo Press.

Mroz, Thomas A. (1987). The sensitivity of an empirical model of married women's hour of work to economic and statistical assumptions." Econometrica, 55, 765-801.

Nalson, J. S. (1964). Problems of resource use on the family farm. Australian Journal of Agricultural Economics, 8(2), 46-56.

National Center for Development Studies. (1986). Off-farm employment in the development of rural Asia. Papers presented at a conference held in Chiang Mai,Thailand, 23 to 26 August 1983, Australian National University, Canberra.

Nelson, F. D. (1984). Efficiency of the two-steps estimator for mdels with endogenous sample selection. Journal of Econometrics, 24, 181-86.

Perry, J. E. (1990). Returns to Labor From Farm and Non-Farm Employment. Ph.D. Dissertation, Oklahoma State University.

Polzin, Paul, and Peter MacDonald. (1971). Off-Farm Work:A Theoretical Analysis. Quart. Journal Economics, 85, 540-545.

Reddy, Venkateshwar K., and Jill L.Findeis. (1988). Determinants of Off-Farm Labor Force Participation:Implications for Low Income Farm Families. North Central Journal of Agricultural Economics, 10, 91-102.

Riethmuller, P. C. and Spillman, N. D. (1978). Off-farm employment in the grazing industry. Quarterly Review of the Rural Economy, Introductory Issue, November: 44-7.

Robinson, C.and P. McMahon. .(1980). "he off-farm income of farm families in the Australian grazing industry. Quarterly Review of the Rural Economy, 2(4), 400-4.

Robinson, C.and P. MaMahon (1981). Off-farm investment and employment in the Australian grazing industry: a preliminary analysis. Review of Marketing and Agricultural Economics, 49(1), 25-45.

Robinson, Chris, Pat McMahon, and John Quiggin. (1982). Labor Supply and Off-Farm Work by Farmers:Theory and Estimation. Australian Journal Economics, 26, 23-38.

Rosenfeld, R. (1985). Farm Women, Chapel Hill:The Univ.of North Carolina Press.

Salant, Priscilla. (January 1984). Farm Households and the Off-farm Sector: Results from Mississippi and Tennesse. Mississippi Agriculture and Forestry Experiment Station and U.S. Department of Agriculture, Economic Research Service, Agricultural Economics Research Report No.143.

Salter, Leonard A., Jr. and Larry F. Diehl. (1940). Part-Time Farming Research. Journal of Farm Economics, 22(3), 581-600.

Salter, L. A.Jr. (1936). What is part-time farming?" Journal of Farm Economics, 18(1).

Sander, William. (1983). Off-farm employment and incomes of farmers. Oxford Agrarian Studies,12, 34-47.

Schaub, James O. (1986). A Simultaneous Equations Model of Multiple Job Holding Farmers with Endogenous Farm Inputs. Ph.D. thesis, North Carolina State University.

Schmitt, G. (August 1991). Theory of Resource Allocation by Farm Households: The Role of Off-farm Employment, Household Production and Transaction Costs. Paper presented at the XXIst International Conference of Agricultural Economists, Tokyo, Japan, 22-29, 1991.

Schultz, Theodore W. (1961). Investment in Human Capital. American Economic Review, 51(1), 1-17.

Sexton, Roger N. (1975). Determinants of Multiple Job-Holding by Farm Operators. Ph.D. dissertation, North Carolina State University.

Shields, John R. (1981). Labor Time Allocation Decisions of Low Farm Inocme Families in Michigan. Ph.D. thesis, Michigan State University.

Shishko, Robert and Bernard Rostker. (1976). The Economics of Multiple Job-Holding. American Economic Review, 66, 298-308.

Simpson, Wayne, and Marilyn Kapitany. (1983). The Off-Farm Work Behavior of Farm Operators. American Journal of Agricultural Economics, 65, 801-805.

Singh, Inderjit, Lyn Squire, and John Strauss. (1986). Agricultural Household Models: Extensions, Applications, and Policy. Baltimore and London: The Johns Hopkins University Press.

Simpson, Wayne and Marilyn Kapitany. (1983). Off-farm work behavior of farm operators. American Journal of Agricultural Economics, 65, 801-5.

Spitze, R. G. F. 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, Jill L. Findeis, and Daniel A. Lass. Ames: Iowa University Press: 163-180.

Stallman, Judith I., and James H. Nelson. (1992). The First Job Decision and the Probability of Off-Farm Work. Education, Off-Farm Employment and Rural Economic Development: Perspectives from States in the Southeast. Proceedings of a Rural Development Symposium at the 1992 meetings of the Southern Agricultural Economics Association, ed. David L. Debertin. Southern Rural Development Center.

Streeter, D., and W. E. Saupe. (1986). Nonmonetary Considerations in Farm Operator Labor Allocations. A.E.res. 86-28. Ithaca:Department of Agricultural Economics, Cornell University.

Sumner, Daniel A. (1981). Wage Functions and Occupational Selection in a Rural Less Developed Country Setting. Rev. Economics and Statistics, 64,513-19.

Sumner, Daniel A. (1982). The Off-Farm Labor Supply of Farmers. American Journal of Agricultural Economics, 64, 499-509.

Sumner, Daniel A. (1991). Useful Directions for Research an Multiple Job-Holding Among Farm Families. in Multiple Job-Holding Among Farm Families, ed. M. C. Hallbert, Jill L. Findeis, and Daniel A. Lass. Ames: Iowa University Press: 149-162.

Teixeira, Ruy A. and Paul L. Swaim. (1991). Skill Demand and Supply in the New Economy: Issues for Rural Areas. in Education and Rural Economic Development: Strategies for the 1990's. ERS Staff Report No. AGES 9153. Agriculture and Rural Economy Division, Economic Research Service, U.S. Department of Agriculture.

Thompson, S. (1985). A Model of Off-Farm Employment. Forum No.10,Kieler Wissen- schaftsverlag, West Germany.

Tokle, J. G., and Wallace E. Huffman. (1991). Local Economic Conditions and Wage Labor Decisions of Farm and Rural Nonfarm Couples. American Journal Agricultral Economics, 73,652-670.

Tubman, W. (1977). A note on the off-farm income of farm families in Australia. Australian Journal of Agricultural Economcis, 21(3), 209-14.

Tweeten, Luther. (1991). Traditional Farm Commodity Programs and Multiple Job-holding. in Multiple Job-holding among Farm Families, ed. M. C. Hallberg, Jill L. Findeis, and Daniel A. Lass. Ames:Iowa University Press.

United States Department of Agriculture. (1991). Farm Costs and Returns Survey. (Questionnaire) Agricultural Statistics Board National Agricultural Statistics Service United States Department of Agriculture. O. M. B. Number 0535-0125.

United States Department of Commerce. (1935). Part-time Farming in the United States. United States Government Printing Office. Washington.

United States Department of Commerce. (1935). Part-time Farming in the United States. United States Government Printing Office, Washington.

Wales, T., and A. Woodland. (1980). Sample Selectivity and the Estimation of Labor Supply Functions. Intern. Economics Rev., 21, 437-68.

Willis, I. R. (1978). Part-time farming in central Victoria. Review of Marketing and Agricultural Economics, 46(3), 196-219.

APPENDIX

```
**********  Data Generation  ******************************************** ;

  %LET PVARS1 = P485-P489;
  %LET PVARS2 = P764-P784;
  %LET AVARS1 = A485-A489;
  %LET FVARS2 = F485-F489;
  %LET AVARS2 = A764-A784;
  libname yr91 'v:\fcrs91';
  libname for91 's:\for';
  libname shin 'd:\shin';
  data one;
  merge yr91.all91vv
    (keep= state strata segment tract subtract
     p61  p67  a69  p161-p168 p196-p199 p202-p206 p209-p213 p238 p241 p245
     p248 p249 p250 p253 p255-p257 p285 a260 p261 p265-p267 p284 a288-a299
     p323 p328 p329 p330 p332 p338 p346 p347 a352 a357 a362 a367 a372 a377
     a378 a383 a388 a393 a398 a399 a400-a408 a410-a414 a416-a421 p423 p424
     a425
     a431 a436 a441 a446 a447 a452 a457 a462 a467-a471 a473-a480 a482-a484
     p664 p666
     a671 a674 a675 a678 a679 p681 p682 p704-p705 p727 p728 p739-p750
     p752-p784
     p787 p789 p791-p799 p825 p829-p840 p847-p858 p875 p876
     version ecoclass typefarm  farmorg ef_v2)
  for91.for91hh
      (in = hh
      keep= state strata segment tract subtract
      yrwork op_educ op_age sp_age sp_educ miles op_miles opnumyr
      sp_miles op_ins sp_ins spnumyr opunable spunable fraised op_hisp
      sp_hisp op_race sp_race op_more sp_more op_cover sp_cover op_jtype
      sp_jtype version married);
  by state strata segment tract subtract;
   if version = 2 ;
   if hh;
array refuse
      yrwork op_educ op_age sp_age sp_educ miles op_miles opnumyr
      sp_miles op_ins sp_ins spnumyr opunable spunable fraised op_hisp
      sp_hisp op_race sp_race op_more sp_more op_cover sp_cover op_jtype
      sp_jtype ;
do over refuse;
   if refuse = . then refuse = 0;
end;
              *********************************************************
               Impute values by reported sales class and type of farm

               Wages and Salaries
               Non-farm business income
               Income from another farm or ranch operation
                     **V2**                           **ALL**
               Interest and dividends
               Retirement
               Transfer payments
               Other off-farm sources       Other off-farm sources
               ***********************************************************;

ARRAY PCELL2 &PVARS2;
                       /**ASSIGN VALUE CODES TO THE MIDPOINT**/
   DO OVER PCELL2;
      SELECT  (PCELL2);
           WHEN ( -1)    PCELL2 = -1;
           WHEN (  0)    PCELL2 = 0;
           WHEN (  1)    PCELL2 = 0;
           WHEN (  2)    PCELL2 = 500;
           WHEN (  3)    PCELL2 = 1750;
           WHEN (  4)    PCELL2 = 3750;
           WHEN (  5)    PCELL2 = 7500;
           WHEN (  6)    PCELL2 = 12500;
           WHEN (  7)    PCELL2 = 17500;
           WHEN (  8)    PCELL2 = 22500;
           WHEN (  9)    PCELL2 = 27500;
           WHEN ( 10)    PCELL2 = 32500;
           WHEN ( 11)    PCELL2 = 37500;
           WHEN ( 12)    PCELL2 = 45000;
           WHEN ( 13)    PCELL2 = 55000;
           WHEN ( 14)    PCELL2 = 70000;
           WHEN ( 15)    PCELL2 = 90000;
           WHEN ( 16)    PCELL2 = 137500;
           WHEN ( 17)    PCELL2 = 212500;
           WHEN ( 18)    PCELL2 = 375000;
           WHEN ( 19)    PCELL2 = 750000;
           WHEN ( 20)    PCELL2 = 1000000;
           WHEN (2400)   PCELL2 = 2400;
           WHEN (4500)   PCELL2 = 4500;
           WHEN (6000)   PCELL2 = 6000;
           /*THESE WERE NOT CODED WITH VALUE CODE
             ASSUMES AMOUNT WAS CORRECT*/
           WHEN ( -2)    PCELL2 =-500;
           WHEN ( -3)    PCELL2 =-1750;
           WHEN ( -4)    PCELL2 =-3750;
           WHEN ( -5)    PCELL2 =-7500;
           WHEN ( -6)    PCELL2 =-12500;
```

```
            WHEN ( -7)    PCELL2 =-17500;
            WHEN ( -8)    PCELL2 =-22500;
            WHEN ( -9)    PCELL2 =-27500;
            WHEN (-10)    PCELL2 =-32500;
            WHEN (-11)    PCELL2 =-37500;
            WHEN (-12)    PCELL2 =-45000;
            WHEN (-13)    PCELL2 =-55000;
            WHEN (-14)    PCELL2 =-70000;
            WHEN (-15)    PCELL2 =-90000;
            WHEN (-16)    PCELL2 =-137500;
            WHEN (-17)    PCELL2 =-212500;
            WHEN (-18)    PCELL2 =-375000;
            WHEN (-19)    PCELL2 =-750000;
            WHEN (-20)    PCELL2 =-1000000;
         END;
      END;

         /*********MAKE CATEGORIES FOR IMPUTATIONS*********/

IF                ECOCLASS LE 11 THEN SALCLS = 1;
   ELSE IF 12 LE ECOCLASS LE 17 THEN SALCLS = 2;
   ELSE IF        ECOCLASS GE 18 THEN SALCLS = 3;
IF                TYPEFARM LE 1  THEN COMMOD = 1;
   ELSE IF 2  LE TYPEFARM LE 8  THEN COMMOD = 2;
   ELSE IF 13 LE TYPEFARM LE 14 THEN COMMOD = 2;
   ELSE IF        TYPEFARM EQ 9
              OR  TYPEFARM EQ 10
              OR  TYPEFARM EQ 12 THEN COMMOD = 3;
   ELSE IF        TYPEFARM EQ 11 THEN COMMOD = 4;

   /**IMPUTE FOR AGE AND EDUCATION OF OPERATOR BASED ON GRAND MEANS**/
IF P704 LE 0 THEN OP_AGE = 53;ELSE OP_AGE = P704;
IF P705 = -1 THEN OP_EDUC = 2;ELSE ELSE OP_EDUC = P705;
IF                          OP_AGE LT 35 THEN AGE = 1;
   ELSE IF   OP_AGE GE 35 AND OP_AGE LT 45 THEN AGE = 2;
   ELSE IF   OP_AGE GE 45 AND OP_AGE LT 55 THEN AGE = 3;
   ELSE IF   OP_AGE GE 55 AND OP_AGE LT 65 THEN AGE = 4;
   ELSE IF   OP_AGE GE 65                  THEN AGE = 5;

       ******IMPUTE VALUES FOR OFF-FARM INCOME;
       ******VALUES ARE MEANS BASED ON VERSION, AND CATEGORY;
A764 = P764;
IF P764 = -1 THEN DO;                       **WAGES AND SALARIES;
   IF AGE=1 THEN DO;
      IF OP_EDUC=1 THEN A764 = 13495.32;
      IF OP_EDUC=2 THEN A764 = 18339.06;
      IF OP_EDUC=3 THEN A764 = 15442.42;
      IF OP_EDUC=4 THEN A764 = 28936.16;
      IF OP_EDUC=5 THEN A764 = 32500.00;
   END;
   ELSE IF AGE=2 THEN DO;
      IF OP_EDUC=1 THEN A764 = 14479.29;
      IF OP_EDUC=2 THEN A764 = 24124.22;
      IF OP_EDUC=3 THEN A764 = 19851.98;
      IF OP_EDUC=4 THEN A764 = 25970.59;
      IF OP_EDUC=5 THEN A764 = 52540.89;
   END;
   ELSE IF AGE=3 THEN DO;
      IF OP_EDUC=1 THEN A764 = 26886.50;
      IF OP_EDUC=2 THEN A764 = 22344.52;
      IF OP_EDUC=3 THEN A764 = 36601.40;
      IF OP_EDUC=4 THEN A764 = 28476.27;
      IF OP_EDUC=5 THEN A764 = 38001.69;
   END;
   ELSE IF AGE=4 THEN DO;
      IF OP_EDUC=1 THEN A764 = 17750.23;
      IF OP_EDUC=2 THEN A764 = 17675.96;
      IF OP_EDUC=3 THEN A764 = 29741.38;
      IF OP_EDUC=4 THEN A764 = 40670.23;
      IF OP_EDUC=5 THEN A764 = 55326.12;
   END;
   ELSE IF AGE=5 THEN DO;
      IF OP_EDUC=1 THEN A764 = 10502.18;
      IF OP_EDUC=2 THEN A764 = 8315.65;
      IF OP_EDUC=3 THEN A764 = 13797.58;
      IF OP_EDUC=4 THEN A764 = 22513.83;
      IF OP_EDUC=5 THEN A764 = 8330.67;
   END;
 END;

 IF P765 = -1 THEN DO;                               **SP WAGES/SALARIES;
   IF       COMMOD = 1 THEN A765 = 16534.43;
   ELSE IF COMMOD = 2 THEN A765 = 14283.46;
   ELSE IF COMMOD = 3 THEN A765 = 15746.00;
   ELSE IF COMMOD = 4 THEN A765 = 10926.15;
 END;
 ELSE IF P765 NE -1 THEN A765=P765;
 IF P766 = -1 THEN DO;                               **OT WAGES/SALARIES;
   IF       COMMOD = 1 THEN A766 =  9121.41;
   ELSE IF COMMOD = 2 THEN A766 = 10389.10;
   ELSE IF COMMOD = 3 THEN A766 =  9952.96;
   ELSE IF COMMOD = 4 THEN A766 =  9646.75;
```

```
END;
ELSE IF P766 NE -1 THEN A766=P766;
IF P767 = -1 THEN DO;                                   **OP BUSINESS;
  IF      COMMOD = 1 THEN A767 = 27465.37;
  ELSE IF COMMOD = 2 THEN A767 = 25100.46;
  ELSE IF COMMOD = 3 THEN A767 = 39527.18;
  ELSE IF COMMOD = 4 THEN A767 = 16404.75;
END;
ELSE IF P767 NE -1 THEN A767=P767;
IF P768 = -1 THEN DO;                                   **SP BUSINESS;
  IF      COMMOD = 1 THEN A768 = 19601.10;
  ELSE IF COMMOD = 2 THEN A768 = 11216.97;
  ELSE IF COMMOD = 3 THEN A768 = 14580.20;
  ELSE IF COMMOD = 4 THEN A768 = 17160.53;
END;
ELSE IF P768 NE -1 THEN A768=P768;
IF P769 = -1 THEN DO;                                   **OT BUSINESS;
  IF      COMMOD = 1 THEN A769 =  9718.48;
  ELSE IF COMMOD = 2 THEN A769 = 17098.88;
  ELSE IF COMMOD = 3 THEN A769 = 12457.02;
  ELSE IF COMMOD = 4 THEN A769 = 21254.05;
END;
ELSE IF P769 NE -1 THEN A769=P769;
                                                        **INCOME FROM
                                                          ANOTHER FARM;
IF P770 = -1 THEN A770 = 19658.23;ELSE IF P770 NE -1 THEN A770=P770;
IF P771 = -1 THEN A771 =  6172.23;ELSE IF P771 NE -1 THEN A771=P771;
IF P772 = -1 THEN A772 = 22236.59;ELSE IF P772 NE -1 THEN A772=P772;
IF P773 = -1 THEN DO;                                  **OP INTEREST;
 IF SALCLS = 1 THEN A773 = 5723.11;
 ELSE IF SALCLS = 2 THEN A773 = 3620.52;
 ELSE IF SALCLS = 3 THEN A773 = 5642.13;
END;ELSE IF P773 NE -1 THEN A773=P773;
IF P774 = -1 THEN DO;                                  **SP INTEREST;
 IF SALCLS = 1 THEN A774 = 1599.28;
 ELSE IF SALCLS = 2 THEN A774 = 3199.84;
 ELSE IF SALCLS = 3 THEN A774 = 4958.73;
END;ELSE IF P774 NE -1 THEN A774=P774;
IF P775 = -1 THEN DO;                                   **OT INTEREST;
 IF SALCLS = 1 THEN A775 =  797.22;
 ELSE IF SALCLS = 2 THEN A775 = 1128.85;
 ELSE IF SALCLS = 3 THEN A775 = 6061.71;
END;ELSE IF P775 NE -1 THEN A775=P775;

                                             **OTHER OFF-FARM INCOME;
                                             **BY HOUSEHOLD MEMBER;
                                             **RETIREMENT, PUB ASST, OTHER;
IF P776 = -1 THEN A776 = 10301.08;ELSE IF P776 NE -1 THEN A776=P776;
IF P777 = -1 THEN A777 =  5093.15;ELSE IF P777 NE -1 THEN A777=P777;
IF P778 = -1 THEN A778 = 12290.70;ELSE IF P778 NE -1 THEN A778=P778;
IF P779 = -1 THEN A779 =  5991.87;ELSE IF P779 NE -1 THEN A779=P779;
IF P780 = -1 THEN A780 =  3193.26;ELSE IF P780 NE -1 THEN A780=P780;
IF P781 = -1 THEN A781 =  4245.26;ELSE IF P781 NE -1 THEN A781=P781;
IF P782 = -1 THEN A782 = 17129.08;ELSE IF P782 NE -1 THEN A782=P782;
IF P783 = -1 THEN A783 =  9271.92;ELSE IF P783 NE -1 THEN A783=P783;
IF P784 = -1 THEN A784 =  2793.11;ELSE IF P784 NE -1 THEN A784=P784;

   A485 = SUM(A764,A765,A766);   **WAGES/SALARIES;
   A486 = SUM(A767,A768,A769);   **OTHER OFF-FARM BUSINESS;
   A487 = SUM(A770,A771,A772);   **OTHER FARM BUSINESS;
   A488 = SUM(A773,A774,A775);   **INTEREST;
   A489 = SUM(A776-A784);        **OTHER OFF-FARM INCOME;

**********  Variables Definition  ************************************ ;
                                                                      *
livst1   Livestock and poultry income from marketing contracts        ;
         livst1 = sum ( of a452 a457 a462 a467 a468 ) ;
                                                                 *
livst    Livestock and poultry cash income                            ;
         livst = livst1 + sum ( of a425 a469-a471 a473-a475 ) ;
                                                                      *
crop1    Crop income from marketing contracts                         ;
         crop1 = sum ( of a352 a357 a362 a367 a372 a377 a378 );
                                                                      *
crop2    Crop cash income                                             ;
         crop2 = crop1 + sum ( of a400-a408 );
                                                                      *
ccc      Net change in CCC loans                                      ;
         ccc = (a410 + a414) - a412 ;
                                                                      *
crop     Crop income plus net CCC loans                               ;
         crop = crop2 + ccc ;
                                                                      *
sales    Livestock, crop income, plus net CCC loans                   ;
         sales = livst + crop ;
                                                                      *
inv01    Net changes in value of livestock and poultry inventories    ;
         inv01 = a675 - a674 ;
                                                                      *
inv02    Net change in value of non-CCC crop inventories              ;
         inv02 = a679 - a678 ;
                                                                      *
```

```
invent   Net changes in value of crop, livestock, feed, fert., invent. ;
         invent = sum ( of inv01-inv02 ) ;
                                                                       *
consum   Value of farm products used or consumed on the farm           ;
         consum = a476 + a477 ;
                                                                       *
totrev   Total value of farm production                                ;
         totrev = sales + invent + consum ;
                                                                       *
exp01    Purchased feed expense                                        ;
         exp01 = p202 ;
                                                                       *
exp02    Purchased livstock expense                                    ;
         exp02 = sum ( of p209-p212 ) ;
                                                                       *
exp03    Livestock contractor expense                                  ;
         exp03 = p423 + p424 ;
                                                                       *
exp04    Livestock leasing expense                                     ;
         exp04 = p323 ;
                                                                       *
exp05    Custom feed, pasturing, grazing expense                       ;
         exp05 = p203 + p204 + p205 ;
                                                                       *
exp06    Veterinary services and supplies expense                      ;
         exp06 = p206 ;
                                                                       *
exp07    Hired labor expense                                           ;
         if farmorg le 3
            then do ;
                    if p267 > 0
                       then exp07 = p265 - p267 ;
                       else exp07 = p265 * ((100 - p266) /100 ) ;
                 end ;

         if farmorg= 4 or farmorg = 5
            then exp07 = p265 ;

         exp07 = round ( exp07, 1 ) ;

         if exp07 lt 0 then exp07 = 0 ;
                                                                       *
exp08    Contract labor expense                                        ;
         exp08 = p261 ;
                                                                       *
exp09    Labor fringe benefit (cash only) expense                      ;
         exp09 = p284 ;
                                                                       *
exp10    Fertilizer, lime, and chemicals expense                       ;
         exp10 = p197 + p198 ;
                                                                       *
exp11    Seed and plant expense                                        ;
         exp11 = p196 ;
                                                                       *
exp12    Fuel and oil expense                                          ;
         exp12 = p213 ;
                                                                       *
exp13    Repairs and replacement parts - vehicles, mach, equip. expense;
         exp13 = p257 ;
                                                                       *
exp14    Hand tools, and supplies, farm shop power equipment           ;
         exp14 = p256 ;
                                                                       *
exp15    Land, farm, irrigation, building maintenance, repair expense  ;
         exp15 = sum ( of p328-p330 p338 p346 ) ;
                                                                       *
exp16    Containers                                                    ;
         exp16 = p255 ;
                                                                       *
exp17    Custom hired work expense                                     ;
         exp17 = p199 ;
                                                                       *
exp181   Utilities                                                     ;
         exp181 = sum ( of p238 p241 p245 ) ;
                                                                       *
exp182   Motor vehicle registration and licensing fees                 ;
         exp182 = p249 ;
                                                                       *
exp183   Other unrecorded expenses                                     ;
         exp183 = p347 ;
                                                                       *
exp18    General business expenses (excluding insurance)               ;
         exp18 = exp181 + exp182 + exp183 + p253 ;
                                                                       *
exp19    Real estate and property taxes                                ;
         exp19 = p250 ;
                                                                       *
exp20    Total interest paid                                           ;
         exp20 = p248        ;
                                                                       *
exp21    Cash rent and AUM fee expense                                 ;
         exp21 = p61 + p67 ;
```

```
                                                                          *
exp22    Estimate of non-cash expenses for paid labor                     ;
         exp22 = p285         ;
                                                                          *
totexp   Total cash/noncash operating expenses--exc. marketing expense    ;
         totexp = sum ( of exp01-exp22 ) ;
                                                                          *
netr     Net revenue from farming                                         ;
         netr = totrev - totexp ;
                                                                          *
inc01    Government payments                                              ;
         inc01 = sum ( of a416-a421) ;
                                                                          *
inc02    Income from custom work, and machine hire                        ;
         inc02 = a478 ;
                                                                          *
inc03    Income from livestock grazing (non-contract)                     ;
         inc03 = a479 ;
                                                                          *
inc04    Other farm related income                                        ;
         inc04 = a480 + a482 + a484 ;
                                                                          *
inc05    Income from hunting, fishing, other outdoor recreation           ;
         inc05 = a483  ;
                                                                          *
inc06    Income from land rented to others                                ;
         inc06 = a69 ;
                                                                          *
inc07    Fee income from crops removed under production contract          ;
         inc07 = sum ( of a383 a388 a393 a398 a399 ) ;
                                                                          *
inc08    Fee income from livestock removed under production contract      ;
         inc08 = sum( of a431 a436 a441 a446 a447 ) ;
                                                                          *
other    Total other farm income                                          ;
         other = sum ( of inc01-inc08 ) ;
                                                                          *
depr     Depreciation on farm business assets                             ;
         depr  = a260 ;
                                                                          *
fhr_o    Hours worked on farm by operator                                 ;
         fhr_o   = sum ( of a288-a299 ) *52/12;
                                                                          *
fhr_s    Hours worked on farm by spouse                                   ;

         a739=p739;
            if p739=-1 then a739=1;
         a740=p740;
            if p740=-1 then a740=1;
         a741=p741;
            if p741=-1 then a741=1;
         a742=p742;
            if p742=-1 then a742=1;
         a743=p743;
            if p743=-1 then a743=1;
         a744=p744;
            if p744=-1 then a744=1;
         a745=p745;
            if p745=-1 then a745=1;
         a746=p746;
            if p746=-1 then a746=1;
         a747=p747;
            if p747=-1 then a747=1;
         a748=p748;
            if p748=-1 then a748=1;
         a749=p749;
            if p749=-1 then a749=1;
         a750=p750;
            if p750=-1 then a750=1;

         fhr_s   = sum ( of a739-a750 ) *52/12;
                                                                          *
fhr_3    Hours worked on farm by other unpaid workers                     ;

         a752=p752;
            if p752=-1 then a752=1;
         a753=p753;
            if p753=-1 then a753=1;
         a754=p754;
            if p754=-1 then a754=1;
         a755=p755;
            if p755=-1 then a755=1;
         a756=p756;
            if p756=-1 then a756=1;
         a757=p757;
            if p757=-1 then a757=1;
         a758=p758;
            if p758=-1 then a758=1;
         a759=p759;
            if p759=-1 then a759=1;
         a760=p760;
            if p760=-1 then a760=1;
```

```
        a761=p761;
           if p761=-1 then a761=1;
        a762=p762;
           if p762=-1 then a762=1;
        a763=p763;
           if p763=-1 then a763=1;

        fhr_3   = sum ( of a752-a763 ) *52/12;
                                                                    *
acres   Total acres of crop planted                                 ;
        acres   = p168-p161-p162-p163-p164-p165-p166+p167  ;
                                                                    *
expf_o  Operator experience in farming                              ;
        expf_o  = yrwork ;
                                                                    *
edu_o  Operator education                                           ;
        edu_o  = op_educ ;
                                                                    *
edu_s   Spouse education                                            ;
        edu_s  = sp_educ ;
                                                                    *
ohr_o   Hours of work off-farm of operator                          ;
        ohr_o   = sum ( of p829-p840 ) * 52 / 12 ;
        if ohr_o < 0 then ohr_o = 0 ;
                                                                    *
ohr_s   Hours of work off-farm of spouse                            ;
        ohr_s   = sum ( of p847-p858 ) * 52 / 12;
        if ohr_s < 0 then ohr_s = 0 ;
                                                                    *
wage_o  Market wages of operator                                    ;

        a7647 = a764 + a767;
        if a7647 > 0 and ohr_o = 0 then ohr_o = 1800 ;
        if p764 = -1 and ohr_o = 0 then a764 = 0 ;
        if p767 = -1 and ohr_o = 0 then a767 = 0 ;
        if ohr_o > 0 then wage_o  = (a764+a767) / ohr_o ;
        else              wage_o  = 0 ;
        if ohr_o > 0 and a764 = 0 and a767 = 0 then wage_o = 16.26 ;
                                                                    *
wage_s  Market wages of spouse                                      ;

        a7658 = a765 + a768 ;
        if a7658 > 0 and ohr_s = 0 then ohr_s = 1600 ;
        if p765 = -1 and ohr_s = 0 then a765 = 0 ;
        if p768 = -1 and ohr_s = 0 then a768 = 0 ;
        if ohr_s > 0 then wage_s  = (a765+a768) / ohr_s ;
        else              wage_s  = 0;
        if ohr_s > 0 and a765 = 0 and a768 = 0 then wage_s = 8.02 ;
                                                                    *
oth_o   Other income of operator from off-farm                      ;
        oth_o= sum ( of a765 a766 a768-a784 )  ;
                                                                    *
oth_s   Other income of spouse from off-farm                        ;
        oth_s= sum ( of a764 a766 a767 a769-a784 )  ;
                                                                    *
income_o Total other income of operator                             ;
          income_o = oth_o + other ;
                                                                    *
income_s Total other income of spouse                               ;
          income_s = oth_s + other ;
                                                                    *
age_o   Age of operator                                             ;
        age_o   = op_age ;
                                                                    *
age_s   Age of spouse                                               ;
        age_s   = sp_age ;
                                                                    *
expop_o Off-farm work experience of operator on a particular job    ;
        expop_o = opnumyr ;
                                                                    *
expoa_o Off-farm work experience of operator on any job             ;
        expoa_o = p875 ;
        if expoa_o < 0 then expoa_o = 0 ;
                                                                    *
expop_s Off-farm work experience of spouse on a particular job      ;
        expop_s = spnumyr ;
                                                                    *
expoa_s Off-farm work experience of spouse on any job               ;
        expoa_s = p876 ;
        if expoa_s < 0 then expoa_s = 0 ;
                                                                    *
hlth_o  Health condition of operator                                ;
        hlth_o= p787 ;
                                                                    *
hlth_s  Health condition of spouse                                  ;
        hlth_s= p789 ;
                                                                    *
distj_o Distance to the operator's job                              ;
        distj_o = op_miles ;
                                                                    *
distj_s Distance to the spouse's job                                ;
        distj_s = sp_miles ;
```

```
                                                                          *
insur_o Operator receiving health insurance ?                             ;
        insure_o= op_ins ;
                                                                          *
insur_s Spouse receiving health insurance ?                               ;
        insure_s= sp_ins ;
                                                                          *
child   Number of children                                                ;

        a825 = p825 ;
          if p825 = -1 then a825 = 2 ;
        child   = a825 - 2 ;
        if child < 0 then child = 0 ;
                                                                          *
dist_t  Distance to the nearest town                                      ;
        dist_t  = miles ;
                                                                          *
rais_o  Operator raised on a farm ?                                       ;
        rais_o = fraised ;
                                                                          *
span_o  Operator Spanish Origin ?                                         ;
        span_o = op_hisp ;
                                                                          *
race_o  Race of operator                                                  ;
        race_o = op_race ;
                                                                          *
span_s  Spouse Spanish Origin ?                                           ;
        span_s = sp_hisp ;
                                                                          *
race_s  Race of spouse                                                    ;
        race_s = sp_race ;
                                                                          *
fin_o   Times operator unable to find job                                 ;
        fin_o  = opunable ;
                                                                          *
fin_s   Times spouse unable to find job                                  ;
        fin_s  = spunable ;
                                                                           *
safe    Safety of farming                                                 ;
        safe  = sum ( of p791-p799 ) ;
                                                                          *
lanbuil Total value of land and buildings                                 ;
        lanbuil = a671 ;
                                                                          *
tim_o   Off-farm work time constraint - operator                          ;
        tim_o  = op_more ;
                                                                          *
tim_s   Off-farm work time constraint - spouse                            ;
        tim_s  = sp_more ;
                                                                          *
cov_o   Operator's insurance cover other member ?                         ;
        cov_o = op_cover ;
                                                                          *
cov_s   Spouses's insurance cover other member ?                          ;
        cov_s = sp_cover ;
                                                                          *
type_f  Type of farming                                                   ;
        type_f  = typefarm ;
                                                                          *
type_o  Type of Work - Operator                                           ;
        type_o = op_jtype ;
                                                                          *
type_s  Type of Work - Spouse                                             ;
        type_s = sp_jtype ;
                                                                          *
state   State Name Where Farm is located                                 ;
      * state = state_ab ;
                                                                          *
own      Ownership of the Farm                                            ;
         own = p664;
                                                                          *
resid    Residence in Town?                                               ;
         resid = p666;

**********  Imputation of Education  **********************************;

if edu_o = 1 then educ_o = 9 ;
if edu_o = 2 then educ_o = 12 ;
if edu_o = 3 then educ_o = 14 ;
if edu_o = 4 then educ_o = 16 ;
if edu_o = 5 then educ_o = 18 ;
if educ_o = . then educ_o = 12 ;

if edu_s = 1 then educ_s = 9  ;
if edu_s = 2 then educ_s = 12 ;
if edu_s = 3 then educ_s = 14 ;
if edu_s = 4 then educ_s = 16 ;
if edu_s = 5 then educ_s = 18 ;
if educ_s = . then educ_s = 12 ;

**********  Regional Dummy  *********************************************;
```

```
if state= 1  or state= 21 or state= 28 or state= 47 or
   state= 5  or state= 22 or state= 40 or state= 48 or
   state= 10 or state= 12 or state= 13 or state= 24 or
   state= 37 or state= 45 or state= 51 or state= 54
   then r_south=1 ;  else r_south=0 ;

if state= 4  or state= 6  or state= 8  or state= 16 or
   state= 30 or state= 32 or state= 35 or state= 41 or
   state= 49 or state= 53 or state= 56
   then r_west=1 ;  else r_west=0 ;

if state= 17 or state= 18 or state= 19 or state= 20 or
   state= 26 or state= 27 or state= 29 or state= 31 or
   state= 38 or state= 39 or state= 46 or state= 55
   then r_midwe=1 ;  else r_midwe=0 ;

if state= 9  or state= 23 or state= 25 or state= 33 or
   state= 34 or state= 36 or state= 44 or state= 50
   then r_norea=1 ;  else r_norea=0 ;

**********  Type of Farming Dummy  ***********************************;

if type_f= 1  then t_grain = 1  ; else t_grain = 0 ;
if type_f= 2  then t_crops = 1  ; else t_crops = 0 ;
if type_f= 3  then t_crops = 1  ; else t_crops = 0 ;
if type_f= 4  then t_crops = 1  ; else t_crops = 0 ;
if type_f= 5  then t_crops = 1  ; else t_crops = 0 ;
if type_f= 6  then t_crops = 1  ; else t_crops = 0 ;
if type_f= 7  then t_crops = 1  ; else t_crops = 0 ;
if type_f= 8  then t_crops = 1  ; else t_crops = 0 ;
if type_f= 9  then t_beef  = 1  ; else t_beef  = 0 ;
if type_f= 10 then t_livst = 1  ; else t_livst = 0 ;
if type_f= 11 then t_dairy = 1  ; else t_dairy = 0 ;
if type_f= 12 then t_livst = 1  ; else t_livst = 0 ;
if type_f= 13 then t_crops = 1  ; else t_crops = 0 ;
if type_f= 14 then t_crops = 1  ; else t_crops = 0 ;

**********  Race Dummy  **********************************************;

 if race_o  = 1  then white_o = 1  ; else white_o = 0 ;
 if race_o  ne 1  then nonwt_o = 1  ; else nonwt_o = 0 ;

 if race_s  = 1  then white_s = 1  ; else white_s = 0 ;
 if race_s  ne 1  then nonwt_s = 1  ; else nonwt_s = 0 ;

**********  Health Problem Dummy  ************************************;

if hlth_o = 1 then health_o = 1 ; else health_o = 0 ;
if hlth_s = 1 then health_s = 1 ; else health_s = 0 ;

**********  Health Insurance Coverage Dummy  *************************;

if cov_o = 1 then cover_o = 1 ; else cover_o = 0 ;
if cov_s = 1 then cover_s = 1 ; else cover_s = 0 ;

**********  Type of Work Dummy  **************************************;

if type_o= 1  then wad_o = 1  ; else wad_o = 0 ;
if type_o= 2  then wte_o = 1  ; else wte_o = 0 ;
if type_o= 3  then wpd_o = 1  ; else wpd_o = 0 ;
if type_o= 4  then wse_o = 1  ; else wse_o = 0 ;
if type_o= 5  or type_o = 0 then wot_o = 1  ; else wot_o = 0 ;

if type_s= 1  then wad_s = 1  ; else wad_s = 0 ;
if type_s= 2  then wte_s = 1  ; else wte_s = 0 ;
if type_s= 3  then wpd_s = 1  ; else wpd_s = 0 ;
if type_s= 4  then wse_s = 1  ; else wse_s = 0 ;
if type_s= 5  or type_s = 0 then wot_s = 1  ; else wot_s = 0 ;

**********  Raised on a Farm Dummy  **********************************;

if rais_o = 1 then raise_o = 1 ; else raise_o = 0 ;

**********  Off-Farm Work Time Constraint Dummy  *********************;

if tim_o = 1 then time_o = 1 ; else time_o = 0 ;
if tim_s = 1 then time_s = 1 ; else time_s = 0 ;

**********  Difficulty Finding Off-Farm Job Dummy  *******************;

if fin_o = 1 then find_o = 1 ; else find_o = 0 ;
if fin_s = 1 then find_s = 1 ; else find_s = 0 ;

**********  Ownership of Dwelling Dummy  *****************************;

if own = 1 then owner = 0 ; else owner = 1 ;

**********  Location of Dwelling Dummy  ******************************;

if resid = 1 then reside = 1 ; else reside = 0 ;
```

```
********  Safety of Farming Dummy  ***********************************;
if safe > 0 then safety = 1 ; else safety = 0 ;
**********  Off-Farm Participation Variable  *************************;
if ohr_o > 0  then parti_o = 1 ; else parti_o = 0 ;
if ohr_s > 0  then parti_s = 1 ; else parti_s = 0 ;
```

VITA 2

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Doctor of Philosophy

Thesis: NON-PECUNIARY BENEFITS AND FARM AND OFF-FARM LABOR SUPPLY OF FARM HOUSEHOLDS.

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