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LABOR TIME ALLOCATION DECISIONS OF LOW FARM-INCOME FAMILIES IN MICHIGAN

Michigan State University PH.D. 1981

LABOR TIME ALLOCATION DECISIONS OF LOW FARM-INCOME FAMILIES IN MICHIGAN

By

John R. Shields

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ABSTRACT

LABOR TIME ALLOCATION DECISIONS OF
LOW FARM-INCOME FAMILIES IN MICHIGAN

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The central concern of this research has been to determine what Personal-Household attributes and Farm-Business characteristics are statistically significant in their association with annual hours-of-work for both on-farm and off-farm labor supply. First, the family attributes of age, schooling, number of children, farming experience, market wage rate, spouse labor income, investment income, and county residence are examined. Then, the farm characteristics of assets, debts, acres rented in, and agricultural income were included as explanatory variables.

The population studied consists of all small farm households earning under $20,000 annually from gross agricultural sales in 1973 and located in Michigan's lower peninsula. A stratified random sample, comprised of 243 low farm-income households, was drawn from the ten different counties included in a general baseline survey of small family farms conducted in 1974 under the auspices of the department of agricultural economics.

The household production function model is used to analyze the time allocation decisions of individual male and female heads of households in an interdependent framework. Consumer choice theory underlies the labor supply function

while human capital theory is used to specify the wage earnings function.

Multiple regression analysis using ordinary least squares was selected as the optimal method of estimation, given the complexity and cost of more sophisticated estimation procedures as well as the inherent limitations of the data utilized. An instrumental variable technique was employed to impute the off-farm wage rate for the entire sample based on earnings information reported by the subsample of working male and female heads of households.

The Farm-Business model performed better than the Personal-Household model in terms of higher $\bar{R}^2$ values for the on-farm and off-farm labor supply equations of both sexes. The explanatory variables of the two models generally had the correct signs; that is, they are in conformity with the theoretical expectations derived from a thorough review of relevant literature. The lone exception is the negative sign, significant at the .01 level, for the county residence (in a Standard Metropolitan Statistical Area) variable in the female off-farm equation of the Personal-Household model.

The addition of animal and crop enterprise variables to the Farm-Business model substantially raised the explanatory power of the equations and gave the expected signs with respect to their degree of labor intensity. However, for lack of a strong theoretical base the results are reported in an appendix. Future explorations in the more complete formulation of this model might justify its validity.

Labor supply decisions are more properly examined in a life cycle context; but in the absence of longitudinal data the cross-section sample was stratified by three age categories to approximate 'representative' stages that correspond to entry, growth and disinvestment in agriculture. The results do not support the proposition that life cycle differences exist in the labor supply of household members. But this may be due to a sampling design that produced too few elements in the youngest age group.

By way of generalization the estimations of the Personal-Household and Farm-Business models produced results that are fully consistent, not only with economic theory, but also with the empirical findings of similar studies of farm households in Illinois, Iowa, and North Carolina.

DEDICATION

To

All Those Languishing A.B.D.'s

Striving To Finish Their Ph.D. Dissertation:

"The brain will not fail, when
the will to achieve is in earnest."

Don Juan in Hell

The Dream Sequence
Man and Superman
by George B. Shaw

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No research is possible without data; so I am truly grateful for the cooperation of Professor Ralph Hepp in granting me access to the Michigan Small Farm Family Program survey information collected under his direction.

And for welcoming my initial expression of interest in small farm research and encouraging me to pursue my specialization in labor economics in his capacity as the initial Chairman of my dissertation committee before his departure overseas, I offer thanks to Professor Warren Vincent.

Computer programming assistance was absolutely essential for the successful completion of this research, and I was fortunate to have had the instructive help of two very find individuals -- Dave Zeitler and Hank Griffen.

Finally, putting pen to paper is only the start; transforming the written scrawl into lasting print is what gives the writer his ultimate satisfaction. So, for her tireless efforts on my behalf a sincere vote of thanks for a job well done goes to Sandy Bolton, whose skills as a typist are a marvel to behold.

* * * * *

Though words cannot possibly express the depth of my heartfelt appreciation for her moral and financial support during the writing of this dissertation over a few too many Michigan winters, I am compelled at the very least to acknowledge the personal and professional sacrifices made on my behalf by my loving wife Elizabeth. To you, I owe all!

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CHAPTER I

NATURE AND SCOPE OF RESEARCH

In this beginning chapter the research problem is first defined and circumscribed (section A) and then addressed in terms of stated assumptions and working hypotheses, which contribute to the formulation of research objectives for this study (section B). Finally, the rationale and validity of the proposed research is made explicit (section C).

A. PROBLEM DELINEATION

1. PROBLEM STATEMENT

Briefly stated, the central concern of this research is to determine what Personal-Household attributes and Farm-Business characteristics are statistically significant in their association with annual hours of on-farm labor supply.

A related, but subsidiary, problem is to find out which of the above mentioned type variables influence the amount of annual hours of off-farm labor supply to wage employment -- full or part time. Investigating this aspect of time allocation is symmetrical to the on-farm study and may offer additional insights in understanding more completely the main problem stated above.

The forces in question are identified as follows:

(a) Personal-Household attributes of the husband and wife -- age, schooling, number of children, farming experience, market wage rate, spouse labor income, investment income, and county residence.

(b) Farm-Business characteristics -- farm assets, farm debts, acres rented in, and agricultural income. (NOTE: These variables will be formally defined in section C-2 "Explanatory Variables" of Chapter IV.)

2. INVESTIGATIVE BOUNDARIES

The subject group was narrowly defined by Thompson [1975], who collected the data, to include only those farm operations located in Michigan's lower peninsula whose enterprise type and levels would not normally have been expected to generate more than $20,000 annual gross agricultural sales as of the survey data year 1973. The precise qualifying definition used on the survey questionnaire was 10 acres or more of land and enterprises smaller than:

Dairy -- 25 milk cows + feed crops

Cash grain -- 220 tillable acres

Beef cattle feeding -- 100 feeders + feed crops

Beef cow and calf -- 80 cows + feed crops

Farrow and finish swine -- 30 sows - 2 litter system + feed crops

Feeder pig production swine -- 60 sows - 2 litter system + feed crops

Feeder pig finish swine -- 500 feeders + feed crops

Poultry -- 3,500 laying hens + feed crops

Fruit -- 40 acres

This definition of a small farm is taken as given, though extensive debate over what constitutes a 'small farm' (or even just a 'farm') has been widely reported in the literature -- without satisfactory resolution to all contesting parties [Brewster 1977; Foote 1970; Hildreth and Worden 1976].

Our use of the term "low farm-income" families in the title of this study reflects the choice of agricultural sales classes as a criteria for sample selection. However, it should be noted that although such low farm-income households are what is more popularly referred to as small farmers, the latter are not necessarily low-income farm families -- given the alternative sources of income available to an operator and spouse.

No attempt was made to classify farms according to established Agricultural Census categories of primary and part-time based on the proportion of an operator's work time spent on his agricultural enterprise.

B. PROBLEM RESOLUTION

1. UNDERLYING PROPOSITIONS

Two fundamental, albeit untested, premises are set forth about the population from which the sample of small farm operators was drawn and to which inferences will be made as a result of this study. They are: (a) small farm household heads are individually rational in their actions pursuant to their expressed goals; (b) small farm households

possess an explicitly stated or implicitly understood goal function which is presumed to be rooted in the maximization of utility.

More specifically, a fair return on the investment of their land, labor, and capital resources is sought through their 'efficient' employment for a given state of managerial and technical knowledge, which may vary among farmers.

Admittedly, such propositions cannot fully account for farming as a leisure activity (e.g., especially among the high total-income 'hobby' farmers) where utility, but not necessarily further income, maximization is paramount. But in the main they have some reasonable basis as evidenced by the findings of Olson who concluded that "this research also indicated that small farm operators reported a desire to increase income from the small farm" [Olson 1978, p. 123]. Moreover, his study showed that "Tests of rationality indicated that there was no significant difference between small, medium, and large farmers in terms of rationality of decision making" [Olson 1978, p. 128].

2. WORKING HYPOTHESIS

Economic theory, past empirical work, and logical reasoning suggest certain and possible relationships between some of the aforementioned variables and on-farm and off-farm labor supply, the anticipated directions (positive or negative) of which are discussed more fully in the research design chapter. The expected signs (+, -, o) represent the research/declarative form of hypotheses; however, the actual

estimation of these relationships will be in the form of the statistical/null hypothesis (i.e., that the variables have no significant effect on labor supply). The reasoning behind each of these hypotheses is presented in the DISCUSSION paragraph immediately following the measurement description of each "Variable Definition" in section C-2 of Chapter IV.

3. RESEARCH OBJECTIVES

The primary aim is to determine what influence, if any, the foregoing factors may have on the amount of labor time allocated to on-farm and off-farm work activity of small farm operators and their spouses. Of particular interest are the variables for which some theoretical basis exists for hypothesizing a relationship; that is, does standard labor supply theory, developed with the urban dwelling, single-job-holding population in mind, also hold for the rural domiciled farmer with multiple-job-holding opportunities. There is no reason to suspect not. Also of interest are the potentially different influences of the same variables on male operators and their wives with respect to labor supply decisions. A comparison of research results will be made with similar previous studies for their empirical consistency.

C. RESEARCH JUSTIFICATION

1. RESEARCH RATIONALE

The M.S.U. SMALL FARM PROGRAM reflects a nationwide awakening to the special needs of small farmers and the

associated problems of low income. Witness the titles of Congressional Hearings held in the mid 1970's: "Will the Family Farm Survive in America?" (1975); and "Assistance to Small Farmers in Upgrading Their Operations" (1976). These, in part, were a response to the critical 1975 report to Congress by the Government Accounting Office's (G.A.O.) Comptroller General entitled "Some Problems Impeding Improvement of Small-Farm Operations: What the Department of Agriculture Could Do, But Doesn't!" The Report pointed out that:

> The Department and land-grant colleges have not made a concerted effort to solve problems impeding the economic improvement of small-farm operations. Also they have not adequately (1) evaluated the economic and social impacts of production-efficiency research nor (2) determined the assistance that small-farm operators need to plan for and adjust to changes brought about by such research. [U.S. G.A.O. Comptroller General 1975, p. ii]

The Michigan Cooperative Extension Service, in conjunction with Michigan State University's Department of Agricultural Economics, has made a commitment to assist small farmers. Accordingly, certain monies have been earmarked for this client group in the late 1970s -- with specific outreach activities being initiated and supportive research projects being undertaken.

Program goals have been formulated for meeting the needs of full-time, part-retired, and part-time farmers [Hepp and Halsey 1978]. They include such broad aims as locating those farmers not currently being served by existing agricultural production and marketing programs; helping farmers clarify

their personal goals and specify their economic objectives for the farming operation; provide basic information on land use, enterprise selection, water management, machinery purchase, pesticide application, estate planning, etc.; and promote learning experiences to show these farm households how to utilize their resources efficiently.

Among the research projects sponsored by the Agricultural Experiment Station having an orientation toward limited resource farmers were "The Role of Small Farmers in the Agricultural Production System" (Vincent 1973-78) and "Analysis and Application of Farm Accounting and Business Management Data" (Nott 1973-76). Doctoral dissertations completed in the Department of Agricultural Economics are "Description and Analysis of Limited Resource Farmers in Michigan" [Thompson 1975] and "Non-Formal Education Delivery Systems to Reach Limited Resource Farmers in Michigan" [Olson 1978]. This dissertation involves further analysis of the survey data collected by Thompson under the supervision of Hepp.

2. PROPOSAL VALIDITY

The research on labor time allocation decisions of low farm-income families in Michigan proposed herein meets the four basic criteria of a valid study: (1) appropriateness -- it addresses a legitimate public policy issue of how the Cooperative Extension Service can (no longer a matter of 'whether it should') identify and assist more than the current 30% of small-farm operators being reached, and to

better understand what factors are associated with more or less on-farm activity; (2) uniqueness -- Michigan, unlike the States of North Carolina, Iowa and Illinois where similar on-farm labor supply studies of farm households were conducted, is a highly urban-industrialized region with substantial off-farm job opportunities well dispersed geographically so that a wide variety of employment positions are generally within reasonable commuting distance of most Michigan small-farm operators and spouses. Such wage employment possibilities constitute a competitive choice with on-farm work for substantial numbers of the State's farm population. In addition, this study is not narrowly focused on the influence of supplementary income grants on labor supply of farm households participating in a negative income tax program (e.g., R.I.M.E.) but instead examines the influence of a wide range of variables broadly classified as Personal-Household attributes and Farm-Business characteristics for which data is available; (3) feasibility -- Consumer choice theory underlying labor-leisure decisions is well developed; and household behavior models of labor supply are generating consistent results. Econometric estimation methodology for cross section analysis of labor supply equations is widely discussed in the empirical literature, though admittedly there are many unresolved issues surrounding non-sampling error biases. And relevant usable data is available for analysis from a 1974 sample survey of 243 lower peninsula small-farm households by Thompson [1975];

(4) generalizability -- By virtue of the geographic area sampled the results can be inferred to the bulk of Michigan's small-farm population. These results can then be compared with those found in other states. Moreover, replication elsewhere of the research design is also possible.

SUMMARY

With the problem defined and its scope delimited to discovering what household attributes and farm characteristics are associated with changes in the on-farm labor supply of Michigan operators and spouses in low farm-income households, this chapter then sets forth the underlying assumptions, working hypotheses, and research objectives of and justification for this dissertation. It thus has focused the following review of literature on hours-of-work labor supply studies with particular reference to farm-household decision making.

CHAPTER II

REVIEW OF RELEVANT LITERATURE

This chapter constitutes a critical examination of the general labor supply literature for both urban and farm populations. It provides an exposition of the theoretical foundations and analytical paradigms (section A), discusses the pros and cons of alternative estimation techniques for available data bases (section B), and finally reviews the various research that has special reference for the study herein of Michigan farm households (section C).

A. CONCEPTUAL FRAMEWORK

1. THEORETICAL FOUNDATIONS

The study of labor time allocation decisions is rooted in the complementary economic theories of consumer demand and human capital, explored below.

a. Consumer Demand Theory

The traditional theory of consumer behavior underpinning labor supply analysis (i.e., labor/leisure dichotomy) stems from Lionel Robbins classic article [1930] on supply of labor in terms of demand for leisure. This led to fruitful analyses of the effects of income and prices (i.e., wage rates) on the supply of labor, even though it subsequently

became apparent that the single category of 'leisure' as a sole alternative to market work was inadequate. This traditional theory rests on the view that an individual attempts to maximize utility U, which is obtained directly from the services provided by the goods x_i purchased in the market -- all in a single period framework.

$$U = u\ (X_1,\ X_2,\ .\ .\ .,\ X_n)$$

The consumer's utility is subject only to his money income (I) constraint:

$$I = \sum_{i=1}^{n} x_i p_i$$

The purchasing power of money income (I) is determined by product prices (p_i) prevailing in the market place. Consumption of a good is, thus, determined by a person's income, market prices of each good, and the residual variable called taste (T) which is included for sake of completeness,

$$D_{x_i} = d\ (\frac{I}{p},\ \frac{p_i}{p},\ T)$$

where p is a price index used to express variables in real terms. An important implication of the foregoing is that price income-compensated changes in the relative price of any good lead to changes in the opposite direction in the quantity demanded of that good.

An inherent weakness of this received theory of consumer demand (i.e., choice) is its inability to cope adequately with behavioral decisions involving choices related to non-monetary factors (e.g., allocation of a consumer's nonmarket

time; deciding on family size), which necessarily restricts its application to the market sector. Moreover, household survey data analyzed heretofore show that the independent variables, income and prices, explain only a small part of the variation in the demand for specific goods, whereas the proxies for taste (such as family size, family age-structure, education, occupation, race, and socio-economic status) exhibit systematic effects on behavior [Ferber 1973, p. 1315]. This undue reliance on the catch-all 'taste' as an explanatory variable in the demand function for market goods, though logical, seems unwarranted inasmuch as neither economics, nor any other discipline for that matter, has a well-developed theory of taste that can explain how it is formed or predict its effects.

A modern reformulation of standard consumption theory has been proposed by Becker [1965] with variations by Lancaster [1966] and Muth [1966]. This 'new' approach actually resurrects an earlier, albeit rudimentary, one attributable to anthropologist Margaret Reid [1934], who in her book Economics of Household Production focused attention on the unpaid activities of household members that substitute for goods or services obtainable in the market. The neo-household approach of Reid's successors is, thus, more noteworthy for the formal development of its implications than for its original conceptualization.

This household production function (HPF) approach consists of three main components: goods and services purchased

in the market place; the time of a household member divided between market work and aggregated non-market activities (i.e., homework and leisure); and the activities and/or commodities produced by the household. The household, comprised of its individual members, is viewed as both a producing and consuming unit that sequentially: (1) draws on its capital assets (e.g., savings) and nonlabor income (i.e., property derived; not government transfers), and/or supplies some of its available time (i.e., labor) to the wage market in quantities sufficient to accumulate income needed to acquire (i.e., buy) market goods and services; (2) these goods and services are then combined as 'inputs,' sometimes with portions of remaining household member time (t_i) to produce output called commodities (or characteristics); (3) from these commodities utility is then directly obtainable in consumption -- an activity for which additional time is required.

> The optimal allocation of time is quite analogous to the optimal allocation of income. One's time resource must be so distributed as to give an equal yield in all sectors of use. Otherwise, it would pay to transfer time from an activity with a low yield to one with a high yield ... until equilibrium had been reached. [Linder 1970, p. 3]

Under this formulation these household produced commodities would also include what is popularly called 'leisure,' that is, pure time activities (such as beach combing) or time intensive commodities (such as playing golf) which combine physical goods with time inputs to "produce" recreation. However, no formal distinction is usually made between homework

and leisure.

Hence, a consumer's demand for market goods/services are not desired for their own sake (i.e., direct utility), but only as inputs, usually in combination with time, into the home production of commodities which are then consumed by the household. They are not exchanged in the marketplace and thus have no explicit market price; though their value (adjusted for product quality differences) may be determined by pricing market equivalents. Thus, a production decision also represents a consumption decision, and the two processes can be considered one and the same [DeTray 1973, p. v]. This type of decision is dependent upon the price of market goods/services and the value or scarcity of time. Note that although the production/consumption decision is of a simultaneous nature, the production and consumption activities are separate and sequential [Pollack and Wachter 1975, p. 255].

The cost of producing these household commodities depends upon the price of market goods/services (i.e., the competitive market value), the opportunity cost of time (i.e., the old "time is money" adage, using either observed market wages or asking non-market wages for those not working), and an imputed rate of return to household capital (e.g., interest on savings). For instance, "the more valuable time is to the household, relative to the price of market goods/services, the higher the cost of all commodities -- especially those whose production requires relatively large amounts of time" [Detray 1977, p. 2].

As households attempt to maximize their utility and minimize their production costs, they respond to: (1) changes in both the prices and productivity of factors, (2) changes in the relative shadow prices of household commodities (i.e., only implicit prices can be used in the absence of market prices), and (3) changes in their full real income.

Some examples of maintained hypotheses follow. A reduction in the price of some factor of household production (e.g., a market bought good such as an automatic washing machine) will shift the household production process toward techniques that are more intensive in the use of that factor, and away from methods that make intensive use of other factors (e.g., hand wringer wash tub and household time) as well as toward commodities that use the newly lowered priced factor relatively more intensively.

Alternatively, if the price of one factor (e.g., a household member's time, measured in terms of an individual's market wage rate representing the opportunity cost of time or the money equivalent of marginal utility of work) [Gronau 1970, pp. 10-11] rises relative to another factor (e.g., a market bought service such as automobile repair), it will, ceteris paribus, cause a substitution in the production process of a commodity (e.g., automobile maintenance) away from time intensive modes (e.g., household members time combined with a do-it-yourself tune-up kit) and towards a more money-intensive method of production involving an

increased use of market bought goods/services as inputs (e.g., commercial car repair service).

This relative factor price change will also result in a substitution in consumption in favor of goods-intensive activities [Gronau 1970, pp. 10-11] such as cooking with time saving microwave ovens. Cooking, by the way, is also one of those household activities akin to child rearing, that is difficult to distinctly identify as production versus leisure. It obviously can combine both elements, not too unlike 'hobby' farming! We should also point out here that household time is not necessarily a required input for every commodity produced at home. (e.g., Heat can be produced automatically by combining the market bought goods of a furnace and gas as opposed to the old fashioned wood burning stove which required time for log chopping and fire stoking.)

But, of course, the acquisition of such market goods as inputs to the household production and consumption processes requires that more household member time be supplied to market work in exchange for money with which to purchase such goods and services.

Naturally, one can also observe intrahousehold substitution among members' labor as the value of time (i.e., offered wage rate in the market) of one individual rises relative to others in household production activity. An example would be a mother who turns over the care of a younger child to her older children while she secures a wage market job.

Likewise, if the marginal productivity of a mother's

time in household production is valued higher than her market wage offer, ceteris paribus, she is likely to opt for household production activity. An example parallel to the last, involves the commodity of intellectual skill development in the early formative years of a child under 3, for which there is no available market service (e.g., day care babysitting) nor even a non-market substitute (e.g., older child in household) for the mother's input of time. Of course, the ceteris paribus caveat ignores the impinging influences of taste for market versus non-market work, household income, and other factors which would affect labor supply decisions.

By way of formal summary of the preceding exposition, let the two person household's utility function be

$$U = u\ (Z_1,\ Z_2,\ .\ .\ .,\ Z_n)$$

where Z_j stands for both the services from and the quantity of the commodity Z_j, each of which has a separate production function (or technical constraint) of:

$$Z_j = z_j\ (X_i,\ H_{mi},\ H_{fi},\ E)$$

where X_i is the vector of market bought goods/services, where H_{mi} and H_{fi} represent home time of the male and female heads of household in the production of Z_j respectively, and where E represents a vector of environmental variables that reflect the technology level of household production (e.g., education, socio-economic background, health status, etc.) [Michael and Becker 1973, p. 382].

The equilibrium condition for utility maximization is that point at which the marginal utility of Z_j is equal to

the sum of the marginal costs of using both time and goods/services to produce Z_j, which are the arguments of the household's utility function, instead of the market bought goods/services in the conventional theory of consumption behavior [Ferber 1973, p. 1323].

In addition, there are the total time (T) constraints of the husband and wife:

$$T_m = N_m + H_m + L_m$$

$$T_f = N_f + H_f + L_f$$

where N is market labor time, H is home production time, and L is leisure/consumption time; and there is the income (I) budget (i.e., goods/services) constraint:

$$I = \sum_{t=1}^{T} R_t \sum_{i=1}^{n} (p_i X_i)_t$$

$$= \sum_{t=1}^{T} R_t \, (w_{mt} H_{mt} + w_{ft} H_{ft}) + A_o$$

where p_i is the price of a unit of services of market goods X_i which both incorporates the discounted value of initial assets and can be transferred between periods, w_{mt} and w_{ft} are the respective wage rates for males and females, A_o is the discounted value of non-wage property income (i.e., initial assets), and where $R_t = 1/(1 + r_o)\ (a + r_o)\ (1 + r_1)\ .\ .\ .\ (1 + r_t - 1)$ is the discounted value at the beginning of period zero of one dollar received at age t [Ghez and Becker 1975, pp. 3-4 and 32].

These time and income constraints, which are not independent, can be collapsed into a single household

constraint of full income (F) accounting for the total resources of time and income:

$$F = \sum_{t=1}^{T} R_t \sum_{i=1}^{n} [p_i X_i + (w_{mt} H_{mt} + w_{ft} H_{ft})]$$

$$= \sum_{t=1}^{T} R_t \, [wT_m + wT_f + A]$$

The left side of the equation shows how full wealth is spent: in part directly on goods, and in part indirectly by using time for consumption. If all time is spent at market labor activity (i.e., work) the right side of the equation would be the discounted value of money income called full wealth, the sum of human and property wealth [DeTray 1973, pp. 15-16; Ghez and Becker 1975, pp. 2-4 and 32].

To elaborate, full income is the potential money income that would be earned if all available household time were allocated entirely to its most profitable money generating activity [Becker 1965, p. 497]. For example, time can be converted into money via market work and hence into goods/services, thereby using less time in consumption and more at labor. The full income constraint represents the value of time in both market work and home production. The inclusion of consumption and leisure under non-market time means that for most households money income will be exceeded by full income, the latter being a better indicator of welfare since it reflects foregone earnings associated with labor time withholding [Fox 1975, p. 47]. Note that one family's potential full income can be greater than another, even

though it might conceivably have a lower money income -- perhaps by choice due to a different utility preference function. Full wealth, then, is the potential lifetime sum total of all household resources, including the total value of time, whether or not that time is spent in the market place working. The distinction is an important one because monetary earnings are not independent of how the household allocates its resources over its lifetime and therefore does not change from one period to another except for exogenous changes in the household's economic condition brought about by unanticipated gifts, inheritances, wage rate change, etc. Families obviously can alter their wealth through the investment decisions they make over a lifetime. In this framework these changes are not ruled out, but are assumed to be anticipated with perfect foresight. Operationally, this means that the household has some notion of its lifetime wealth position that changes very little from time period to time period and on which current consumption decisions are based [DeTray 1972, p. 15]. It is important to reiterate that the magnitude of this aggregate household resource constraint is independent of the fraction of time the household chooses to allocate to income earning activities in the wage labor market, which in the traditional theory of choice forms the basis of the income constraint.

The foregoing household production function approach is analogous to the theory of the firm in that the household, as a producing unit, invests in capital assets (savings), capital

equipment (durable goods), and training investments in its 'labor force' (human capital of family members) while maximizing its objective function subject to technological and resource constraints. But it must also make complex decisions in its capacity as an earning unit (e.g., allocating resources to the most profitable opportunities for members' time and money assets) and as a consuming unit (e.g., budgeting and investing wisely to raise the household standard of living).

Moreover, it must accept personal risks (e.g., illness and accidents to household members) and economic risks of change inflicted by the cumulative effect of other household decisions and in terms of fluctuation in aggregate incomes, and prices, and employment [Johnson 1975, pp. 47-48, 51]. Furthermore, an analysis of household decisions must consider the social and economic institutional setting that influences behavioral values and constraints [De Tray 1977, p. 6].

The perceived advantages of the household production function approach relative to traditional consumer choice theory can be summarized as follows:

1) Recognition that the family household, not its individual members, is the appropriate basic unit of analysis for examining decision making with respect to consumption behavior [Johnson 1975, pp. 47-48].
2) Attention paid to the non-market sector of household behavior by investigating changes in production technology and corresponding output of commodities, rather than

adherence to a restricted focus on market goods/services only as the direct source of utility.

3) Division of economic household behavior into production and consumption activities such that preferences for commodities are made distinct from the resources of market goods/services and household time, thereby relating the utility function exclusively to the former.

4) Inclusion of production technology levels that avoids confounding with undue dependence on taste variables for interpreting observed household behavior, thus strengthening reliance on changes in income as well as money and time costs associated with acquiring market goods/services, producing commodities, and eventually consuming them.

5) Incorporation of time, the ultimate limited and non-accumulative scarce factor, into the analysis of household behavior. Time becomes a fundamental unit of cost (along with the money price of market bought goods/services) in individual allocation decisions with respect to supplying wage labor toward acquiring the market goods/services, processing them into home produced commodities, and consuming same [Johnson 1975, p. 22; T. W. Schultz 1972, p. 844].

6) Examination of interdependent behavior of household members in a comparative advantage context whereby the relative productive efficiencies and opportunity costs of each family member enter the household decision making

function in determining time (i.e., labor) allocation among alternative uses. Such gains from trade within the family are in accordance with well established trade theory.

7) Represents a much needed effort to learn about the internal workings -- especially decision making processes -- of family households.

8) Makes money income resolvable into the work time required to earn it, so that consumption and labor supply decisions are both facets of the allocation of the basic resource possessed by every individual -- time.

9) Makes explicit the interdependence of several household decisions about:

   a) family labor supply, time, and consumption expenditures in a single time period;

   b) labor force attachments, family size, and expenditures on goods and human capital investments (e.g., education, on-the-job training) in a life cycle analysis.

The foregoing advantages not-with-standing the household production/consumption function (HPF) approach does have its limitations, the most general one of which is that it is still in its formative exploratory stages with much refinement necessary for empirical research on precisely stated and refutable hypotheses [DeTray 1977, p. 2]. Some of the principal drawbacks are:

1) The presumed existence of a single household utility

function as an aggregation of all family members' individual utilities is somewhat suspect.

2) Another problem in the application of the HPF approach is the assumption all household activities are production processes, whereas they may well be expressions of preference orderings. Moreover, it is difficult to determine where production functions stop and utility functions begin -- especially when direct empirical measures of 'commodities' produced and other relevant variables are not available [Pollack and Wachter 1975, p. 274].

However,

> Even if we have no observations on the production of commodities by the household, we can still study the allocation of time and goods among household activities. [That is to say,] ... We can still derive the demand function for the activity inputs as functions of P, w, and A. (P = good's prices, w = wage rate, A = non-labor income.) [Pollack and Wachter 1975, p. 275]

However, the foregoing does depend on our being able to distinguish the use of a market good/service or time in one activity from its use in other activities; and for time allocation, it must be possible to divide the day into non-overlapping activities. (i.e., Time cannot be used simultaneously in two activities.) Fortunately,

> If this can be done, then the allocation of goods among activities can be analyzed without the household production function apparatus! [Pollack and Wachter 1975, p. 276]

3) Another serious difficulty is the prevalence of joint production (i.e., where an activity has more than one

commodity associated with it and hence reduces the cost of producing each), most notably when time spent in a production activity is also a direct source of utility (i.e., work time may be a form of consumption as in the "joy of cooking," the fun of gardening, or the love of farming!). Therefore, it is only in cases of household indifference among alternative uses of their time that (a) the price of time will equal the marginal wage rate [Gronau 1970, pp. 10-11] and that (b) the household production/consumption function approach will provide a satisfactory account of the allocation of time [Pollack and Wachter 1975, p. 256].

It is recommended that:

> When household activities can more plausibly be interpreted as directly producing a specific type of utility or satisfaction, the appropriate alternative is to analyze the "inputs" -- the allocation of (market) goods and time among household activities -- as a function of (market bought) goods prices, the wage rate (i.e., cost of time), and non-labor income. [Pollack and Wachter 1975, p. 272]

Supposedly this framework still retains the insightfulness of the household production/consumption function approach's emphasis on household produced commodities, while dispensing with these two burdensome assumptions that aren't critical to the study of allocation of time and goods among activities -- provided only that these allocations are themselves observable [Pollack and Wachter 1975, p. 276].

4) The useful application of the HPF approach is also

contingent upon having the implicit commodity prices in the demand function independent of the commodity bundle consumed; but for this to be the case household production technology must be assumed to exhibit constant returns to scale and no joint production (i.e., separability) -- a restriction which, if violated, would mean that commodity prices depend on the household's consumption pattern and hence on tastes; that is, price differences among households reflect differences in taste as well as technology. This would render inaccurate the demand for commodities as a function of commodity prices. Yet, this was the very situation the household production/consumption function approach was designed to rectify [Pollack and Wachter 1975, pp. 256 and 269-72].

5) Finally, the HPF approach does not distinguish between time spent at home work (i.e., home production time) and time used in leisure (i.e., home consumption time). These functions should be separable, and not aggregated into one entity called "non-market" or "home" time and presented as a single alternative to market labor time [Gronau 1976, p. 2]. The importance of this was first pointed out by Mincer [1962] in his classic study of "Labor Force Participation of Married Women" and confirmed in subsequent research [Bloch 1973; Gronau 1976], which showed that "changes in the socio-economic environment (e.g., change in the wage rate, income, education, and number of children) have different effects

on work-at-home and leisure and on the allocation of time of husbands and wives" [Gronau 1976, p. 3].

b. New Home Economics

In an effort to make modern consumer demand theory more amenable to the practical difficulties of empirical research, Gronau [1976] has revamped Becker's HPF approach [1965], which allows only a dichotomous choice of time allocation between market and non-market time, to more closely approximate the tripartite analysis of market labor, housework, and leisure time pioneered by Mincer [1962], whose labor supply model was revitalized into the broader context of "new home economics" with implications for the study of many other topics: health maintenance, consumption patterns, savings and investments, transportation modes, education and training, information search and migration, marriage choices, fertility and family size, child care, etc.

Essentially, Gronau's model specifies that work-at-home (i.e., home production time) generates services which have a close substitute in the market, while leisure (i.e., home consumption time) has only poor substitutes in the market. It is assumed that personal work has at least some degree of disutility and that available labor service substitutes will be purchased in the market if the cost is sufficiently low. Correspondingly, use of a surrogate to enjoy leisure is impractical if not impossible [Gronau 1976, p. 6].

Using the HPF terminology, a household is said to

maximize its welfare:

$$U = u\ (Z_1,\ Z_2,\ .\ .\ .,\ Z_n)$$

by maximizing the amount of commodities, Z_j, each of which is a combination of goods and services (X) and consumption time (L):

$$Z_j = z\ (X_i,\ L_i)$$

These goods can either be purchased in the market (X_m) or be produced at home (X_h). It is assumed that Z is not affected by the composition of X, to which the household is indifferent in consumption. In fact $Z = z\ (X_m,\ X_h,\ L)$ has been demonstrated to have little predictive power [Gronau 1976, p. 6]. It is further assumed for simplicity that the commodity production functions (1) are linear homogeneous, (2) differ between commodities, and (3) are independent of each other (i.e., the production process of Z_1 is unaffected by the level and method of producing Z_2). Moreover, while fully cognizant of Pollack and Wachter's [1975] critique, Gronau [1976] nevertheless reluctantly assumes for simplicity sake that no joint production or consumption prevails. (NOTE: A detailed exposition is presented in section A-2 'Analytical Paradigms' of this chapter.)

c. Life Cycle Allocations

Consumer demand (i.e., utility) theory (e.g., optimizing goods and time allocation among alternative activities) and human capital (i.e., investment) theory (e.g., improving the mental and physical capabilities of human stock) are but partial views of the world. The effort

to integrate these approaches with reference to consumption and labor supply decisions has principally involved examining series of static utility maximizing choices over the life cycle [Ghez and Becker 1975] that would provide variation in consumption behavior with age. A fundamental premise of this life cycle approach is that households take account of expected future events when making decisions (e.g., goods consumption patterns and labor force participation) as first proposed in Fisher's [1930] theory of interest and planning over time, during which the value of time changes according to one's present life stage (i.e., age group) and thereby affects the household production/consumption technology chosen. Time intensive modes are more likely during both the early stage of schooling and the later period of retirement when time has a lower opportunity cost (i.e., value) and less working hours are supplied to the labor market -- relative to the prime age working years, when the value of time is higher (i.e., opportunity cost of leisure in terms of foregone earnings) and goods-intensive household processes predominate [Michael and Becker 1973, p. 389].

> When wage rates are high, not only is the production of each commodity relatively goods-intensive, but consumption shifts towards relatively goods-intensive commodities and away from time-intensive commodities. The latter (e.g., children or grandchildren) would be consumed more at younger and older ages if wage rates or more generally the cost of time rose at younger ages and fell eventually; conversely, goods-intensive commodities would be consumed more at middle ages. These age patterns in the consumption of time and goods intensive commodities strengthen the tendency for consumption time to fall initially (with age) and for goods

> to rise initially with age. [Becker 1975, p. 59]

Life cycle patterns of goods consumption and time usage have generally been analyzed by constructing "typical profiles" of a "representative" consumer [Smith 1975; Heckman 1976; Ghez and Becker 1975; Weiss and Blinder 1976; Ryder, Stafford and Stephan 1976] rather than by examining how a cross section of consumers respond to variations in such initial conditions as their wage rates, human and financial asset levels, market rates of interest, tax rates, etc. at identical ages in their life cycles [Heckman 1976, pp. S11 & 21]. The latter approach is one of "comparative dynamics" whereby "at each age, the consumer may be viewed as re-maximizing remaining life time utility," given initial conditions from previous optimal behavior [Heckman 1976, p. S22].

Obviously a dynamic mode is more appropriate for what is really a dynamic problem: the allocation of resources over an expected life span, during which today's decisions influence tomorrow's choices. Unfortunately, as more variables are progressively endogenated into dynamic models, it becomes increasingly difficult, if not well nigh impossible, to obtain explicit solutions to these models -- even if adequate longitudinal data were readily available [Stephan 1975]. However, dynamic models can be useful in alerting us to the interdependencies that exist and could possibly alter the conclusions of the simple models more commonly employed; as such, the former can provide a rigorous test of the latter.

James P. Smith has done the most in advancing labor supply research on "Family Decision-Making Over the Life Cycle" [Smith 1972, 1973, 1975]. Following Smith's lead numerous other researchers [DeTray 1973, p. 37; Da Vanzo and Greenberg 1973, p. 73] have acknowledged the necessity of a life cycle component by incorporating them into their models. However, rarely can they go beyond a pro forma inclusion for the lack of longitudinal data on which such multi-period empirical research should appropriately be done. Basically, what the life cycle aspect of labor supply attempts to account for is the effect of income generated by the accumulation of assets over a lifetime. It is thus presumed that during early periods of a household's work life, individual members (especially male heads) will supply more labor to the market when they are trying to get established (e.g., purchase of an initial home) than in later periods when disinvestment of fixed assets (e.g., sale of an oversized home, when the children have grown up and gone) in order to live off the more liquid capital gains and interest thereon.

d. Human Capital Theory

The other intellectual base, besides consumer choice theory, upon which labor supply analysis rests is human capital theory in terms of self investment decisions during a particular time frame and/or spanning several periods. Under Becker's revised specification [Becker 1975, p. 63] investment in human capital is the third major category (in

addition to market labor force activity and aggregated non-market production/consumption activity) to which time may be allocated. Human resource investment in oneself (or dependent children) is a time-intensive activity that can take the form of schooling, on-the-job training, personal health care, migration, etc. and involves expenditures (i.e., actual outlays for market goods/services as well as the opportunity cost of foregone earnings associated with sacrificed labor market time and earnings and/or home produced commodities) that contribute to the creation of more productive human stocks which can provide a stream of future services possessing both monetary and psychic value. Assuming a person knows his discount rate and probable remaining occupational lifetime over which monetary returns will be garnered, a rational cost/benefit analysis can be employed for human capital investment decisions.

Predictably, time spent building human capital declines with age as the present value of future returns decreases the cost of investment and rises in terms of foregone earnings [Becker 1975, pp. 64-65]. The psychic value return of human capital investment constitutes personal satisfaction derived from consumption activities, which in a HPF framework would include the all important use of non-market time in production (e.g., children as human capital investment can contribute to household production besides being objects of personal gratification to parents). Hence, human capital investments can expand the opportunity set of a household and

increase its "full real income" by raising the market value of time (i.e., the wage rate) and by raising the productivity of non-market consumption activities, through which a lower household commodity price index results [Michael and Becker 1973, pp. 389-90; Becker 1975, p. 67]. The increased productivity, and thus value, of human time can be attributed to two effects: a 'worker effect' whereby improved labor skills from human capital investment result in higher efficiency in production, and an 'allocation effect' whereby improved management skills result in increased efficiency in resource allocation in response to changing conditions (i.e., technology, market, etc.). The ability to adjust rapidly to disequilibrium has economic value, as the literature on the adoption of innovations -- especially in agriculture -- well documents [Welch 1970; Huffman 1974; T. W. Schultz 1975].

Human capital investments of education (formal schooling) and experience (on-the-job training) strongly influences the efficiency with which people are able "to perceive, to interpret correctly and to undertake action that will appropriately re-allocate their resources" [T. W. Schultz 1975, p. 827]. Such "allocative ability" presumes a household has full knowledge of its production possibilities and value thereof and uses rationality in the application of decision criteria (e.g., balancing marginal costs and marginal benefits) governing the allocation of household resources, the principal one of which is time --

proportionately more so, the poorer the household is in terms of wealth and non-labor income resources. The value of this time in alternative uses therefore reflects not only market conditions of demand and supply but also human capital investments -- hence, the contribution of Human Capital Theory to the analysis of labor supply decisions of households.

In terms of usual labor supply studies such human capital variables as health/disability status, job market experience (i.e., on-the-job training), and education (i.e., formal schooling) are included not only as determinants of hours of work, but also as determinants of the wage rate/ earnings which has a price-quantity relationship with hours [Mincer 1974]. The importance of human capital theory in this regard will be seen later during the discussion of instrumental variable techniques for imputing wages for both those who don't work in the wage market as well as those who do.

2. ANALYTICAL PARADIGMS

While the previous sub-sections on theoretical foundations included an exposition of not only consumer choice and human capital theories, but also the household production/ consumption model, this section will limit its focus to specific illustrations of the latter as it pertains to allocation-of-time decisions only.

The accompanying figures are merely modern extensions of the text-book labor-leisure choice diagrams (Figure II-1)

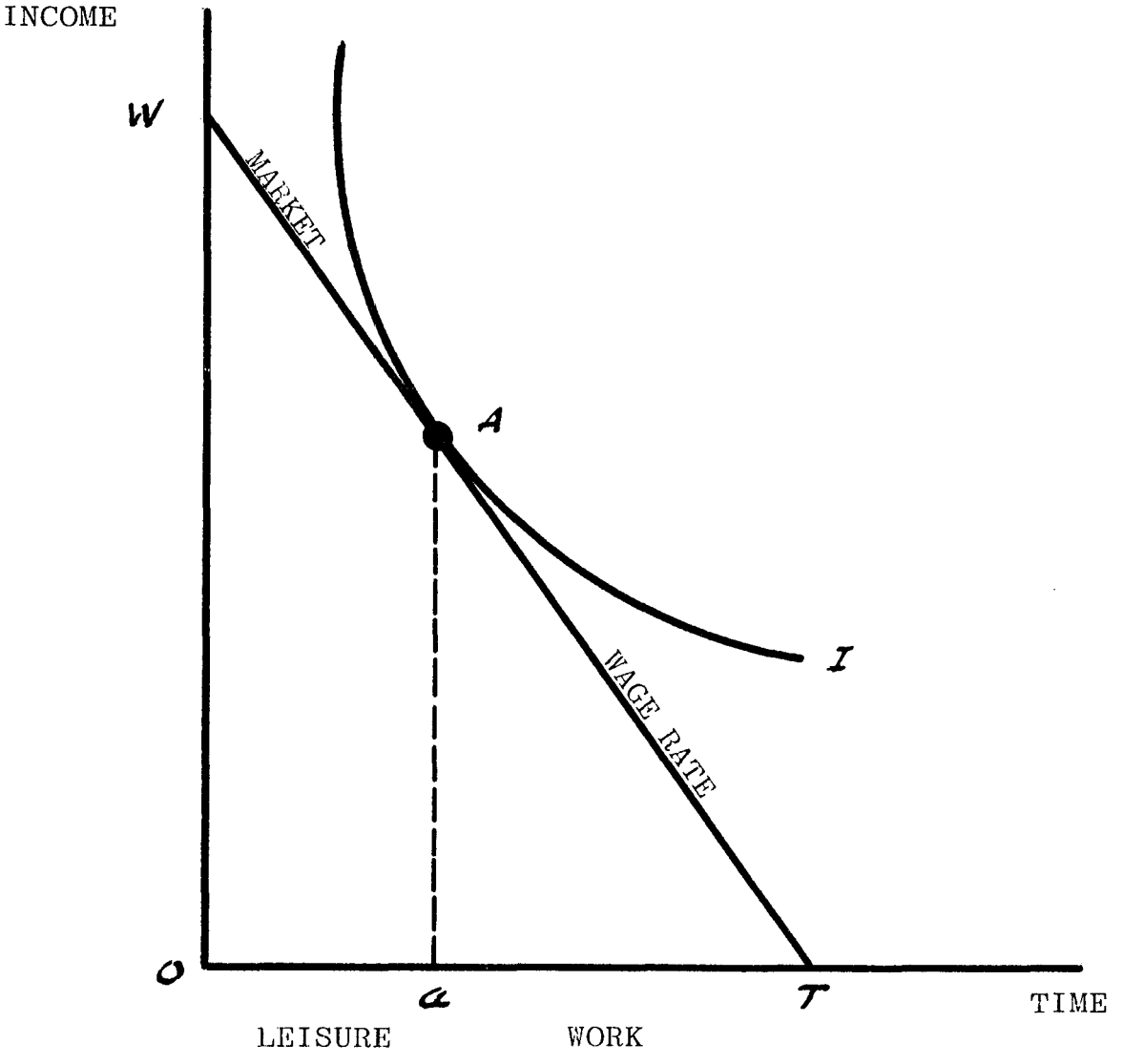

Figure II-1. Simple labor/leisure choice model.

that now incorporate household production as the third alternative in the decision framework.

In Figure II-2 we have on the vertical axis the composite good Z, representing the bundle of goods that can be made in the home or bought in the market as inputs for use (along with household time) in commodity production. Time is measured along the horizontal axis T, where OT would be a corner solution of full-time leisure with no home production and no purchased goods. Any interior solution along the concave opportunity frontier curve involves the use of time in activities other than leisure. Allowing for 8 hours of sleep in a 24 hour day leaves 16 hours for allocation between leisure, home production and market work. At point A, where the real market wage rate line WA is tangent to the opportunity frontier curve, it can be seen that aT (3) hours of time will be allocated to home production activity -- leaving Oa (13) hours for further allocation between leisure and market work.

The indifference curve I_1, signifying the household utility function, is drawn tangent to the real wage rate line WA thus revealing the time allocation preference of the decision maker. (NOTE: For purposes of simple exposition a single person household is illustrated; see Evenson [1978] for detailed presentation of the more complex graphical analysis of the two person household, complete with gains from specialization achieved through application of the comparative advantage principle.) Tangency at point B_1 indicates

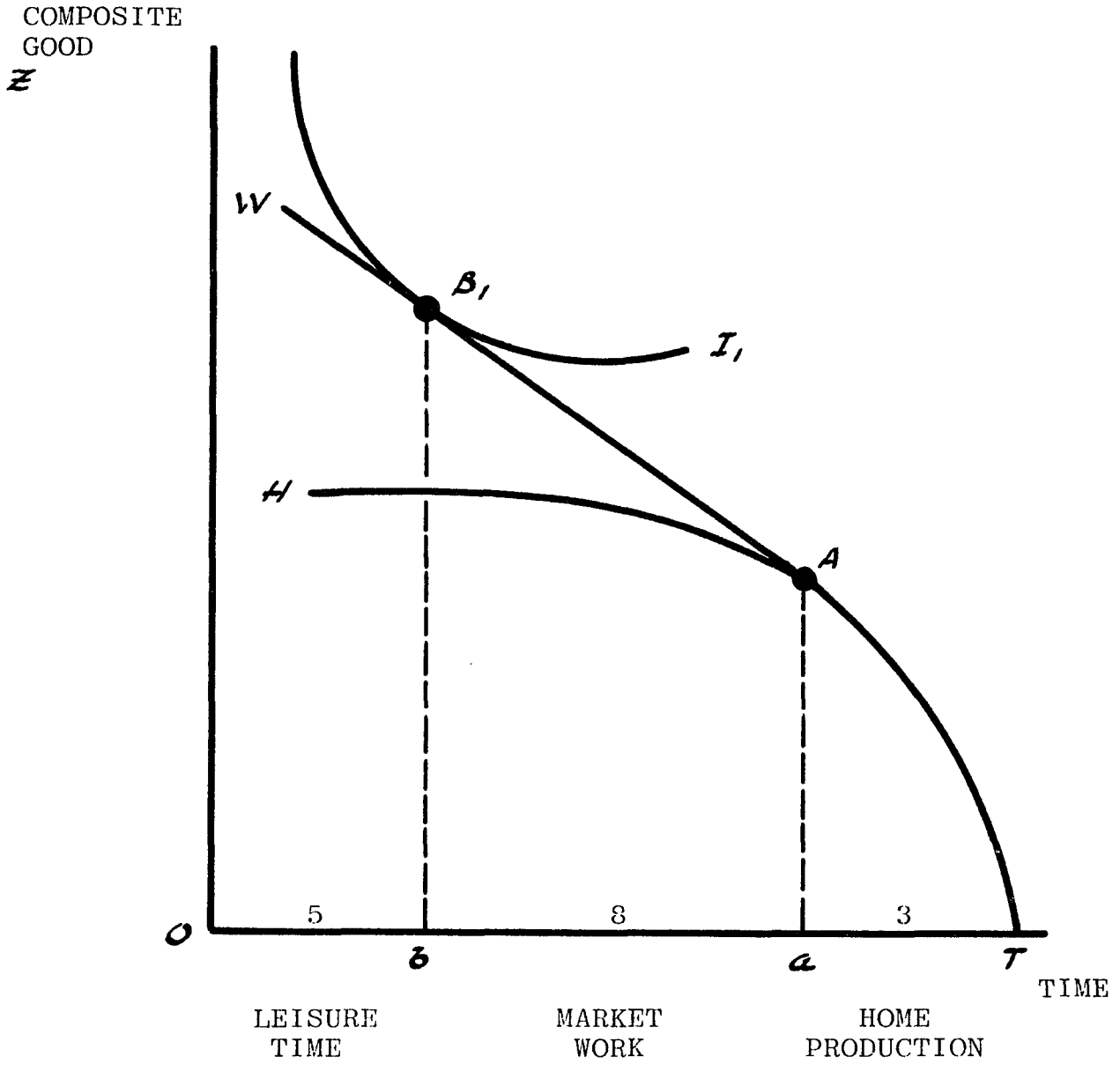

Figure II-2. Household production function model.

a decision to devote ba (8) hours to market work, leaving Ob (5) hours for leisure. The closer that point B is to the Z axis, the more goods-intensive (as opposed to leisure-intensive) is production/consumption.

Farm production can easily be incorporated into the basic household model already presented. In Figure II-3 there are two opportunity frontiers drawn -- the familiar home production curve HT, plus the combined home-and-farm production curve FT. The off-farm real wage rate line WC is shown tangent to the farm-and-home production possibilities frontier FL at point C, which divides available time into cT (7) hours for farm-and-home production activities and Oc (9) hours of leisure and market work. It is assumed here for purposes of illustration that the returns to labor are initially greater in agricultural production compared to off-farm wage employment, due to diminishing returns to labor on-farm for a given level of complementary inputs in production. This makes farm employment his primary job and off-farm employment his secondary job. The farmer will continue to work at his primary farm job so long as the marginal wage rate received from farming exceeds the wage he would gain from off-farm employment. However, when the off-farm wage offer WC rises above (i.e., becomes a steeper slope than) the marginal wage rate FC from farm work, the operator will be induced to transfer some of his work time to the off-farm job. That is, the farmer can move to a higher indifference curve tangent to the off-farm wage rate instead

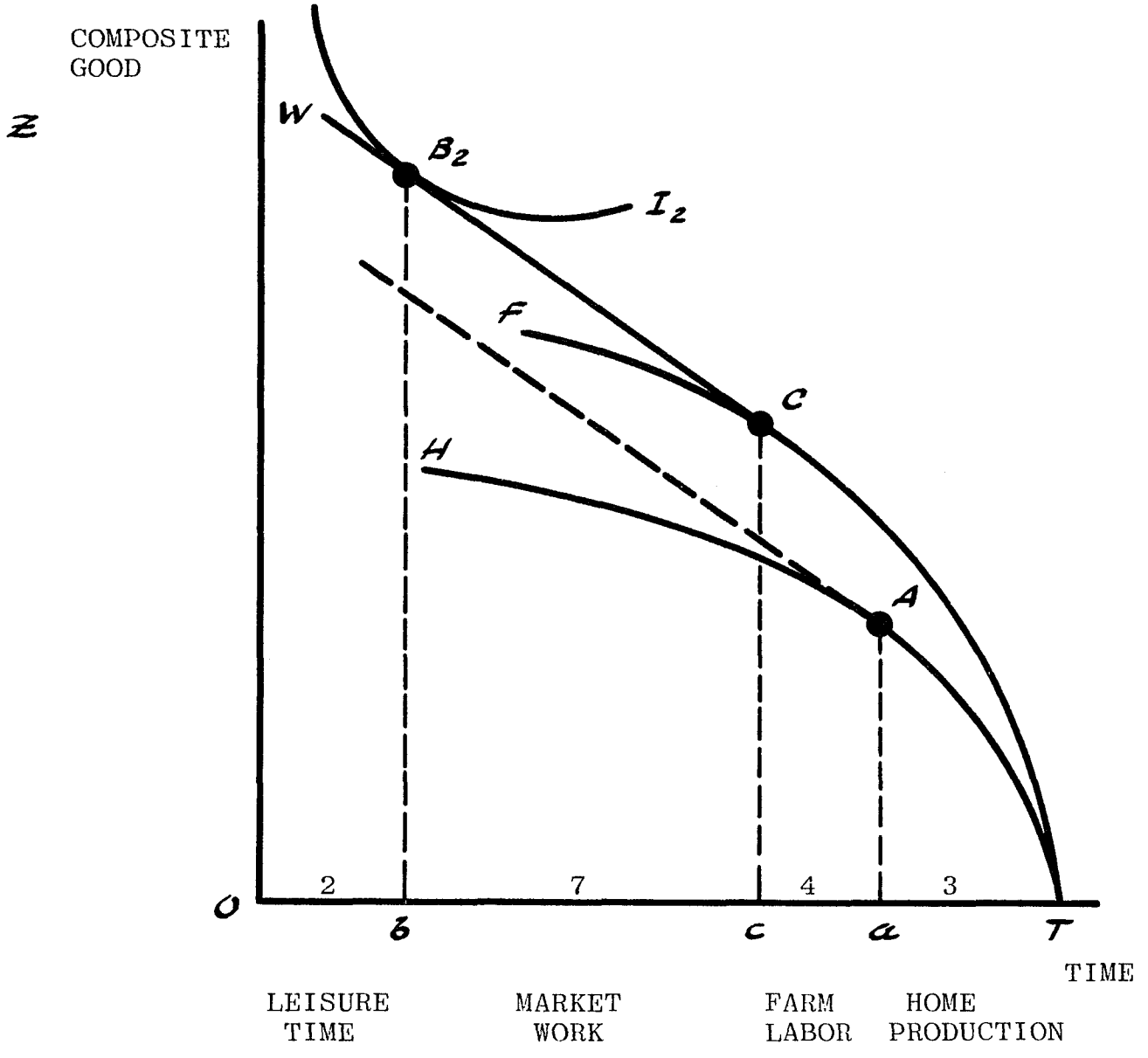

Figure II-3. HPF farm model and work/leisure preference.

of the on-farm wage rate.

The allocation of time between farm production and home production is determined by the location point A on the home production curve where its slope is equal to the real off-farm wage rate line WC. Hence, aT (3) and ca (4) represent the hours spent in production activity in the home and on the farm respectively. The indifference curve I_2 enables us to discover the household's preference between market work time bc (7) and leisure time Ob (2), which is determined by its tangency with the off-farm wage rate line WC at point B_2.

B. RESEARCH METHODOLOGIES

1. DATA BASES

Longitudinal or panel data is conspicuous by its general absence in labor supply studies. In light of recent development of the household life cycle model of decision making [Smith 1975] this type of data is badly needed. Unfortunately, such data that is available is usually of the five to ten year range, which constitutes at most only one stage of the full life cycle. The best data available in this regard is the University of Michigan's Income Dynamics Panel data upon which only a few labor supply studies have been conducted [Wales and Woodland 1976, 1977].

Cross section data is by far the most prevalent available. Many labor supply studies have been done on 1/1000 Census of Population data, mainly 1960 vintage [Kosters 1966, 1968; Ashenfelter and Heckman 1974; Ghez and Becker

1975]. The 1967 S.E.O. (Survey of Economic Opportunity) data has been a popular sample population for numerous labor supply studies -- especially those listed in one published compendium [Cain and Watts 1973]. The formulation of the household life cycle model has highlighted the limitations of cross-section compared to longitudinal data. But innovations in sample stratification (e.g., age cohort groups) and statistical techniques, in addition to economic modelling, have helped make this type data more amenable to estimation.

In recent studies of off-farm and on-farm employment of farm operators, the data examined have included: the 1973 USDA survey of 960 tobacco farmers in Virginia, North Carolina and South Carolina [Sexton 1975]; the 1971 statewide survey of 1400 farm operators in Illinois, collected under the auspices of the University of Illinois Department of Agricultural Economics [Sexton 1975; Barros 1976; Sumner 1978]; the 1964 U.S. Census of Agriculture [Huffman 1973], and the 1969-72 Rural Income Maintenance Experiment (R.I.M.E.) data on 250 Iowa and North Carolina farm family participants (plus control group farmers) [Bryant and Hager 1977; Kerachsky 1975, 1977; Primus 1975, 1977].

Sub-optimal as it is to have no recourse but to conduct analyses on data for purposes unintended by the original survey designers, it is even more distressing that the reliability of such general data is questionable -- being plagued with deficiencies like those noted for the regular U.S. Census of Agriculture [Ingram and Prochaska 1972],

which in 1969, compared to 1964, provided less, not more, detailed information on family members appropriate to the household model of labor supply [Huffman 1976]. Even some of the R.I.M.E. data was subject to considerable measurement error, requiring careful editing, as, for example, with the net income variable which is of critical importance not only for determining participation eligibility in the income maintenance program, but also for estimating household labor supply responses to it [Primus 1977, p. 864]. These data problems notwithstanding, the R.I.M.E. studies [Kerachsky 1975; Primus 1975] have also been criticized for their faulty specification of variables [Huffman 1977].

Comparison of results among these studies is difficult because the same variables are not consistently used in each; moreover, even for identical variables the measures selected may differ for reasons of judgement and data limitations.

2. ESTIMATION TECHNIQUES

Selection of estimation procedures is influenced not only by the substance and form of data available for analysis, but also by the type of variables specified -- especially response variables, which are discussed below.

Labor supply studies are typically concerned with examining the effects of explanatory variables on two different kinds of response variables, categorical and continuous: labor force participation, and hours-of-work. Labor force participation (LFP) is a discrete variable which

can be measured on the basis of aggregated data for a group of individuals' participation rate (L.F.P.R.) or disaggregated data for each individual's participation status (L.F.P.S.).

LFP status is usually of a dichotomous (binary) nature whereby a value of '1' is assigned to a person who is in the labor force (i.e., employed) and a value of '0' is designated for the person not in the labor force (i.e., unemployed). In symbol notation, since labor force participation Yi can only assume two different values, 1 and 0, the expectation of Y is:

$$E(yi) = [1 \cdot fi(1)] + [0 \cdot fi(0)] = fi(1)$$

where fi(1) is the probability that a person with certain (observable) characteristics and (unobservable) preferences will enter the labor force.

The importance of labor force participation in a study of annual hours of work is based on the idea that the latter is conditional upon the former [Heckman 1974, 1977]. Such a formulation of labor supply decision making can thereby include for estimation individuals reporting zero hours of work as non-participants and thus avoid the possibility of selectivity bias associated with selecting only a subsample (i.e., those working) from the entire sample. This relates to the problem of truncation when observation of the response variable is bounded at zero.

Labor supply measured in hours-of-work has a truncated distribution of values; that is, no negative value of hours worked is possible. This presents a problem, especially when

there are a large number of observations concentrated at and near zero. This difficulty is most acute when estimating the labor supply of secondary workers such as housewives and potential multiple-job-holding farmers, large proportions of whom are not working in the wage sector.

There exist four basic methods for coping with this situation. One, assume that the individuals with zero hours-of-work are similar in every other respect to the working segment of the sample and exclude them from the sample. Ordinary least squares is then used to estimate the hours-of-work equation based on the subsample of positive values for the response variable. This is a strong assumption and much information is lost if the number of cases with zero hours worked is relatively high. Such sample censorship results in selectivity bias.

A second method is to include nonparticipants and assign them a zero value for hours-of-work. The conventional O.L.S. is then used to estimate hours-of-work for the entire sample [Greenberg 1972, p. 11]. Of course such studies admit to truncation bias [T. P. Schultz 1975, p. 33].

The third method takes into consideration the zero bounded distribution of observations on hours-of-work. The technique used to address this situation is TOBIT -- an integration of PROBIT for the binary decision of whether or not to work and ordinary least squares for the choice of the non-zero levels of wage work. It is designed to allow for variation in the dependent variable that is limited [Tobin

1958; Greenberg and Hosek 1976, p. 16]. However, this can be a computationally burdensome and costly procedure.

At this point it should be noted that the preceding two methods usually involve some form of an estimated wage rate imputed primarily on the basis of human capital characteristics thought to determine wages and be common to the entire sample, regardless of labor force participation status. The wage rate is estimated on the basis of the job holding subsample for which actual wage rates can be observed. Then, once the coefficients for the wage equation are known, estimated wages can be assigned to the entire sample. However, this procedure is not used in the fourth method of estimating hours-of-work.

This most recent method [Heckman 1974, 1977] of estimating a continuous labor supply function also involves incorporating the labor force participation decision into the hours-of-work decision. But whereas the rudimentary form [Boskin 1973, pp. 164-65] is a two stage process whereby the hours-of-work decision is made conditional on the decision to participate in the labor force, this exposition involves a three step process. First, LOGIT analysis is used on the entire sample, working and non-working, to estimate the probability that an individual is in the labor force. Second, for those in the labor force the probability that they are working is calculated. Third, using O.L.S., an hours-of-work labor supply function (but only for those actually employed) that includes as regressors the probability of labor force

participation along with their actual wage rate is estimated. No imputation of the wage rate is necessary to preclude selectivity bias, since the initial step in the procedure utilized information from the entire sample -- inclusive of those not participating [Heckman 1976]. Unfortunately, "Although Heckman's work represents a significant methodological advance, it was computationally quite expensive and his technique was, therefore, never adopted in applied research" [Smith 1980, p. 9]. Rand Corporation comparisons between Heckman's method and the alternative of imputing wages to all women and estimating the hours equation over the complete sample indicate much smaller systematic differences are found between them than is true of the comparison with the procedure of using only the subsample of working women [Smith 1980, p. 10].

The problem of zero truncation becomes unimportant and the slope of an ordinary least squares (OLS) function over workers will closely approximate the TOBIT index function, if discontinuity in labor supply is large. Discontinuity exists when observations of hours worked do not occur near zero, but instead at some substantially higher number of minimum entry hours. Such discontinuity is attributable to equality of the market wage with the reservation wage at a positive quantity of hours, which in turn is due to the fixed time (e.g., commuting, rest) and money (e.g., gasoline, meals, uniforms) costs of work. In other words, an individual will work at least that minimum number of hours which will cover

his fixed expenses of being employed, such that net earnings will be positive; otherwise, why take a job at all. It has been noted that fixed time costs reduce observed hours worked, while fixed money costs increase the hours worked. When the discontinuity is sufficiently large, the importance of selectivity may be severely diminished [Smith 1980, pp. 14-15, 20, and 22].

Experiments contrasting simple linear (OLS) estimates and non-linear maximum likelihood (TOBIT) estimates [T. P. Schultz 1975] found them to "produce quite similar results at the sample means, indicating that OLS is a good linear approximation to TOBIT" [Smith 1980, p. 19]. They do, however, diverge significantly away from each other at the extreme (i.e., zero) end of the hours of work distributions when the labor supply function does not exhibit discontinuity.

The advantages of the TOBIT framework are that: (1) it explicitly estimates the variance of the disturbances about the TOBIT index, (b) it provides estimates of the two components of the expected labor supply: the participation rate and hours worked conditional upon participation [T. P. Schultz 1975], and (c) it increases the reliability of predictions for demographic groups (i.e., non-labor force participants) that are not representative of the sample means [Smith 1980, p. 19]. A difficulty of using TOBIT is that the estimates of the coefficients are not directly interpretable, at least not as the values of dependent variables approach the bound, nor are they easily transformed

into an interpretable form [Kerachsky 1975, p. 87].

When it comes to actual empirical results, the TOBIT procedure in comparison with the linear ordinary least squares method, accounts for only a slightly increased share of the variance of hours worked. "In sum, the TOBIT technique seems a warranted application of more costly non-linear estimation procedures to the study of labor market behavior. As a first approximation, however, linear methods are not likely to lead one far astray" [T. P. Schultz 1975 as reported in Smith 1980, p. 81].

For essentially these reasons Kerachsky [1975] elected not to use TOBIT analysis of on- and off-farm labor supply analysis, while Sexton [1975] and Sumner [1978] opted for the use of OLS in their analysis of farm household labor supply.

Of the various techniques subsumed under the simple or multiple linear regression model, Ordinary Least Squares (O.L.S.) is the one technique most commonly used for estimating continuous and unbounded linear functions. O.L.S. is known to yield best linear unbiased estimators (i.e., B.L.U.E.) for both bivariate and multivariate regression analyses, if its assumptions are met. Specifically, the estimated disturbance term is assumed to have the following characteristics: randomness of individual errors, homoskedastic (or constant) variance of the errors for all observation of explanatory variables, and independence of the error terms. If such assumptions are not violated, O.L.S.

estimators have the desirable properties of unbiasedness (i.e., the expected value of the estimator coincides with the true value), efficiency (i.e., distribution of the estimator is highly concentrated about the sample mean), and consistency (i.e., the estimator increasingly occurs closer to the mean as sample size becomes larger). Violation of these and other assumptions will adversely affect such desired estimation properties. (NOTE: This matter is more fully discussed under section E "Estimation Accuracy" of Chapter III.)

C. EMPIRICAL STUDIES

1. CLASSIC WORKS

Leaving aside the creative theoretical thinking of Lionel Robbins, Jacob Mincer, Gary Becker, and Reuben Gronau (among other distinguished labor economists) whose contributions to the field have already been discussed with reference to "Conceptual Frameworks" (section A), the immediate focus here is on the application of such models to actual data with all its inherent and seemingly endless deficiencies.

Among the many pathbreaking studies, there is one to which all others repeatedly express an intellectual debt; and that is Jacob Mincer's 1962 paper entitled "Labor Force Participation of Married Women: A Study of Labor Supply." In it he was the first to distinguish between work at home and leisure, at least for female householders. He also viewed a family's labor supply decision as being based on its

perception of potential income from labor and other sources over an intermediate time horizon rather than just on actual current earnings. These two innovative ideas were followed up by many researchers in the 1960s and 1970s, most of whom were associated with either the National Bureau of Economic Research (N.B.E.R.) or the Rand Corporation.

The first contribution of Jacob Mincer, that of distinguishing between home work and leisure rather than lumping it together as non-market time, has been most energetically pursued by Reuben Gronau in his many studies on "The Value of Time" [Gronau 1970, 1973, 1974, 1976, 1977]. Again, the difficulty has been with the lack of comprehensive information on time use. Not surprisingly it is the anthropologists who are in possession of such data as a result of their direct observations of households in other cultures, usually less technically advanced. Economists are now gathering such information by field surveys and direct observation, but -- alas -- mostly in the agrarian societies of less developed countries [DeTray 1977]. Consequently, the 'frontier' literature is not likely to be on the U.S. population with its keener sensitivity to intrusions upon privacy in terms of direct observation and data collection. One exception is the University of Michigan diary of time use data.

The whole thrust of time valuation within the household context is really an effort to reflect adequately the important contributions of female heads rather than just

concentrating on male labor supply. Hence, literature of the late 1960s and 1970s has been dominated by studies of married women (as well as the many reports on low income families -- female and male heads of household). Moreover, a good proportion of these labor supply studies is focused on labor force participation decisions as opposed to hours-of-work, which is the response variable for this research.

Because of the different data bases, the different variable measures, the different behavioral models, and the different estimation procedures, it becomes well nigh impossible to make consistent comparisons of research results across the vast number of studies. However, the Rand Corporation has conducted two sensitivity analyses of studies having a common data base: one on male hours-of-work [Da Vanzo, DeTray and Greenberg 1973] and another on housewive's labor force participation decisions [Cogan 1975].

2. RECENT PROBES

Capitalizing on all this theoretical and empirical groundwork of the 1960s and early 1970s, agricultural economists began to examine the off-farm migration and multiple-job-holding using a household behavior model. Previous diagnostic examinations of on-farm labor supply are minimal and, with one exception, have been focused on the impact of Rural Income Maintenance Experiments (R.I.M.E.) conducted in North Carolina and Iowa in the early 1970's [Bryant and Hager 1977; Karachsky 1977; and Primus 1977]. These studies examined the influence of government income

supplements on the labor supply decisions of farmers. The aforementioned exception was a study principally concerned with off-farm employment that incidentally included on-farm labor supply regression equations [Sumner 1978]. Kerachsky's [1975] analysis of R.I.M.E. data looked at self-employment (as well as off-farm work) of husbands in a multiple-job-holding context (while limiting his focus on wives to wage employment in a single market framework). Primus's [1975] investigation of R.I.M.E. data concentrated on the farm work response of farm operators. Bryant and Hager's [1977] study of the R.I.M.E. data zeroed in on the unpaid farm work of farm wives. Sumner's [1978] examination of the Illinois farm survey data pertained to the on-farm hours of work (in addition to the off-farm labor supply) of operators (while restricting his analysis of wives to their decision to participate in the wage market). A detailed review of the findings for these studies is deferred until Chapter V, section B-2 "Empirical Consistency" where the results of the research herein are analyzed with respect to their consistency with other empirical works such as these.

A few other studies, essentially using the same methodology but devoted exclusively to <u>off-farm</u> labor supply decisions of farmers, have also been published in the last few years [Huffman 1973, 1976, 1980; Sexton 1976; Barros 1977; Scott 1977; Kada 1979]. Numerous other studies have looked at the phenomena of multiple-job-holding and off-farm employment generally [Hathaway and Waldo 1964; Loomis 1962,

1964, 1965; Hathaway and Perkins 1965]; and there are many others examining non-farm income.

Why, then, the dearth of on-farm labor supply studies? The answer may lie with the critical assumption that multiple-job-holding is a transitory, rather than permanent, adjustment to the changing structure of agriculture and a prelude to eventual complete off-farm migration. This, of course, was a reasonable assumption in the past and many studies seemed to confirm this phenomenon during the precipitous decline in farm population during the quarter century following World War II. Thus the major concerns were with understanding the nature of off-farm migration, formulating structural adjustment policies, and designing manpower training programs for these farm leavers. Consequently, previous studies examined off-farm labor supply with the implicit assumption that less time was accordingly being supplied on-farm. However, knowing the extent of off-farm work and its determinants can be no more than an indirect measure of on-farm labor supply. This is especially so with reference to limited resource small-farm operators, for whom on-farm and off-farm work are not mutually exclusive and may not even have some precise ratio of hours trade-off. This is not to suggest that off-farm labor studies aren't indicative of on-farm work time -- especially for the farm population as a whole; it is merely that they are insufficient, if one's principal focus is the farmer in the capacity of a self-employed operator. And this has become more apparent as

Agricultural Census figures for the 1970's indicate a substantial leveling off of rural and farm out-migration [Beale 1976, 1977].

In the case of Michigan, past small-farm surveys have provided evidence of a more permanent, rather than transitory, nature of multiple-job-holding among operators [Loomis 1962, 1964, 1965; Hathaway, et al. 1966; Thompson and Hepp 1976; Hepp 1979]. Hence, the specific emphasis of this study is with the on-farm labor supply decisions of low farm income families in Michigan.

3. INTERDISCIPLINARY QUESTS

a. Seminal Writings

Sociology is the only other academic discipline to study U.S. farm households in detail. Their studies can be classified into three major categories: (a) Conjugal power structure and farm family decision making, (b) Goal setting and value formation of farm families, (c) Career mobility and off-farm migration of farm operators.

Conjugal power structure studies focus primarily on who possesses authority to make decisions within the family. Various types of power are identified (e.g., reward, coercive, legitimate, referent, expert) and theories are advanced to explain why one spouse rather than another might exercise more authority in decision making (e.g., whether wife should work) [Safilios-Rothschild 1970; Centers, et al. 1971; Olson and Rabunsky 1972]. The Resource Theory concerns how personal attributes (e.g., years of schooling, occupational status,

income level, degree of social participation) influence the exercise of authority, while the Exchange Theory relates how personal possessions (e.g., money, love) can be bartered among household members in an effort to maximize one's power.

Although these two theories have not been fully substantiated with respect to farm household studies [Wilkening and Bharadwaj 1968; Wilkening 1968], they are mentioned because they are concerned with family decision making which presumably includes the allocation of time which is central to the labor economist's models of the household. Moreover, some of their findings concerning involvement with farm tasks (i.e., labor) -- especially of the wives -- is of potential interest to labor economists. Such discoveries are reported in the next section "Pertinent Findings."

Goal setting and value formation, the second area of concern by sociologists studying farm families, is one in which Michigan Cooperative Extension Service agents found small farm operators to be in need of counseling [Olson 1978]. A review of sociological studies on decision making relating to the field of consumer economics reports that "an appreciable proportion (of farmers) do not have clear financial goals or plans in the sense of clearly enunciated programs of allocation of income or acquisition of assets," although they were "much more common among ... farmers in younger families, those better educated, and in families where the wife was in a professional or managerial occupation"

[Ferber 1973, p. 1327].

The farm family studies in this area are concerned with household members' individual aspirations and how they are associated with participation in decisions about the farm business [Wilkening and Bharadwaj 1968]. Generally, farm household studies have found that while husbands were the most frequent deciders about operational matters (e.g., agricultural enterprises) decisions involving financial investment (e.g., buying farm land, borrowing money) are usually of a joint nature [Wilkening 1958; Wilkening and Morrison 1963; Honey 1959; Ferber 1973, p. 1328].

Career mobility and off-farm migration constitute the third category of sociological studies pertaining to farm households. They have identified some factors associated with the reduction of on-farm labor and the corresponding increase in off-farm labor as operators switch to part-time/ multiple-job-holding status or leave agriculture altogether.

b. Pertinent Findings

One relevant finding is that "as (farm) income level goes up so does the degree of task specialization and hence less involvement of (the) wife in farm activities;" and "with increasing size of the enterprise, there is less overlap of the family and the occupational areas of activity." So "as the size of farm enterprises increases the wife is less involved in both work and decision making roles in the farm area. At the same time the husband is less involved in certain household tasks and decision making, leaving these to

the wife" [Wilkening 1968, pp. 2-3].

The influence of education on farm labor supply of wives has also been noted: "the more schooling, the more she is expected to influence decisions, yet the less likely she in involved in farm tasks." Although "wives with higher education relative to their husbands are more likely to be involved in farm tasks" [Wilkening 1968, p. 3].

In a separate study it was found that patterns of task allocation are in conformity with the economists household model of labor time allocation; specifically, "farm wives who participate highly in the farm area do not participate highly in household area" [Wilkening and Bharadwaj 1967, p. 710].

With respect to off-farm employment decisions of farm wives the evidence indicates independence of choice; that is, it is not a joint decision or even one dictated by or requiring consent of the husband [Burchinal and Bauder 1965, p. 527; Wilkening and Bharadwaj 1967, p. 708]. The significance of this for labor economists is that a husband has not been found to be a constraint on his wife's off-farm labor supply.

As for farm operators (i.e., male), rural sociologists have endeavored to identify the factors that are associated with mobility out of full-time farming toward either part-time farming and/or complete exit from agriculture. In particular, lower total farm income and farm income per family member, proximity to numerous non-farm jobs, and

younger age are significantly associated with the shift toward part-time farming [Bennett 1967, p. 163].

Other reasons include health problems, land tenure (i.e., lease renewal terms), and underemployment associated with limited acreage -- though the reallocation of labor is often solved via multiple-job-holding rather than abandonment of farming [Guither 1963, p. 570].

Another study found that people leaving agriculture were not necessarily the small scale or part-time farmers. "The people who are presently leaving agriculture are not those with the lowest incomes, the least efficient, the poorest farmers, or the physically disabled." Moreover, since barriers to off-farm migration exist in the form of low level job skills, little wage work experience, and lack of job information, the expected full impact of falling product prices and resulting low incomes is somewhat mitigated. "If it is a contest to see who can stay the longest without starving, it will more likely be the subsistence farmer with a minimum of credit obligations; not the larger, mechanized, efficient organizations operating on credit with foreclosure threats" [Hill 1962, p. 426]. Those with attractive alternatives off-farm are not the 'people left behind' [National Advisory Commission on Rural Poverty 1967].

c. Economics Interface

Aside from one article on farm adjustment problems jointly authored by an agricultural economist and rural sociologist [Heady and Ackerman 1959] and one other very

excellent article by a sociologist on farmer goals and values [Gasson 1973], which in part was addressed to agriculture economists, little formal cooperative research of the two disciplines has been reported -- at least in their major professional journals.

Ironically, the one such published study that does attempt to integrate the findings of sociologists with those of economists is concerned with labor supply decisions of household members, "Family Power Structure and Family Labor Supply" [Kushman and Scheffler 1975]. As the authors state "we view the dichotomy between sociology and economics as unfortunate. The labor supply decision is important to the family, and labor supply behavior is likely to reflect the way in which the decision is reached." Their model of labor supply allegedly provides evidence on sociological theories of decision making. Specifically, the hypothesis of male dominance by virtue of superior resources vis a vis the female is not supported. This result is consistent with previous sociological findings already cited [Burchinal and Bauder 1965; Wilkening and Bharadwaj 1967]. The male dominance hypothesis was tested by examining the impact of spouse wage rates in the husband and wife's labor supply equations. The assumption is that the male makes his labor supply decision prior to the female and that the wife takes male labor supply as a constraint beyond her control. No cross substitution effect is expected in terms of female labor supply response to a change in male wage rate, though

it will demonstrate an own substitution effect for a change in her wage rate. The male model implies that in the female labor supply function, the response to a change in the male wage will consist entirely of an income effect resulting from the increased earnings of the male from his higher wage rate.

SUMMARY

This chapter has presented an overview of the well established economic theories of consumer choice and human capital, which constitute the foundation of labor supply studies. Moreover, production principles derived from the theory of the firm provide the framework for the recently developed household production function model, which can be used to analyze labor supply decisions and suggest relevant explanatory variables. Comparison of least squares with TOBIT and related estimation techniques indicates that while the latter is more sophisticated in overcoming selectivity bias of sample censorship, the use of OLS with an instrumental variable for the wage rate can give comparable results with less computational complexity and cost. The Rand Corporation studies cited herein have provided thorough guidelines for the research design of this and similar dissertations done on the labor supply of farm households. An examination of these dissertations, in conjunction with a reading of rural sociology studies, has contributed to a realistic understanding of farm household decision making

dynamics in the interrelated matters of family goals, income maximization, and labor time allocation. This leads to the next step of scrutinizing the data in terms of its adequacy and accuracy.

CHAPTER III

DATA COLLECTION AND PROCESSING

This chapter provides an overview of the data utilized for empirical analysis with reference to the survey subjects (section A), how the sample was selected (section B), what data was garnered and by what instruments (section C), why and how the data was transformed from its original state (section D), and lastly the difficulties of statistical estimation (section E).

A. SURVEY POPULATION

1. SUBJECT UNIVERSE

The theoretical, albeit finite, population under consideration consisted of all limited resource farmers* located in Michigan's lower peninsula, which contained 97% of all such farmers in the entire State according to the 1969 Census of Agriculture. It is from this group that the sample was taken and to which population the sample survey research

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* Defined to include those farmers (1) who owned more than 10 acres of land and earned a maximun of $20,000 but more than $50 from agricultural product sales, and (2) who owned less than 10 acres of land but grossed more than $250 in agricultural product sales.

results are to be generalized.

2. DATA GATHERING

A field survey was conducted to assemble cross-section data during a three week period in April of 1974. The information was obtained through the use of a written questionnaire administered orally by interviewers, to whom subjects responded. A copy of the questionnaire used in the survey may be found in Appendix A. A pretest of the questionnaire was carried out in order to improve the quality of data as well as refine the type of data collected in the final revised questionnaire used.

B. SAMPLING PLAN

1. SAMPLING METHOD

A probability sample of the multistage stratified random type was used by Thompson [1975] in gathering the field data. This sampling method involved four steps.

2. SAMPLING UNITS

First, all counties of the lower peninsula were sorted into 10 classes approximating "natural" groupings based on such criteria as geographical contiguous regions (all except one), plus principal agricultural enterprise activity, farm numbers, and urban area proximity. (NOTE: See Thompson 1975, p. 10 and Thompson and Hepp 1976, pp. 3-4 for list of counties by groups.) Second, one county was randomly selected from each group. Third, three townships were

randomly selected from each county, from which a 3% sample of all small farms was sought. In all counties a maximum of two townships was sufficient to obtain the desired sample percentage. Fourth, limited resource farmers were randomly drawn from the previously selected county townships.

3. SAMPLING FRAME

The township plat book listing farm owners was used as the register from which potential small farmers were identified (i.e., those owning less than 200 acres who were reckoned to fall within the definition of limited resource farmers). The register was reviewed for accuracy by the local county extension director and township board of supervisors. This corrected list formed the population from which the sample was drawn.

The basic observation unit (i.e., sampling element) was the two member farm household. Detailed data collection was limited to the husband and the wife as heads of household, although general information on the family was also gathered.

4. SAMPLE SIZE

Personal interviews were obtained from 275 farm operator households. After discarding 32 interview schedules as being unusable, the final sample size equaled 243 households including 239 men and 231 women. The exact non-response rate of households is unknown, since no record was kept of the total number of households contacted that could be compared with the number of households for which questionnaires were

completed. However, Hepp in a personal recollection to this researcher in 1980 thought that it was very low -- under five.

For purposes of the analysis herein this sample was further divided into three sub-groups, life cycle stage I (age 34 and under) being the smallest (36 men, 46 women), stage II (age 35 to 54) being the largest (116 men, 112 women), and stage III (age 55 and over) being intermediate in size (86 men, 70 women). The discrepancy between the aggregate number of men (239) and women (231) and the disaggregated age groups is due to the fact that specific age information for one male and three females was not recorded in the survey data. Furthermore, an examination of the "Life Cycle Labor Supply Analysis" of Appendix E reveals the number of cases for each age group to be less than reported here for both sexes; this is due to the loss of cases when missing data occurred for variables entered in the multiple regression equations.

C. DATA COMPOSITION

1. REFERENCE PERIOD

The time frame for which data was collected was the calendar year 1973.

2. INFORMATION SOURCE

Data was obtained from interview respondents on the basis of personal recall; although referral to any records or

documents in their possession was not precluded.

3. FACTUAL CONTENT

Questions were asked under seven broad categories: Personal demographics (section A) on the age and education of the husband and wife, plus the number and ages of their children; Family living information (section B) on-farm residence, own agricultural commodity consumption, and minimum required income; Farm activities data (section C) on land use, crop and livestock enterprises, and on-farm labor of household members; Off-farm employment figures (sections D and E) of the husband and wife with respect to time worked and wage rates; Farm business statistics (section F) on capital investments -- assets and debts; Household income (section G) derived from agricultural sales, non-farm investments and transfer payments. (NOTE: See section C "Variable Definition" of Chapter IV for details about and analysis of the variables selected from this data set.)

D. MISSING OBSERVATIONS

In the course of examining the computer printout of raw data transcribed from the survey questionnaire of 243 small farm households, it became apparent that many card/column spaces were left blank by interviewers who should properly have recorded zero or positive values for each question. This meant that missing values existed for those variables with blanks. And if one of those variables is slated for use

in the analysis, the whole case will be discarded by the listwise deletion computer program and with it the information on all other variables of the household. Biased coefficients of the regressors could result from such missing observations, a topic discussed in section E-2 "Non-Sampling Error" of this chapter. The blanks were not always random in nature. A close examination of the raw data computer printout revealed that sometimes patterns of blanks occurred for blocks or categories of related questions asked in a sequence. Curiously, the patterns were observed for consecutively numbered cases in specific counties, thereby indicating a consistent failure by a single interviewer. This does not constitute prima facie evidence that all such blanks could forthwith be converted to zeros. Instead, consistency checks and remedial assumptions were relied on for making any and all coding changes in the data.

It should be noted here that in one instance 22 blanks for FARMDEBT occurred for all 22 cases in Cass county. This is due to the fact that in randomly selecting the counties the surveyors decided to pretest the initial questionnaire in Cass county before drafting the final version, which was used in all the sample counties except Cass. Rather than use the final instrument in Cass they used data from the initial questionnaire, which did not include data on the variable FARMDEBT.

1. CONSISTENCY CHECKS

To assess the true extent of the problem a missing data file was obtained from the computer which listed the number of blanks for each variable. Next, so as to prevent the loss of information (i.e., reduction in the usable number of cases from the original sample of 243 households) a series of internal consistency checks were constructed such that it could logically be deduced that at least some of the blanks should rightfully have values of zero. For example, if a blank existed for "off-farm hours of work" and a previous question on "current employment" had a coded response of no job, then obviously the variable "off-farm hours of work" should be assigned a zero value instead of a blank. By the same token, however, if a response to the "current employment" question indicated an off-farm job was presently held, then a blank for the "wage rate" variable could not logically be changed to a zero; and the remaining information on that case would not be retrieved if the variable with the blank was included in the analysis. (NOTE: See Appendix B "Missing Data Adjustments" for a complete description of the consistency checks used).

2. REMEDIAL ASSUMPTIONS

Where internal consistency checks were not possible for the purpose of changing blanks to zero values in order to retain information of household cases, some reasonable assumptions were made that allowed such a conversion. For example, if a non-sensitive question such as the marital

status of an operator was blank it was assumed that no wife was present and the blank left by the interviewer actually represented a zero code. (NOTE: See Appendix B "Missing Data Adjustments" for a complete statement of the assumptions made for each variable.)

Of course, there were some variables for which logical consistency checks or reasonable remedial assumptions were insufficient. The principal ones were OPFARMYR (20), WIFARMYR (20), OPFARMHR (9), WIFARMHR (14) OPWAGEST (10), WFWAGEST (18), OPWAGINC (17), WFWAGINC (6), WFEDUCYR (17), FARMDEBT (30), and INVSTINC (11). These variables are all defined in Chapter IV.

In these situations the blanks remained such and information was lost on those entire cases if the variable in question was included in the analysis. And because missing values for most potential variables are not all concentrated in a few cases in select counties, but rather are seemingly dispersed across many households in the survey, an increase in regressors tends to reduce the sample cases. This, of course, is an argument in favor of keeping the model simple. However, some variables are essential to the model by reason of economic theory, regardless of this problem. Consequently, for both on-farm and off-farm analyses male cases fluctuated in the 190's while female cases ranged from the 170's to 180's. This amounts to a considerable loss of cases from the 239 men and 231 women of the 243 households.

E. ESTIMATION ACCURACY

Accuracy of a survey takes into account sampling errors as well as non-sampling errors, and refers to how close a sample estimate comes to the true population value. However, because the bias attributable to non-sampling error cannot be measured, the measurable precision (e.g., standard error of the mean) of sampling error approximates the accuracy of estimation -- assuming little or no bias [Spurr and Bonini 1973, p. 231; Moser and Kalton 1972, p. 68].

1. SAMPLING ERROR (Precision)

Sampling error depends on the type of sampling design used; and on the size of sample.

a. Sampling Design

The stratified multi-stage probability sample used by the original survey researchers would seem to ensure control of sampling error from the first source, since "a stratified sample generally has a smaller error ... than a simple (without replacement) random sample of the same size" [Spurr and Bonini 1973, p. 218].

b. Sample Size

With regard to the second source of sampling error "the reliability of a sample usually (i.e., except for small populations) depends almost entirely on the absolute size of the sample and not on the percentage of the population sampled" [Spurr and Bonini 1973, p. 234]. Nevertheless, the survey included "three percent of the number of limited

resource farms, according to the 1969 Census of Agriculture, in each of the designated counties [Thompson 1975, p. 11]. Unfortunately, no explanation is provided for emphasizing the criteria of percentage instead of absolute size; and no reference is made to the relation between precision of the sample mean and the size of the sample. For stratified random samples a standard error S.E. ($\bar{X}$) is calculated for each stratum before combining the results into a weighted sum for the whole sample [Spurr and Bonini 1973, pp. 345-50; Moser and Kalton 1972, p. 90].

2. NON-SAMPLING ERROR (Bias)

Concerning the survey data adopted for the labor supply analysis herein, precautions were presumably taken by the survey designers to minimize the potential (albeit unmeasurable) bias that can arise in conjunction with imperfect data gathering procedures -- in particular, non-sampling errors related to sample selection (e.g., inadequate frame or population coverage) and variable measurement (e.g., defective instrumentation, unsound interviewing practices, inexact respondent answers, imprecise processing). The researcher cum data analyst, as distinct from the role of data collector, is responsible for any additional bias stemming from faulty judgements made with respect to econometric modeling and statistical estimation choices.

Some of the more common problems associated with labor supply analyses, as reported in the literature and alluded to in the earlier discussions of "Research Methodologies" in

section A of Chapter II, as well as in the whole of Chapter IV on "Research Design and Statistical Procedures," are briefly reviewed here in terms of their immediate relevance to this study of on-farm labor supply.

a. Unrepresentative Sample

Although the "sampling plan" was thoroughly discussed in section B of this chapter, the pertinent matter of having an adequate sampling frame (i.e., population list) was deferred until now. In actuality, identification of the very small farmers (i.e., those with gross agricultural sales less than $2,500 annually) has proven to be a difficult task even for the U.S. Census of Agriculture, which in 1974 failed to collect detailed data on this, the poorest segment of the limited resource farm sub-population. Similarly, the use of plat books, which may not include (or at least may not be current on) small landholders, and editing by the county extension directors and township boards of supervisors, who may not be aware of (or at least may not be in touch with) this constituent group, make suspect any claim to complete population coverage. However, it should be realized that the cost of overcoming this deficiency tends to be prohibitive.

b. Measurement Error

Otherwise known as reporting bias or errors in variable, this phenomena is an especially "well known and much lamented problem in empirical research in economics," especially with respect to the income variable which tends to be underestimated by respondents [Cain and Watts 1973, p. 361].

In particular, non-wage income such as farm revenue from agricultural product sales is notoriously under-reported for tax purposes [Palmer and Pechman 1978, p. 20]. But, since farm income (i.e., gross sales) was used only as an upper boundary in identifying the population of limited resource farmers and not as an explanatory variable in the on-farm labor supply function, the problem should not be acute. However, gross farm income is used as an explanatory variable in the analysis of hours worked off-farm.

Another related problem concerns the transitory 'noise' that exists when reported wage rates deviate from the theoretically desired permanent (or normal) wage relevant for the entire life cycle. However, when the sample is broken up into three life cycle stages (i.e., age ranges) for estimation, use of reported market wages in calculating the off-farm income variable is extrapolated for a narrower band of years and may be less of a problem than might otherwise be expected.

Unfortunately, the most erroneous measurements may possibly be in the annual hours-of-work on-farm, since farm operators were asked to informally estimate their annual labor supply without calculating and reporting the separate components that could account for seasonal and weekly variability. This is not to say there is measurement error, but rather only to recognize its potential existence. Be that as it may, it is equally important to realize that a completely accurate tally of on-farm hours would require an

exhorbitant amount of time and money to regularly observe (or at least periodically survey) labor by activities over a year's time. In that context, this Michigan farm survey data may be no different than the Illinois farm survey on which a similar study was done [Sumner 1978]. Moreover, this same difficulty also plagued the Rural Income Maintenance Experiment [Palmer and Pechman 1978, p. 12].

c. Missing Observations

When whole cases (i.e., households) must be discarded for lack of data (i.e., blanks) on any one variable, information is lost on all other variables for the case. This type of bias is usually due to non-response to specific questions, particularly those requesting sensitive information. Such may have been the case with FARMDEBT in 8 of the 30 cases of missing data. In other instances it may be more a matter of faulty instrumentation whereby the interviewee is uncertain of what response to give; the FARMYR variable, with 20 missing cases, asked for farming experience of heads of household together instead of separately. Alternatively, it could be inadvertent oversight by the interviewer or it may be an inability to answer -- at least not with any reasonable accuracy.

But, for this survey the bulk of missing data is probably attributable to the interviewers, some of whom seemingly let blanks represent zero values when "recording" interviewee responses.

Because "it is very difficult to state rules of thumb

for dealing with missing observations, there is no substitute for careful thought on the part of the analyst" [Pindyck and Rubinfeld 1976, p. 194]. Hence, the situation was rectified by constructing internal consistency checks and making tightly reasoned remedial assumptions. (NOTE: See section D of this chapter as well as Appendix B on "Missing Data Adjustments.")

These corrective steps notwithstanding a solution to the continued existence of missing observations in cross section analysis is to drop the observations for a variable from consideration, if they appear to be missing at random (e.g., not available because of data reporting errors). Under such circumstances, "the least squares estimator of the slope estimator will be an unbiased and consistent estimator, and the only effect of dropping the observations is a loss of efficiency" [Pindyck and Rubinfeld 1976, p. 194]. Only if the missing observations were identical in value to the sample mean of the available observations, would the variance of the estimated parameter not increase. In two instances, this is particularly unlikely. This is because Cass county, which includes 22 sample households, accounts for 16 of the FARMYR missing observations. This means that the inclusion of this variable may effectively eliminate Cass county households from the sample and cause selectivity bias.

Another option, besides dropping the missing observations from analysis is to replace them with the sample mean

of the available observations. In a multiple regression model this procedure might yield different slope estimators and more efficiency, if only one of the several independent variables has missing observations [Pindyck and Rubinfeld 1976, pp. 196-97]. Unfortunately, the Michigan Small Farm Survey data involves the use of more than one variable with missing observations; thus, rendering this solution questionable. Besides which, it cannot easily be assumed that for the variable FARMYR Cass county is representative of the other counties from which the sample mean would be calculated.

An instrumental variable technique can also be used whereby cases lacking observations for a variable are assigned an estimate based on a regression analysis of cases which have recorded values. The difficulty is in the selection of a proper instrument, which in the absence of economic theory (as with imputed wage rates) is not obvious. Also, if observations are missing for more than one right hand variable such that more than one instrumental variable (i.e., imputed wage) is contemplated problems can arise [Pindyck and Rubinfeld 1976, p. 199]. Therefore, in those cases where internal consistency checks of the data and remedial assumptions about the data still leave blanks, those cases are reluctantly rejected for inclusion in the analysis.

d. Omitted Variables

Certain explanatory variables, which economic theory and supporting empirical work suggest are important determinants of variation in response variables, can render models

incomplete and thereby affect the estimation results. The exact patterns of bias that may occur are virtually impossible to discern [Kerachsky 1975, pp. 99-102]. Fortunately, those variables omitted herein for lack of information are not critical to the model, but their potential effects warrant a discussion of them. (NOTE: See section A-3 "Omitted Variables" in Chapter IV.)

e. Sample Censorship/Selectivity

The extent to which the use of only a portion of the entire sample is necessitated by data constraints and thereby biases the results has been of paramount interest to labor supply economists in recent years. (NOTE: For a full discussion of this, as it relates to estimation difficulties, see section B-2 "Estimation Techniques" of Chapter II.)

SUMMARY

Following a straightforward description of the survey population, sampling plan, and data composition, a discussion of the data gathering process revealed that missing observations occurred through non-response and/or recording errors. The ensuing coding changes used to correct for missing values was successful for all but a few variables, for which the consistency checks and remedial assumptions were not sufficient to completely eliminate the problem. Implications for biased results due to a variety of potential non-sampling errors were then addressed in terms of securing accurate estimates of the explanatory variable coefficients. With

these concerns in mind, the successive chapters on research design and results analysis can be approached more critically.

CHAPTER IV

RESEARCH DESIGN AND STATISTICAL PROCEDURES

This chapter initially describes the general economic model with respect to the functional labor supply relationships and the hypothesized associations between classes of variables for on-farm and off-farm work by sex (section A). Next, the Personal-Household and Farm-Business empirical models are parameterized and appropriate estimation of the equations is discussed (section B). Finally, the labor supply response variable is defined with reference to its possible alternative constructions; and then the explanatory variables are defined in terms of their measurement and expected sign -- followed by a discussion of their validity and complexity for estimation purposes (section C).

A. ECONOMIC MODEL

1. FUNCTIONAL RELATIONSHIPS

The general theoretical household behavior model developed in section A-2 of Chapter II is adapted to the case of agriculture whereby farm family members supply labor to on-farm and off-farm work. The amount of labor time supplied by the farm operator (L_m) will be influenced by the wage rates received in his primary job (W_1) and in his

secondary work (W_2) if such an opportunity for multiple-job-holding exists within commuting distance of his residence. Other factors will be the spouse market wage labor income (I_s) and non-labor income of the household derived from capital holdings (C) -- with the prices of goods ignored by assuming them to be constant in cross-section static analysis. Finally, additional variables of Personal-Household (H) and Farm-Business (B) models are included for analysis. The general form of the labor supply model for the male operator (L_m) is thus expressed as:

$$L_m = f\ (W_1,\ W_2,\ I_s,\ C,\ H,\ B)$$

For the female head of household the general model for her labor supply (L_f) is written as:

$$L_f = f\ (W_1,\ W_2,\ W_3,\ I_s,\ C,\ H,\ B)$$

where W_3 stands for the home production wage rate of the wife -- the remaining variables (W_1, W_2, I_s, C, H, B) being the same type as for the male operator.

In adapting the general model to the agricultural situation the self-employment wage rate for either a primary or secondary job on-farm is not included in the analysis. Hence, only one wage rate is used; and that is the off-farm market wage rate. Also, for lack of an adequate measure the home production wage rate of the wife is dropped in the empirical estimation of female labor supply.

a. Personal-Household Model

This model is essentially that of the general household behavior model found in the labor supply literature

reviewed in Chapter II. No distinguishing features unique to the farm household are included. For on-farm annual hours of work of both sexes (OPFARMHR and WIFARMHR) the explanatory variables are: age for the male operator (OPAGE) and wife (WFAGE) used as a stratifier in the life cycle model (in Appendix E), educational level of the husband (OPSCHOOL) and spouse (WFSCHOOL) as a binary variable indicating the completion of high school, the total number of children at home for the father (HOMCHILD) or the number of young children under five years old present in the household for the mother (YNGCHILD), work experience in farming by years for both heads of household (OPFARMYR and WIFARMYR), off-farm wage rate of the man (OPWAGEST) and woman (WFWAGEST) as estimated by the wage function (in Appendix C), spouse wage income of the husband (OPWAGINC) and wife (WFWAGINC), and investment income (INVSTINC) from non-labor related sources in the current period. The equation for annual off-farm hours of work for both sexes (OPJOBHR and WFJOBHR) includes the additional binary variable indicating residence in a Standard Metropolitan Statistical Area county (SMSACNTY). Each of these variables is discussed fully in section C "Variable Definition" of this chapter.

b. Farm-Business Model

This model is actually an extension of the Personal-Household model, and warrants considerable discussion given that the literature review chapter emphasized the basic model identified in the preceding section. The additional variables

of farm assets (FRMASSET), farm debts (FARMDEBT), acres rented in (ACRENTIN), and gross farm income (FARMINC) have been incorporated to reflect unique aspects of the farm household; although urban households with self-employment in a family business would certainly be similar in nature. The measurement, expected sign, and estimation difficulty are discussed fully in section C "Variable Definition" of this chapter.

The farm asset variable, like the investment income variable in the Personal-Household model described in the preceding section, is included to estimate the wealth effects on labor supply. But whereas the investment income variable consists of non-wage labor earnings from liquid capital holdings of stocks, bonds, and savings (as well as from income derived from land rented out), the FRMASSET variable includes the value of agricultural property in the form of real estate, buildings and machinery. In empirical work researchers have used variables measuring non-labor income or assets to estimate pure wealth effects [Smith 1980, p. 12]. And although in this study the former does include rental income from farm land (which is the major component of the latter variable), INVSTINC and FRMASSET can be considered distinct when viewed respectively in terms of cash flow versus accrual accounting methods. Specifically, take the case of:

> A hypothetical worker who owns ... land that he rents to someone else. His annual return from the land will equal any rent payments he receives plus any increase in the value of the

> land not reflected by the observed rent. According to the accrual approach the worker adjusts his labor supply to the income that is accrued during the year, no matter when this income enters his cash stream. The presumption is that if he wishes, he could immediately realize his full annual return by selling his land. The fact that he does not choose to do so is assumed to be irrelevant to his allocation of time between market and non-market activities. The cash-flow variant is based on the premise that a worker's current labor supply ... is adjusted to the current cash income stream." [Greenberg 1972, p. 33]

It is interesting to note that, contrary to theoretical expectations, empirical studies which included an asset variable typically had positive estimated coefficients, meaning that increasing assets increase market work [Smith 1975, p. 42; Smith 1980, p. 12]. This may reflect positive serial correlation of work time with past work, producing the current assets.

For agricultural households one study found farm assets to have a positive effect for hours worked on-farm and a negative effect for hours worked off-farm [Sumner 1978, p. 58]. The off-farm hours results were the same in another study [Barros 1976, p. 72].

Concern about life cycle influences on assets and labor supply has been expressed by some researchers [Smith 1975, 1980] who believe that assets at any particular age are a result of past and expected future savings, consumption, and labor supply decisions. That is, the preference for accumulating assets early in life (and thus above average wage income in that period) is related to the preference for working less later in life when non-wage income derived from

the accumulated assets is substituted for wage earnings. As such assets are endogenously determined and "the empirical relationship should not be interpreted as reflecting a causal sequence from assets to market work" [Smith 1980, p. 13]. In other words "a substantial proportion of the cross sectional variation in labor supply and asset levels may merely be a reflection of variations in life cycle positions, time preferences, tastes for assets, or lifetime patterns of market wages, and may have nothing to do with the causal relationship between income and labor supply" [Da Vanzo, DeTray, and Greenberg 1973, p. 28]. However, "a transitory increase in labor force participation ... may well be an alternative to dissaving, asset accumulation, or increasing debt. One useful empirical implication of this hypothesis for labor force behavior is that it should be inversely related to the level of family assets, both in the life cycle and in the short run sense" [Mincer 1962, p. 75].

Three approaches have been followed in purging assets of whatever life cycle effects may exist. First, the sample may be stratified by age to construct typical profiles of a representative labor force participant for an age-cohort group [Ghez and Becker 1975; Heckman 1976; Ryder, Stafford, and Stephan 1976; Smith 1975; Weiss and Blinder 1976]. This has been done herein. (NOTE: See section A-1c "Life Cycle Allocation" in Chapter II and Appendix E "Life Cycle Labor Supply Analysis.") Second, the sample may be chosen such

that the "individuals included all faced the same or similar life cycle wage paths, interest rates, and other factors that may affect intertemporal labor supply allocation" [DeTray 1973, p. 26]. Such was the simplifying assumption made for the aggregate cross section analysis herein -- given the relative homogeneity of a sample consisting of small farmers in the same geographic region. Moreover, the bulk of the farm assets for many operators is often inherited and thus could be considered exogenous -- that is, not dependent upon past or future labor supply. The third method removes the effects of differing life cycle characteristics by the regression technique of imputing age adjusted assets using age, education, total number of children, homeowners status, and locational variables as regressors in the asset function [Da Vanzo, DeTray, and Greenberg 1973, p. 69]. This technique was judged inappropriate given the special nature of the assets -- farm property that may have been inherited and thus more a function of characteristics of the present operator's parents for which not data is available.

Farm debt (FARMDEBT) is the second variable included in the Farm-Business model. Usually debt is combined with assets as one explanatory variable, measured either as net worth (assets - debts) or as a ratio (debts ÷ assets). Whereas the former is commonly found in general labor supply studies it has not been used in farm household studies, which have included either the debt-to-asset ratio [Kerachsky 1975, p. 112; Primus 1975, p. 41] or total assets without

debts [Barros 1976, p. 44; Sumner 1978, p. 51]. The drawback of meshing debt with assets is that its distinct effect is obscured; and this is important when assets are non-liquid and the debts are not merely a negative image of assets.

Debt is considered significant because it is thought to reduce the flexibility of altering one's work pattern for a farm operation [Primus 1975, p. 42]. In a multiple-job-holding context such financial obligations should draw forth additional labor supply, which may or may not be devoted fully or even partially to agricultural self-employment; that is because increased farm debt does not exclusively reflect the acquisition of additional farm assets in the form of acreage, buildings, and machinery that require more labor input to be optimally combined with such resources. Instead, farm debt can also result from inefficient management practices and/or adverse market conditions that put a farmer in the red, in which case the regular earnings from an off-farm job may be the most expedient method of paying off creditors and subsidizing an unprofitable farm operation -- although among Illinois farmers it was found that there was little variation in farm debt with the amount of off-farm work or across types of farm. But considerable variation by age did exist [Sumner 1978, p. 51].

The latter finding suggests the relevance of life cycle effects whereby farm operators undertake indebtedness in early years to accumulate assets. Moreover, "size of a

family's mortgage on the amount of stock it holds is probably jointly determined along with other variables such as those that reflect work choices" [Greenberg 1972, p. 35]. Thus farm debt is treated in the same fashion as the farm asset variable.

If rising debt were in fact due predominantly to asset accumulation, the two should be strongly correlated; but such was not the finding among Michigan small farms sampled in this study as FARMDEBT and FRMASSET did not demonstrate a strong association in the cross section regressions.

The presumption behind the inclusion of the acres-rented-in (ACRENTIN) variable is that small farmers who add to their acreage are seeking to achieve economies of size which may or may not require more work time. A study of North Dakota grain farms, not limited to small growers, found that "the time allocated to labor activities by the operator decreases with the size of farm while management time increases. The decrease in labor time with increases in farm size is not exactly offset by increased management time since the total time spent per day increased slightly with size of farm" [Johnson and Hvinden 1978, p. 207]. Therefore, since the annual hours of farm work reported in the Michigan Small Farm Survey presumably includes both labor and management time, on-farm labor supply is expected to increase with additional acres of land rented in. The possible presence of simultaneity between these two variables is recognized, but it is not considered sufficient to justify

the use of a full information estimation technique.

Farm income (FARMINC) is only used as a regressor in the off-farm labor supply equation in which it is analogous to the 'other income' or 'total family income' variables discussed in the literature [Ashenfelter and Heckman 1973; Kerachsky 1975; Watts, et al. 1974]. In this study FARMINC could have been combined with investment income and spouse wage income variables to construct a total family income variable. Only one off-farm study included this type of total family income variable encompassing farm income; and it was an imputed version [Sumner 1978, p. 63]. An estimate was used to purge it of potential simultaneity bias under the assumption that at least some of its components were jointly determined with labor supply.

While it is conceivable that the farm income component could be jointly determined with off-farm hours of work indirectly through on-farm hours if they are not independent of each other, the assumption made herein is that the temporary or permanent part-time or full-time off-farm jobs held by farmers and their spouses do not automatically determine on-farm hours in a one-for-one tradeoff and therefore determine farm income. In fact, "part-time farmers work more hours per year than low income full-time farmers" in Michigan [Loomis 1965, p. 4]. Other influences must be recognized and allowed for. This is an important point because flexibility in off-farm employment in terms of hours per week (e.g., half-time jobs) and weeks per year

(e.g., paid vacation, unpaid leaves of absence, seasonality of job), not to mention evenings and weekends, will often make possible an optimal allocation of labor to the farm -- even accounting for the peak period time requirements of planting and harvesting. The time requirements of the farm business can also vary with the specific enterprises selected, the number of labor saving technologies adopted, the type of cultural practices utilized, the amount of custom work contracted for, the additional farm workers employed, the differential productivity of individual farmers across enterprise activities, and the level of managerial skill achieved by the operator. Moreover, substitutes for the operator's time exist in the form of spouse and family labor, which makes it imperative to also examine labor supply in the context of the entire household rather than just the traditionally identified head of household (i.e., male farm operator).

Indeed, farm income is usually the result of work efforts by the entire household, not just one individual member. And in this context it is likewise assumed that, although there may exist some degree of joint determination of working hours among family members, it is by no means taken to be a tradeoff of a set ratio or to exclude other influencing factors. In fact, another Michigan study [Loomis 1965, p. 4] found that for multiple-job-holding farmers "compared with low income full-time farms, more custom work is hired, family members contribute slightly more

farm work, and mechanization is at a higher level per unit of output." With reference to the last point, several respondents in the study stated that "off-farm income enabled them to have more and better machinery than when they were farming full time." Consequently, it was decided to enter FARMINC as an explanatory variable without imputing estimates of it.

Finally, it should be noted that one recent study did attempt the use of the more desirable simultaneous equations model in estimating the labor supply of farm households [Schaub 1980]. Unfortunately, the results were inconclusive with very few significant variables and the standard errors generally larger than the coefficients. Thus problems of estimation remain for models that potentially contain endogenous variables. (See also section B-2b "Endogenous Explanatory Variables" of this chapter.)

c. Ag-Enterprise Model

The Farm-Business model has been extended to include various animal and crop enterprises. Labor supply equations for male operators and their spouses for both on-farm and off-farm hours-of-work are estimated. The presentation and analysis of these results are found in Appendix D since the theoretical foundation of the Ag-Enterprise model is weak and because of the potential endogenous nature of these variables.

2. HYPOTHESIZED ASSOCIATIONS

The reasoning modes behind the expected signs of the explanatory variables identified in the previous section are basically three: deductively via accepted theory and models; inductively via established empirical knowledge; and intuitively via creative perception. This last one is not reasoning in the strictest sense, but it does account for the reliance researchers must place on human judgements borne more out of spontaneity than logic. While the endeavor has been made herein to exploit the contributions of theory and models to their fullest extent and to utilize for guidance the empirical findings reported in relevant labor supply studies, the fact remains that with so few studies of on-farm and off-farm labor supply using the household behavior approach being reported in the literature formal reasoning may not be sufficient in gaining full insight to the phenomena under scrutiny. Nevertheless, a summary of expected signs for the included explanatory variables follows in Table IV-1. These variables are categorized under the Personal-Household and Farm-Business models for on-farm and off-farm hours of work by male operators and their spouses. Precise definitions of these variables are provided in section C of this chapter, where measurement, estimation, and expected sign of each are discussed fully.

Table IV-1. Hypothesized on-/off-farm variable associations by sex.

EXPLANATORY VARIABLES	RESPONSE VARIABLES			
By General Categories	On-Farm Labor		Off-Farm Labor	
	operator	wife	operator	wife
PERSONAL-HOUSEHOLD				
Education Level (Binary)	o	o	+	o
Children At Home	+	x	+	x
Young Children	x	-	x	-
Farming Experience	+	+	-	-
Off-Farm Wage Rate	-	-	+	+
Spouse Wage Income	o	-	o	-
Investment Income	-	-	-	-
S.M.S.A. Residence (Binary)	x	x	+	+
FARM-BUSINESS				
Assets	+	o	-	o
Debts	+	o	+	o
Acres Rented In	+	o	-	o
Gross Income	x	x	-	o

SYMBOLS:

+ indicates a positive relation.
- indicates a negative relation.
o indicates no hypothesized relation.
x indicates omission from model.

B. ECONOMETRIC SPECIFICATION

1. PARAMETERIZED MODELS

Two distinct, progressively expanded versions of the basic economic model are estimated using the 1974 Michigan SMALL FARM PROGRAM survey data.

a. Personal-Household Model

This standard form of the household model is specified such that the labor supply equation includes only the Personal-Household variables. This model closely approximates many used in non-farm studies and forms a basis for comparison with some of the empirical work mentioned in the literature review.

The Personal-Household model of male operator labor supply on-farm and off-farm is:

$$\begin{aligned} \text{OPFARMHR} = {} & a_0 + a_1\,\text{OPSCHOOL} + a_2\,\text{HOMCHILD} + a_3\,\text{OPFARMYR} \\ & + a_4\,\text{OPWAGEST} + a_5\,\text{WFWAGINC} + a_6\,\text{INVSTINC} \\ & + u_1 \end{aligned}$$

$$\begin{aligned} \text{OPJOBHR} = {} & b_0 + b_1\,\text{OPSCHOOL} + b_2\,\text{HOMCHILD} + b_3\,\text{OPFARMYR} \\ & + b_4\,\text{OPWAGEST} + b_5\,\text{WFWAGINC} + b_6\,\text{INVSTINC} \\ & + b_7\,\text{SMSACNTY} + v_1 \end{aligned}$$

For the wives of farm operators the Personal-Household model is specified for on-farm and off-farm labor supply as follows:

$$\begin{aligned} \text{WIFARMHR} = {} & c_0 + c_1\,\text{WFSCHOOL} + c_2\,\text{YNGCHILD} + c_3\,\text{WIFARMYR} \\ & + c_4\,\text{WFWAGEST} + c_5\,\text{OPWAGINC} + c_6\,\text{INVSTINC} \\ & + y_1 \end{aligned}$$

$$WFJOBHR = d_0 + d_1\ WFSCHOOL + d_2\ YNGCHILD + d_3\ WIFARMYR + d_4\ WFWAGEST + d_5\ OPWAGINC + d_6\ INVSTINC + d_7\ SMSACNTY + z_1$$

a. Farm-Business Model

This model represents an addition of farm business characteristics to the family household attributes already specified in the Personal-Household model. Variables dealing with the financial structure of the farm operation are considered important, given the assumption of income utility maximization by the household. Accordingly, male operator labor supply on-farm and off-farm is made explicit below:

$$OPFARMHR = a_1 + \ldots\ldots + a_7\ FRMASSET + a_8\ FARMDEBT + a_9\ ACRENTIN + u_2$$

where a_1 through a_6 variables (.....) are the same as in the Personal-Household model.

$$OPJOBHR = b_0 + \ldots\ldots + b_8\ FRMASSET + b_9\ FARMDEBT + b_{10}\ ACRENTIN + b_{11}\ FARMINC + v_2$$

where b_1 through b_7 variables (.....) are the same as in the Personal-Household model.

The corresponding model for the wife's labor supply in the self-employment and wage market sectors is:

$$WIFARMHR = c_0 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + c_7\ FRMASSET + c_8\ FARMDEBT + c_9\ ACRENTIN + y_2$$

where c_1 through c_6 variables (.....) are the same as in the Personal-Household model.

$$WFJOBHR = d_0 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + d_8\ FRMASSET + d_9\ FARMDEBT + d_{10}\ ACRENTIN + d_{11}\ FARMINC + z_2$$

where d_1 through d_7 variables (.....) are the same as in the Personal-Household model.

2. EQUATION FORMULATION

a. Jointly Determined Relations

The household labor supply model views the family, rather than the individual, as the decision making unit. The labor supply choice of each household adult is not only considered to be dependent on his or her own wage rate and the total resources (i.e., potential full income) of the household, but also quite possibly on the wage rate and labor supply of other family members. This raises the issue of how the possible economic and other behavioral inter-relations between family members should be treated.

If the labor supply equations of the male and female heads of household are specified to exclude each member's labor supply dependent variable from the right hand side of the other members' equation as an explanatory variable, then

Zellner's [1962] Seemingly Unrelated Regressions model (SUR) using Generalized Least Squares (GLS) estimation is appropriate. Viewed as a system, these equations are estimated as a single large equation with the anticipation that more efficient estimates (with smaller variance) will result [Pindyck and Rubinfeld 1976, pp. 279-80]. The gain in efficiency is achieved if the independent variables in the different equations are not highly correlated and if the disturbance terms in the different equations are highly correlated. The one known labor supply study which has compared SUR with OLS found that the former resulted in only a "small gain" in efficiency of the estimates and improved the model's explanatory power just a "little bit" [Muhammed 1979, pp. 88-97]. Accordingly, this estimation technique was not utilized.

Alternatively, a system of equations can be formulated wherein each family member's labor supply is made explicitly dependent upon both the wage rate (actual or potential) and the labor supply of every other family member. Full information techniques can be used for estimating such a simultaneous equations model; however, these techniques are "extremely sensitive to both specification error and measurement error," such that the results "make the FIML estimator less desirable than the limited information estimators" in that the latter "estimates only one equation at a time, confines misspecification in one equation to that particular equation and confines an error in measurement in one variable to

those equations containing that particular variable" rather than allowing them to "propogate throughout the whole system in the process of estimation" [Intriligator 1978, p. 420]. Given the distinct possibility of measurement error due to certain aforementioned inadequacies of the survey data and of specification error due to the omission of relevant explanatory variables as discussed in Chapter III, the above concerns are germane. Moreover, full information techniques are computationally complex and expensive to run and also require larger samples than limited information techniques. Consequently, simpler alternatives to simultaneous equation estimators have generally been used in labor supply studies [Greenberg 1972, p. 53].

One of these simpler techniques involves the use of imputed wage rates whereby a potential wage is estimated for all members of a sample from a sub-sample of working individuals with an actual wage rate on the basis of human capital and other characteristics possessed by the entire sub-sample (e.g., males, females). Unfortunately, problems can arise with these potential wage rates, which are estimated by a wage function using the above characteristics as regressors.

For instance, some subgroups (e.g., wage earning wives) are quite small relative to the total group and may be more representative of one end of the wage distribution for such characteristics facing all units of the sample. This could result in biased estimates. Such is potentially the case in

this study with only 54 of 231 adult females reporting a current wage rate.

Another weakness of using an imputed wage of one family member in another member's labor supply equation is the possibility of bias due to the simultaneity between the wage rate of one adult and the labor supply of the other whereby "women with unusually strong tastes for non-market activities [as opposed to market work] seek out husbands with unusually high market wages and they rely in [their] search, to a degree, on the same objective characteristics included in the [husband's] wage function equation" [T. P. Schultz 1975, p. 83]. In other words, the characteristics of a woman's husband, such as his educational level, are not independent of her own characteristics and tastes in the selection of a marriage partner and therefore might affect her own allocation of time.

A final difficulty with using the imputed wage is that it does not account for the hours worked and thus the income that will be earned in the context of part-time versus full-time job opportunities [Hall 1973, p. 106]. These obstacles lead us to consider another alternative -- an earnings variable.

The earnings (wage rate x hours worked) of household individuals has been used by some researchers, including this one, as an independent variable in the labor supply equation of other family members, while others have merely added such wage income to non-employment income to construct

an 'other household income' variable [Greenberg 1972, p. 54 fn 47]. The drawback of using earnings as an independent variable is that the labor supply component (i.e., hours worked) may be endogenous and thus a potential source of bias.

b. Endogenous Explanatory Variables

Although this and numerous other studies are of the cross section type, many aspects of family decision making in the present are actually the result of past decisions and events and of future plans and expectations. Hence, many explanatory variables, taken as given by individuals in the short run and assumed to be exogenous by researchers in accounting for labor supply in a single period framework, should realistically be viewed as endogenous in a multi-period framework. For example, since family size, education level, work experience, net worth (assets minus debts) and investment income (as well as others like health that are omitted from our analysis) are all behaviorally interrelated with past, current, and future labor supply decisions, it is preferable to evaluate labor time allocation in a life cycle model in addition to the usual short term context [T. P. Schultz 1975, pp. 25-30; Smith 1973]. This in fact is accomplished by stratifying the sample into three age cohort groups. (NOTE: See Appendix E "life Cycle Labor Supply Analysis" for the results.)

It should be noted that two other variables utilized in the analysis are possibly endogenous even in a single period

framework -- namely, farm income and acres rented in. Farm income, included only in the off-farm labor supply equation, is generated by the combined work of the operator, spouse, teenage children and hired hands; and to the extent that one individual's on-farm labor is a sizable component of the farm income variable and is actually interdependent with their off-farm labor supply, an endogenous relation may exist. The other explanatory variable, acres rented in, could also be considered endogenous if additional land indeed requires proportionately more labor to farm it. But, it may not -- depending upon whether or not the agricultural operation is labor intensive, whether economies of scale are achieved in the combination of labor and capital with additional land, and whether the efficiency of an individual's present work effort is below full capacity and can be increased. In any event, farm income and acres rented in are treated as exogenous variables in this analysis, since for the reasons stated both of these variables are probably more nearly predetermined than truly endogenous. Furthermore, the models become far more complex if one tries to endogenize all variables that might be considered such.

3. ESTIMATION METHODS

a. Multiple Regression Analysis

Estimation of the parameters of a multiple regression equation can indicate the direction, magnitude, and statistical significance of the association between a response variable and an explanatory variable. Using

non-experimental data in which the independent variables do not stay constant across observations, multiple regression can obtain good estimates of their effects. Thus it is possible to estimate the effect of changing one exogenous variable while the others are held constant. "This makes multiple regression a powerful and widely useful technique" [Beals 1972, pp. 294-95].

Of the various techniques subsumed under the simple or multiple linear regression model, Ordinary Least Squares (O.L.S.) is the technique most commonly used for estimating continuous and unbounded linear functions. O.L.S. is known to yield best linear unbiased estimators (i.e., B.L.U.E.) for both bivariate and multivariate regression analyses, if its assumptions are met. Specifically, the estimated disturbance term is assumed to have the following characteristics: randomness of individual errors, normality in their distribution, linearity of the expected values of errors, homoskedastic (or constant) variance of the errors for all observation of explanatory variables, and independence of the error terms. If such assumptions are not violated O.L.S. estimators have the desirable properties of unbiasedness (i.e., the expected value of the estimator coincides with the true value) efficiency (i.e., distribution of the estimator is highly concentrated about the sample mean), and consistency (i.e., the estimator increasingly occurs closer to the mean as sample size becomes larger). Violation of the assumptions may adversely affect desired estimator

properties.

b. Limited Information Techniques

For Ordinary Least Squares (OLS) to yield unbiased consistent estimates of the parameters in a single equation the explanatory variables must be exogenous; that is, they should be uncorrelated with the stochastic disturbance term. Two Stage Least Squares (2SLS) is an estimation technique that compensates for the inclusion of two or more endogenous variables in an equation. It is a type of Instrumental Variables (IV) estimation technique that is an appropriate and commonly used single equation method for estimating a structural equation of interest that is part of a jointly determined system, even when the rest of the system has not been specified [Da Vanzo and Greenberg 1973, p. 48].

In the first stage each right-hand side endogenous explanatory variable is regressed on all predetermined variables (i.e., those thought to be statistically independent of the disturbances) in the model. This first stage generates estimated values of the explanatory endogenous variables, known as "reduced-form estimates" or "instrumental variables estimates" that (unlike the endogeneity of the variable in its original form) are not correlated with the disturbance. In the second stage the dependent variable is regressed on the reduced form estimates of the explanatory endogenous variables along with the exogenous variables in the equation. Since the first stage purges the explanatory endogenous variables of their correlation with the error term, 2SLS

estimators are consistent, although their variances are larger than those of corresponding OLS estimators.

As a summary judgement "the 2SLS estimator, while not ideal, is a good compromise among the group of estimators. Thus, 2SLS avoids the bias and inconsistency of OLS while at the same time it avoids the sensitivity to specification error and measurement error (and cost) of 3SLS and FIML" [Intriligator 1978, p. 420]. Not surprisingly 2SLS is the mostly widely used technique for estimating simultaneous equation systems in labor supply studies.

C. VARIABLE DEFINITION

1. RESPONSE VARIABLES

The hours-of-work labor supply response variable is continuous in nature. Here, we are interested in knowing how many hours are worked in a week, in a year, or how many weeks are worked in a year. There is much debate on which measure is most appropriate [Hanoch 1980], especially when annual labor supply estimates are made utilizing survey (cross sectional) data as opposed to longitudinal panel data. In the case of "hours-per-week," seasonal (e.g., summertime vacation) and cyclical (e.g., recession layoffs) factors can strongly influence the estimate of yearly hours because it neglects the difference in the number of weeks per year actually worked. An alternative measure of "weeks-per-year" is similarly deficient because it neglects differences in hours-per-week [Rea 1974, p. 284]. It's

advantages are that it is subject to less measurement error than hours and is also less institutionally constrained than the more rigidly defined half-time or 40 hour a week job [Ghez and Becker 1975]. For that reason weeks-per-year has fared better than hours-per-week for the same data set on which both measures were used [Ghez and Becker 1975, p. 120]. A combination measure of hours-per-week times weeks-per-year is a logical solution to the drawbacks of each component separately; and it is the annual hours measure that is used herein for both on-farm and off-farm labor supply.

This brings us to the matter of what variable construction to use, 'recall' or 'budgeted' hours when gathering data [Primus 1977, p. 866]. This is especially true for self-employed persons (e.g., farmers) from whom accurate estimates of hours worked is sought. Relying on recall of the subject is standard in surveys. The respondent is not asked to provide the annual figure directly. Instead, the individual is asked how many weeks per year he worked and how many hours he worked in an average week during the year. This component approach to eliciting the desired aggregate data facilitates recall and ensures more accurate accounting of the hours measure of labor supply.

However, despite such precautions, there exist certain occupational classifications (e.g., self-employed entrepreneur) where "recall" hours of work may be suspect for reasons of irregular work patterns (e.g., seasonality) and of loosely defined business related labor that should be

disaggregated into relevant identifiable (e.g., production, investment, and "leisure") aspects. Agriculture is a prime example of this phenomenon with its peaks and troughs of time-intensive activities (e.g., spring planting, summer spraying, fall harvesting, winter equipment overhaul). Moreover, farm work can also involve labor related to current or future production, as well as to no production at all. Greater precision in recall could be achieved by having the surveyor ask the respondent to estimate the hours worked on each of several activities, with the interviewer adding up the total hours worked; or an observer can record on a regular basis throughout a period of time how many hours are actually devoted to separate activities. Such observation is not easily done -- especially with respect to non-market time.

Budgeted hours can be constructed by obtaining coefficients from independent data on which the number of hours required for a particular agricultural enterprise have been estimated. The survey data examined herein includes the prerequisite information on the number of acres grown for each crop sold and/or on the number of different kinds of livestock marketed. However, no reliable independent data from which the required coefficients might be obtained exists. Consequently, 'recall' hours is the measure of hours-of-work used herein for both on-farm (OPFARMHR and WIFARMHR) and off-farm (OPJOBHR and WFJOBHR) for male operators and their wives respectively.

Survey respondents probably calculated the annual hours on-farm by mentally or manually multiplying the number of hours worked per week times the weeks worked per year in accordance with the instructions to "estimate on weekly bases if necessary to arrive at yearly total;" though these component figures were not recorded on the questionnaire. Several possible measurement errors exist. One is reliance on memory. Then, too, with farming a "hobby" for some part-time operators, some hours may actually reflect leisure.

2. EXPLANATORY VARIABLES

Fortunately, the explanatory variables available from this data set [Thompson 1975] are among those considered important by theoretical postulations and found significant by previous empirical analyses of labor supply. Unfortunately, there are also some important explanatory variables for which no data was collected or for which measurements selected by the original surveyors are inadequate. These omitted variables are described and their potential effects examined in the next section, "Omitted Variables." What follows now is a brief measurement description accompanied by a statement about the expected sign and a discussion of the nature of the explanatory variables.

Two main classes of explanatory variables -- Personal-Household, and Farm-Business -- form the rubric under which may be found the potential causal factors associated with variation in the on-farm hours-of-work labor supply response variable. Listed below are the variables included for

analyses in the labor supply regression equations.

a. Personal-Household Model Variables

OPAGE: Operator's Age (continuous)

WFAGE: Wife's Age (continuous)

MEASUREMENT: The age data was collected by six age categories, but was entered as the midpoint of the age category.

EXPECTED SIGN: There is no prior expectation regarding sign for either on-farm or off-farm for operators or spouses.

DISCUSSION: The age variable was not used in the labor supply function directly. Rather, the analysis includes a stratification of the sample by age categories to approximate life cycle stages of household members. (See Appendix E "Life Cycle Labor Supply Analysis" as well as section A-1c "Life Cycle Allocations" of Chapter II and section A-1b "Farm-Business Model" of Chapter IV.)

OPSCHOOL: Operator's Years of Schooling (binary)

WFSCHOOL: Wife's Years of Schooling (binary)

MEASUREMENT: A value of 1 is assigned for those with twelve or more years of formal education; and a value of 0 is assigned to those completing eleven or less years of school.

EXPECTED SIGN: There is no prior expectation regarding sign for on-farm for either sex.

Off-farm a positive sign is expected for males, but no prior expectation is found for females.

DISCUSSION: Twelve years of schooling is equivalent to a high school diploma and represents the so-called "credential effect" repeatedly found in studies of human capital. It is the completion of certified levels of education (i.e., primary school certificate, high school diploma, college degree), not the incremental number of schooling years (i.e., 7, 11, 13) that matters in terms of gaining employment. Since a high school diploma is a standard minimum requirement in today's work world, twelve years was chosen as the dividing line for the construction of this binary variable.

Based on empirical research Michael [1973] found education to raise productivity of time in market and non-market activity by approximately the same percentage; thus, the increased education of an individual has been assumed to be "Michael Neutral" in terms of influencing the division of the person's labor. It is also assumed that education raises the marginal productivity of all inputs (not just time) by an equal percentage in household commodity production. Hence, no change in production technology is required to achieve increased efficiency, and therefore, no change in labor supply to market wage labor activity occurs

since the demand for purchased goods and services (as inputs into home commodity production) remains at a constant ratio with time [DeTray 1973, pp. 30-31].

In the context of agriculture an increased on-farm wage rate (i.e., roughly formulated as product sales revenues divided by hours-of-work), holding constant agricultural product prices, can be achieved by a declining number of man hours required to produce the same level of output. Thus, an inverse relationship between education and on-farm labor supply could be expected. But, if we assume that additional education imparts skills that also increase his off-farm wage rate, it will be the relative increase in the two wages that will influence the effect on labor supply in the alternative activities. Consequently, in the absence of any information about the specific orientation and content of schooling (e.g., an agricultural technology program emphasizing farm management skills) the "Michael Neutral" assumption prevails.

HOMCHILD: Children Living at Home (continuous)

MEASUREMENT: The number of dependents who are residing at home are included regardless of their educational and employment status.

EXPECTED SIGN: A positive relationship with both

on-farm and off-farm labor supply is expected for husbands. This variable is not used in the wife's labor supply function.

DISCUSSION: A father's labor supply is positively related to both the number of children as well as the age composition of the dependents because his responsibilities increase -- given the man's culturally defined role as the principal 'bread winner' of the household. The magnitude of his family obligations grows with the age composition of the children, who become a more goods-intensive commodity as they grow up and hence less time-intensive in nature. That is, the child requires less parental attention in the form of personal care as he becomes more self sufficient in feeding, dressing and entertaining himself -- all the while requiring more and more material possessions such as games, bicycles, clothing, food, and consumption goods generally.

YNGCHILD: Young Children (continuous)

MEASUREMENT: The number of children under the age of five represents pre-schoolers requiring personal time of the mother for care and feeding.

EXPECTED SIGN: A negative association with on-farm and off-farm hours is expected for wives who are mothers.

DISCUSSION: Like their husbands, the labor supply

of wives also becomes more responsive to wage rate as the children get older (i.e., past the preschool age of 5 years), though not to the same degree as fathers. But unlike them, the mother's labor supply is very responsive to the presence of pre-schoolers in the home. Children at this formative age (and before they are eligible for the free babysitting facilities of schools) are very time-intensive commodities which require much care -- a role society usually assigns the mother. Studies repeatedly show that the presence of pre-schoolers has a negative effect on mother's labor supply even for the highly educated who have a high market opportunity cost attached to their decision to remain outside the labor force. The explanation for this phenomenon centers on three factors: a taste preference to enjoy infants -- mother and child bonding; an investment component whereby mothers, especially those who are educationally aware, teach their children intellectual and social skills in the most critical first three years of life; and a high productivity level in home production of a child commodity for the well-educated mother [DeTray 1973, pp. 33-34; Gronau 1973, p. S192]. As the children get older, they not only become less time-intensive, but they also become

substitutes for mother in home production (e.g., housecleaning, cooking). This allows the mother greater flexibility to respond to higher wage and income opportunities [Bryant 1976, p. 852].

OPFARMYR: Farming Experience in Years (continuous)

WIFARMYR: Farming Experience in Years (continuous)

MEASUREMENT: The number of years the farm operator and his spouse have continuously farmed together is used.

EXPECTED SIGN: It is positive for on-farm and negative for off-farm for both sexes.

DISCUSSION: This variable indicates the acquisition of specialized skills for higher productivity in a particular line of work. One drawback involves the nature of the survey question which asked for a joint response, which may understate actual farm experience of the male operator before he married his current wife. Correspondingly, the reliability of this figure for wives is also open to doubt. Since the mean value for this variable was 20 years, late marriage or remarriage may not be prevalent in this relatively more traditional and stable population.

OPWAGEST: Operator's Estimated Wage Rate (continuous)

WFWAGEST: Wife's Estimated Wage Rate (continuous)

MEASUREMENT: The reported wage rate of the individuals in the subsample that works off-farm

is regressed on the human capital (i.e., age, education, and market work experience) and environmental (i.e., residence in Standard Metropolitan Statistical Area) characteristics which are possessed by the entire sample. Using the coefficients of these regressors wage rates are imputed for those individuals not working and who otherwise would of necessity be excluded from the labor supply analysis. This procedure avoids selectivity bias. Wage rates are also estimated for the subsample that is working and are substituted for their actual wage rates.

EXPECTED SIGN: It is negative for on-farm and positive for off-farm hours for both sexes.

DISCUSSION: Since wage rate is an important theoretical variable in analyzing labor supply but only a portion of the sample has an actual wage to report, it becomes imperative to estimate the effects of wage rates of those individuals in the sample population who are not employed. Assigning a zero wage is unrealistic; and asking respondents what wage they would require to enter the labor force and work a certain number of hours (ceteris paribus) is unreliable. One solution widely used in recent labor supply studies has been a technique that estimates an expected wage for the non-working segment based on the working

segment of the sample, with the estimated wage rate also being assigned to those with observed wages [Kalachek and Raines 1970; Hall 1973; Boskin 1973]. The "imputed" actual wage is most commonly found in labor supply studies of secondary (e.g., married female), rather than primary, household members -- people who generally have greater discretion in the decision whether or not to work [Scott, et al. 1977, p. 271].

An 'instrumental variable' technique is used to impute the market wage rate variable (i.e., OPWAGEST and WFWAGEST) by regressing the observed wage rate on human capital variables common to the entire sample regardless of employment status. A natural logarithmic function is used, with the equation being specified for males as follows:

$$\begin{aligned} LN(OPWAGE) = {} & m_0 + m_1\ OPAGE + m_2\ OPAGE^2 + \\ & m_3\ OPEDUCYR + m_4\ OPEDUCYR^2 + \\ & m_5\ OPMRKTYR + m_6\ SMSACNTY + s \end{aligned}$$

The corresponding equation for females is:

$$\begin{aligned} LN(WFWAGE) = {} & w_0 + w_1\ WFAGE + w_2\ WFAGE^2 + \\ & w_3\ WFEDUCYR + w_4\ WFEDUCYR^2 + \\ & w_5\ WFMRKTYR + w_6\ SMSACNTY + t \end{aligned}$$

The wage estimates are then assigned to those having an actual wage rate as well as to those not working off-farm. (NOTE: For a complete description of this process and the results see Appendix C

"Imputed Market Wage Estimation.")

WFWAGINC: Wife's Wage Income (continuous)

OPWAGINC: Operator's Wage Income (continuous)

MEASUREMENT: This earned income variable of the spouse is a multiplication of hours-per-week times weeks-per-year times the wage rate -- that is, the midpoint of the wage range within which respondents reported their wage.

EXPECTED SIGN: No prior expectation regarding sign exists for the wife's wage income in the male labor supply on-farm or off-farm. The sign is expected to be negative for the husband's wage income in female labor supply on-farm and off-farm.

DISCUSSION: This constitutes a variation of the Spouse Wage variable that is often included in labor supply equations to approximate a household decision-making framework, whereby the husband's (or wife's) market labor is open to influence by the wife's (or husband's) earning capacity. Empirical results are mixed. The coefficient for the husband's wage rate in the wife's labor supply regression is generally negative -- as expected -- and strongly significant. On the other hand, the coefficient for the wife's wage rate in the husband's labor supply equation has proven to have a weak statistically insignificant effect

[Greenberg and Hosek 1976, pp. 23-24]. Spouse income was used instead of spouse wage because of the possibility of seasonal/limited work opportunities (e.g., off-farm employment on a neighboring farm, school bus driving, etc.) could overstate the impact of the wage rate on an annual basis [Greenberg 1972, pp. 53-54].

INVSTINC: Investment Income of Household (continuous)

MEASUREMENT: This non-labor income variable consists of savings account interest, stocks and bonds dividends, and land rent. It excludes transfer payments that are dependent upon employment status (e.g., unemployment insurance benefits, welfare subsidy) or hours worked (e.g., social security checks).

EXPECTED SIGN: A negative relation with on-farm and off-farm labor supply is expected for both sexes.

DISCUSSION: Empirical evidence seems to indicate that this variable has little impact on husband's labor supply [Scott, et al. 1977, pp. 268-72]; although, an expected negative relation has been observed for wives [DeTray 1973, pp. 15-16]. This is not to suggest that the variable lacks theoretical importance; its just that existing measures are inadequate counterparts to the theoretical concept [Smith 1975].

The R.I.M.E. studies [Bawden and Harrar 1977] indicate that the non-labor income (i.e., negative income tax payments) had the effect of lowering off-farm hours and raising on-farm hours of work. So it is possible that investment income could result in a positive relation with on-farm hours of work.

Attention is called to the fact that land rent is included in the measure of this variable and it is bound to be associated with the labor required to work more or less land. As such this investment income variable has an endogenous component, the importance of which depends on the proportion of investment income attributable to land rent.

SMSACNTY: Michigan County of Residence (binary)

MEASUREMENT: Ottawa, Cass, Ionia, and Livingston counties were assigned a code of 1 because they were part of or adjacent to a S.M.S.A.

EXPECTED SIGN: It is positive for both husbands and wives off-farm. For on-farm labor supply this variable is excluded.

DISCUSSION: Mileage to the nearest labor market (i.e., Standard Metropolitan Statistical Area) represents a travel cost of working off-farm in that the longer the distance, the lower the net wage for a given gross wage rate. This is due to

direct outlays for gasoline or public transport fares, the cost of time with respect to its alternative uses in home production, and the psychic utility or disutility placed on this nonleisure use of time.

Recent studies have illustrated the need to be careful in the actual measurement of distance so that it represents the distance from residence to the nearest metropolitan labor market -- a pre-determined figure that is exogenous to the labor supply model. If the actual distance from home to the work place is taken as the measure, a simultaneity problem may arise due to the endogenous nature of the mileage. This is because a worker may choose among many jobs at varying distances and the time and money costs of distance travelled is optimized and jointly determined with the wage offered [Sumner 1976, p. 20]. The survey data utilized herein has data only on the actual distance travelled to the place of off-farm employment. Unfortunately, the distance to the nearest S.M.S.A. cannot be constructed, since the township location of the individual survey respondent's residence is not known; hence, the use of a binary proxy variable indicating residence in or close to a S.M.S.A. county.

b. Farm-Business Model Variables

FRMASSET: Total Farm Assets (continuous)

MEASUREMENT: This variable includes the estimated value of land, farm buildings, and agricultural machinery.

EXPECTED SIGN: It is positive for husbands on-farm; but there is no prior expectation regarding sign for wives on-farm. A negative sign is expected for husbands off-farm; whereas neither a positive nor a negative relationship is expected for wives off-farm.

DISCUSSION: Figures reported for machinery and equipment may vary among respondents because, unlike land and buildings, they depreciate in value and the amount reported may not be consistent across cases. That is to say, the dollar amounts may reflect past acquisition price, estimated replacement cost, current salvage value, or tax record values depending on how each respondent views it. This may impugn the reliability of this variable, yet to exclude this aspect of assets could not be justified. In any case the land and buildings should dominate value of farm assets.

"Monetary" (i.e., liquid) wealth is used as a proxy variable for "full" wealth in empirical analysis. It can be measured as assets alone, as

net worth (i.e., assets minus liabilities), or as a ratio of debts to assets. Irrespective of the measure selected, observed assets may vary systematically, rather than randomly, over the life cycle. For example, it has been suggested that the early stage of working life is centered on accumulation of wealth, such that more labor supply is associated with more assets. And in the later life stage of disinvestment, assets decline and labor supply decreases [DeTray 1973, p. 23; Smith 1975].

If hours supplied do vary systematically over time for the same or different reasons that assets vary, causation could be falsely attributed to an observed relationship between assets and hours worked in the market [Smith 1975]. One way of removing life cycle effects is to stratify the sample according to age groups thought to reflect distinct life cycle stages [Da Vanzo, DeTray, Greenberg 1973].

It should be noted that, regardless of the measure chosen, empirical research has generally turned up insignificant coefficients for this variable [Greenberg and Hosek 1976, p. 12] and unexpectedly positive at that [Smith 1980, p. 12].

FARMDEBT: Farm Debt (continuous)

MEASUREMENT: This variable specifically excludes

household consumer debt. The information may have been retrieved by use of business records but more probably was obtained by recall.

EXPECTED SIGN: It is positive for husbands, but neither positive nor negative for wives on-farm. No apriori expectation exists for either sex off-farm.

DISCUSSION: This variable is potentially a strong indicator of commitments made to self-employment farming and is entered separately instead of as a component of a net assets variable, wherein its effect might be diluted. Such might be the case for young farmers whose financial liabilities for the farm would approximately equal its value -- except in the case of an inherited farm where debts would be minimal relative to assets. For farmers in the middle and later life cycle stages inflation of farm land values would greatly exceed debt.

ACRENTIN: Acres Rented In (continuous)

MEASUREMENT: This land variable represents the number of acres rented in for the purpose of expanding the farm operation beyond the capital investment and land availability constraints.

EXPECTED SIGN: It is positive for husbands, but neither positive nor negative for wives on-farm. The expected sign is negative for husbands

off-farm with no apriori expectation for wives.

DISCUSSION: An expansion of the land base may bring forth additional labor supply from the household to tend the enterprises put on such acres. Conversely, sociologists have found that individuals moving from full-time to part-time farming generally reduce their acreages -- usually by renting less [Bertrand 1967, p. 301].

FARMINC: Gross Farm Income (continuous)

MEASUREMENT: This financial variable is in annual dollars, representing the average gross farm sales receipts for the preceding two years at the time of the survey. Respondent recall of this value should be fairly accurate, if actual income was not underreported for income tax purposes. Likewise overreporting of farm income is possible to purposely give the "expected" impression of being a successful farmer -- a variation of the so-called 'Hawthorne Effect' [Primus 1977, p. 866].

EXPECTED SIGN: This variable is used only in the off-farm equation where the sign is expected to be negative for husbands, but no apriori expectation exists for wives.

DISCUSSION: It is expected that this variable may be highly correlated with the FRMASSET variable. Also, causality from farm income to on-farm labor supply is somewhat implausible. This variable is

hence more appropriately considered for inclusion in the off-farm labor supply function.

3. OMITTED VARIABLES

Variation in the annual hours of work might also be attributed to some explanatory variables that are not included in the analysis. Race, health status, work experience, and the local unemployment rate are the principal ones suggested by a general review of the labor supply literature.

Race, for which no data was collected in the survey by Thompson [1975], would account for any discriminatory hiring practices by employers and unions in the off-farm job market. Accordingly, less off-farm hours and more on-farm hours might be observed for black farmers. Thus, the extent to which non-caucasian farmers are present in appreciable numbers (e.g., Cass county in our sample) the omission of the race variable represents a loss of potentially significant information.

Health status has proven to be a strong predictor of regular wage employment in rural labor markets [Scott, et al. 1977, p. 271], though its influence on the supply of labor to farm activity remains uncertain in the absence of empirical evidence. However, given the strenuous nature of agricultural production activity, it can reasonably be assumed that poor health would be negatively related to on-farm hours of work. Such disabilities as arthritis, vision and hearing losses, heart trouble, plus mental and nervous disorders are the common measures of health status with reference to

employability. Unfortunately, this information is not contained in the survey data.

Work experience, measured as the number of years in the wage labor market, has been found to express a predilection or taste for employment and thus to be positively associated with labor supply. Unfortunately, Thompson's [1975] survey question on the length of time spent in the 'present occupation' (coming as it did immediately after inquiries about hours and wages of a 'currently held job') was sufficiently ambiguous in definition and placement to allow for the possibility of unreliable (i.e., inconsistent) data -- depending upon respondent interpretation of the question. Consequently, this variable was not directly included in the labor supply function. However, as a probable measure of accumulated human capital and increased productivity through on-the-job training in a present position (where skill training tends to be job specific), work experience is likely to be an important determinant of wage rates. Hence, this variable is included in the wage function, which is used to generate estimated wages for all sample elements to be plugged into the labor supply function. (NOTE: See Appendix C "Imputed Market Wage Estimation.")

The unemployment rate is another variable that has been found to affect the labor supply of men negatively with varying degrees of significance [Cohen 1970, p. 44; Rea 1974, p. 285]. The 'discouraged worker' effect, as opposed to the 'additional worker' hypothesis, seems also to prevail for

women [Cohen 1970, p. 85; Sweet 1973, p. 23] and for rural women in particular [Heaton and Martin 1979, p. 72]. However, certain weaknesses of this variable in the study of non-metropolitan populations raise doubts about its usefulness.

First of all, the unemployment rate is likely to reflect long run structural factors, such that rises in the population and labor force can keep the rate high over a period of years and not reflect the shorter run changes in demand opportunities [Cohen 1970, pp. 21-22]. Instead, change in employment provides a better measure of existing job opportunities facing job seekers. For instance, one of two areas with identical unemployment rates might be experiencing a substantial positive change in employment while the other remains static. And since the area with a low employment change will have fewer chances for employment, it is likely that the individual (e.g., farm household member) living in the area will be 'discouraged' and either leave the wage market labor force or refrain from entering it.

Secondly, because the number of discouraged workers is not counted in the unemployment rate, this labor market statistic does not accurately portray the degree to which competition for scarce jobs prevails in non-metropolitan areas.

Third, farm operators who do view unemployment statistics in various regions (e.g., Standard Metropolitan Statistical Areas) as measuring the relative job opportunities may not be

able or willing to shift their supply of labor to those markets where the demand seems greatest (i.e., area with the lower unemployment rate). A previous study of operators in Michigan found that "most part-time and full-time farmers settled down to a permanent residence before they were 35 years old and became geographically immobile" [Loomis 1965, p. 3].

Fourth, characteristics of separate labor markets can differ markedly, especially in terms of the industrial composition and therefore the types of jobs. Thus, for the same unemployment rate in two geographic regions, the demand for labor by occupational skills and sex could vary [Sweet 1973, p. 23].

Fifth, local area unemployment statistics in non-metropolitan areas are inadequate. "Measurement, conceptual, and definitional inaccuracies render comparisons of labor market conditions in non-metropolitan areas, based on the unemployment rate, inaccurate" [Nilsen 1980, p. 1]. Furthermore, the statistical rigor of non-metropolitan figures is unknown since they are taken as the residual of metropolitan estimates [Nilsen 1980, p. 5].

Sixth, interpretation of the unemployment rate can be difficult in non-metropolitan areas since a sizable proportion of the labor force is engaged in self-employment as a secondary activity (e.g., farming). And if unemployment occurs in the primary activity (e.g., off-farm job), unemployment statistics will not reflect this because of the

self-employed status [Nilsen 1980, p. 33].

Although other variables besides race, health status, work experience and the local unemployment rate might also be included to explain some of the variability in the dependent variable, control for all relevant variables is seldom achieved.

The reason additional regressors, beyond those specified by economic theory, are used is to control for the possible effects of other independent variables that are assumed away by the usual ceteris paribus assumption. Although these may serve to explain some of the variability in the dependent variable, control for all relevant variables is seldom achieved.

> First, all theories are simplifications. It is probably never possible to name all the variables that might affect Y; no matter how many are taken into account, someone with ingenuity can suggest another. Useful theories focus on important variables and ignore those with only tiny effect. Second, some of the relevant variables may be difficult or impossible to measure or control. Finally, economic theories seldom give complete information about the form of functional relationships. So simplicity and convenience are among the criteria for judging empirical results. [Beals 1972, p. 265]

The general guideline is, therefore, to keep the model simple and conserve degrees of freedom to strengthen the test on other regressors. Hence, the argument is made for dropping variables for which only weak apriori beliefs are held concerning an hypothesized relation with the dependent variable [Wonnacott and Wonnacott 1972, p. 300]. Of course, variables which are theoretically important in the testing of a model

should be retained regardless of significance. Needless to say, "There is a good deal of art and judgement involved in empirical analysis" [Beals 1972, p. 265].

SUMMARY

With the adaption of the general household behavior model to self-employment in agriculture combined with market work in the wage sector the labor supply equations for on-farm and off-farm hours by sex were formulated. Econometric techniques were evaluated and multiple regression analysis using ordinary least squares with an instrumental variable technique was selected as the optimal method of estimation. Finally, the response and explanatory variables were described with respect to their measurement and expected signs. The empirical results are reported and interpreted in the following chapter.

CHAPTER V

PRESENTATION AND ANALYSIS OF RESULTS

The object of this chapter is to report the research findings (section A) in terms of the descriptive summary statistics of variables and the performance of the Personal-Household and Farm-Business models of on-farm and off-farm labor supply. These findings are then interpreted (section B) with respect to their conformity to theoretical expectation and consistency with empirical findings of similar studies.

A. REPORTED FINDINGS

1. SUMMARY STATISTICS

Comprehensive summaries of the survey data relating to all the questions posed to Michigan small farm households can be found elsewhere [Thompson 1975; Thompson and Hepp 1976]. The intent here is merely to provide mean values and standard deviations for the variables used herein as a reference for analysis of hours-of-work labor supply on-farm and off-farm as well as for specification of the imputed wage function. These summary statistics in Table V-1 are calculated on the basis of those reporting positive values, excluding zeros and blanks.

Table V-1. Summary statistics of data on variables.

Males[a]		Females[b]	
Variable Name [c]	Mean Values (Std. Dev.)	Variable Name [c]	Mean Values (Std. Dev.)
OPFARMHR [183]	1589.08 (1075.82)	WIFARMHR [117]	1091.26 (1073.57)
OPJOBHR [156]	1997.79 (605.31)	WFJOBHR [58]	1357.79 (704.02)
OPAGE [238]	50.04 (13.16)	WFAGE [228]	46.88 (12.81)
OPEDUCYR [239]	11.06 (2.13)	WFEDUCYR [226]	11.38 (1.74)
HOMCHILD [140]	2.81 (1.65)	YNGCHILD [35]	1.54 (.70)
OPFARMYR [213]	21.07 (12.26)	WIFARMYR [213]	21.07 (12.26)
OPMRKTYR [156]	13.57 (9.21)	WFMRKTYR [59]	9.35 (8.91)
OPWAGE [146]	4.48 (1.05)	WFWAGE [54]	2.94 (1.36)
OPWAGEST [233]	4.13 (.61)	WFWAGEST [225]	2.16 (.67)
OPWAGINC [162] (in hundreds)	90.18 (34.53)	WFWAGINC [60] (in hundreds)	45.18 (31.85)
INVSTINC [80] (in hundreds)	12.88 (16.41)		
FRMASSET [242] (in thousands)	62.21 (36.13)		
FARMDEBT [93] (in thousands)	12.25 (12.22)		
ACRENTIN [35]	64.32 (52.45)		

Table V-1. (Continued)

Males[a]		Females[b]	
Variable Name [c]	Mean Values (Std. Dev.)	Variable Name [c]	Mean Values (Std. Dev.)
FARMINC [198] (in thousands)	8.55 (6.73)		

[a] The number of males in households is 239.

[b] The number of females in households is 231.

[c] Means are calculated on the basis of those reporting positive values; that is, n = 243 - (blanks and zeroes). The number in brackets represents the number of households reporting such positive values for each particular variable.

2. MODEL PERFORMANCE

Looking first at the Personal-Household model and then at the Farm-Business model, the on-farm and off-farm regressions for male and female heads of households respectively are examined.

a. Personal-Household Model

i. Male Labor Supply

Ideally specified the Personal-Household model would include continuous measures of age, education, and job market experience. However these had to be dropped from the equation due to strong correlations with the imputed wage rate that was estimated using these variables. Since age is time related, the presence of the farm experience (OPFARMYR) variable in the equation picks up the effect of age without being strongly correlated with the wage estimate. The job market experience (OPMRKTYR) variable was excluded because of a high correlation with the imputed wage, which was retained because of its theoretical basis as well as its use as a means by which selectivity bias could be minimized by inclusion of those not employed in the wage market. The education variable is re-defined as a binary variable (OPSCHOOL) to reflect the completion of high school; so the effect of education is expressed directly as OPSCHOOL and indirectly through OPWAGEST, which also picks up the effect of residence as well as age and job market experience mentioned above.

As reported in Table V-2 the explanatory power, adjusted

Table V-2. Male labor supply estimations[a] of personal-household model.

Explanatory Variables	On-Farm Hours	Off-Farm Hours	Total Hours
Intercept	1444.0668 (674.9125)	-1590.8782 (551.5824)	146.8114
OPSCHOOL	286.9588**[b] (174.5007)	-162.7256 (142.4365)	124.2332
HOMCHILD	112.4144**** (45.1784)	14.3820 (36.9718)	126.7964
OPFARMYR	28.8030**** (7.2300)	-15.9415**** (5.8620)	12.8615
OPWAGEST	-234.1134* (153.0828)	789.3576**** (129.0048)	555.2442
WFWAGINC	-3.6468 (3.2931)	.4634 (2.7521)	-3.1834
INVSTINC	-26.9490**** (6.4816)	-3.2842 (5.2539)	-30.2332
SMSACNTY		165.4785 (132.2339)	
R^2	.16	.35	
$\bar{R}^2$	.14	.33	
n	198	200	

[a] Coefficients are reported with standard errors in parentheses.

[b] Significance levels: **** = .01; *** = .05; ** = .10; * = .15 for the null hypothesis that the parameter equals zero.

for degrees of freedom ($\bar{R}^2$), of the on-farm labor supply equation of the Personal-Household model is not great at .14; although it is higher than Sumner [1978] obtained for Illinois farmers with an equation which similarly excluded farm business and agricultural enterprise variables.

The operator's completion of high school (OPSCHOOL) is associated positively with on-farm labor supply and is significant at the .10 level. While it was thought that the 'credential effect' of possessing a high school diploma might tend to enhance employability off-farm and thereby possibly, though not necessarily, reduce on-farm work, the sign and magnitude of the coefficient is not totally unexpected given the "Michael Neutral" assumption about the increased productivity of education in all endeavors inclusive of self-employment and home production as well as wage work.

An increase in the number of children in the household (HOMCHILD) is positively associated with on-farm labor supply and is significant at the .01 level. An increase in labor supply is expected as family responsibilities grow not only in terms of the marginal expense of raising additional children, but also with respect to the resulting change in the composition of the family towards a more goods intensive structure associated with the presence of older children that a larger family implies. Moreover, the increased availability of supplemental labor in the form of older children, when combined with increased labor of the male head

of household, may reflect greater revenue opportunities as the farm labor resource constraint is overcome and increased agricultural production possibilities are achieved. But the positive sign for this variable could also reflect a taste factor whereby the father wishes to share the "joy of farming" with his children, to instill agrarian values in them by example, and to increase their human capital in the form of increased knowledge of agricultural production.

Years of experience in farming (OPFARMYR) is positive and significant at the .01 level, indicating both a strongly developed taste for farming and an accumulation of human capital skills in agriculture are associated with increased on-farm labor.

The estimated wage rate (OPWAGEST) has the expected negative sign, though it is only significant at the .15 level. This suggests that the higher the off-farm wage rate rises relative to a given on-farm wage rate, the more likely is a lower supply of labor to agricultural work.

The sign of the wife's wage income (WFWAGINC) is negative but not significant at the .15 level. However, this is not surprising since empirical evidence indicates the husband makes his labor supply decisions independent of his wife's employment decisions.

Finally, investment income (INVSTINC), which for some farmers may include rent from land rented out, has the expected negative sign that logically follows from a decrease in farming acreage. Of course, were this variable to be

purged of rental income and be comprised solely of stock dividends and interest from bonds and savings, then the negative sign would imply that this type of income is not used as a source of investment for an expanded farm operation requiring additional on-farm labor, but rather may result in increased leisure activity at the expense of farm production.

The explanatory power of the off-farm labor supply equation is greater than for the on-farm equation. This is primarily due to the strong influence of the estimated wage rate in explaining the variability in hours worked in the wage market.

OPWAGEST is significant at the .01 level and has a positive sign, which means time is allocated away from alternative uses of leisure, home production, or on-farm work.

The only other significant variable is OPFARMYR -- also at the .01 level. The sign, as expected is negative; thus indicating that years of farming experience reflect a taste for farm work and a lesser preference for off-farm employment as an exclusive labor activity.

OPSCHOOL has an unexpected negative sign -- unexpected in that it was thought that completion of high school might provide operators greater opportunity for off-farm employment, given employer preferences for 'credentials'. However, since the estimate is not much larger than its standard error, the results do not invalidate the "Michael Neutral" assumption discussed earlier with reference to the

influence of schooling upon on-farm labor supply.

HOMCHILD, although possessing the expected positive sign, is not significant at the .15 level.

The finding that WFWAGINC has a coefficient less than one that is not significant at the .15 level is consistent with the apriori assumption that no relationship exists between a wife's employment and the husband's labor supply.

INVSTINC has the expected negative sign, though not significant at the .15 level. Such income makes employment sources of income less necessary; hence, fewer hours are worked off-farm.

A new variable, SMSACNTY, which indicates whether a farm is located in or adjacent to a Standard Metropolitan Statistical Area, turns out positive as expected, but is not significant at the .15 level. (NOTE: The coefficient 165.4785 for SMSACNTY in the labor supply equation does not express the total effect,* which is actually 232,6527 when accounting for

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* The total effect of SMSACNTY is calculated (1) by substituting the right hand side of the wage equation for OPWAGEST in the labor supply equation, and (2) by combining terms so that the coefficients are added. Given the wage equation

$$OPWAGEST = m_0 + \ldots + m_5 OPMRKTYR + m_6 SMSACNTY$$

which is substituted into the labor supply equation

$$OPJOBHR = b_0 + \ldots + b_4 OPWAGEST + \ldots + b_7 SMSACNTY$$

such that

$$\begin{aligned} OPJOBHR &= b_0 + \ldots + b_4(m_0 + \ldots + m_6 SMSACNTY) + \ldots \\ &\quad + b_7 SMSACNTY \\ &= b_0 + \ldots + [b_4(m_0 + \ldots + m_5 OPMRKTYR) + b_4 m_6 SMSACNTY] \\ &\quad + \ldots + b_7 SMSACNTY \\ &= b_0 + \ldots + [b_4(m_0 + \ldots + m_5 OPMRKTYR)] + \ldots \\ &\quad + [b_4 m_6 + b_7] SMSACNTY \end{aligned}$$

the influence of SMSACNTY in the wage equation where the coefficient is .0851 in Table C-1 of Appendix C.)

Netting the effect of the explanatory variables in the on-farm and off-farm equations in order to arrive at the total labor supply gives signs that are not contrary to theoretical expectation. Although units of the explanatory variables are not comparable, it is worth pointing out the large change in labor supply that results from a one unit change in OPWAGEST whereby a one dollar increase in market wage is associated with an increase of 555 hours (or approximately 14 forty hour work weeks) annually.

ii. Female Labor Supply

The on-farm labor supply equation for females, as reported in Table V-3, shows results identical to the male on-farm equation with regards to the direction of the relationships of common explanatory variables with the hours-of-work response variable. However, the significance levels do differ, and the explanatory power of the equation is lower.

The positive coefficient for wife's schooling (WFSCHOOL) again illustrates the validity of the assumption that education may increase productivity in all work activity and thus raise the marginal value product of labor in farming.

However, the number of young children (YNGCHILD) does not have the expected negative sign that would indicate a constraint upon involvement with the farm operation. It may be that residence on the 'work site' allows the wife to

Table V-3. Female labor supply estimations[a] of personal-household model.

Explanatory Variables	On-Farm Hours	Off-Farm Hours	Total Hours
Intercept	533.8517 (346.3638)	-919.9604 (207.9743)	-386.1087
WFSCHOOL	238.2922 (171.5049)	-225.4402*** (100.5362)	12.8520
YNGCHILD	115.4990 (120.9875)	-219.9510**** (69.8835)	-104.4520
WIFARMYR	11.3604**[b] (6.8982)	1.7780 (4.0086)	13.1384
WFWAGEST	-24.4476 (126.3070)	827.9640**** (86.0216)	803.5164
OPWAGINC	-3.9916**** (1.5369)	-1.4487* (.8924)	-5.4103
INVSTINC	-15.3967**** (5.7445)	-1.5358 (3.3340)	-16.9325
SMSACNTY		-512.6875**** (101.5777)	
R^2	.10	.38	
$\bar{R}^2$	.07	.35	
n	180	185	

[a] Coefficients are reported with standard errors in parentheses.

[b] Significance levels: **** = .01; *** = .05; ** = .10; * = .15 for the null hypothesis that the parameter equals zero.

participate. In any case this variable was not significant at the .15 level.

Years of farming experience (WIFARMYR) is positively related to labor supply but is of weak significance. This variable does not measure the intensity of that experience with respect to involvement; rather, for wives especially, it may merely reflect the period of farm residence.

As with the male, the estimated off-farm wage rate (WFWAGEST) does have the expected negative sign but is not significant at the .15 level.

Interestingly the spouse's off-farm wage income (OPWAGINC) does have the expected negative sign and is quite significant. This confirms the idea that the wife's labor supply decisions take into consideration the monetary contribution to household well-being of the husband's wage market income.

Investment income (INVSTINC), inclusive of rentals from farm land, decreases the labor supply as expected and is significant at the .01 level.

The explanatory power of the off-farm labor supply equation for females, at .35, is slightly above that of the male operator's equation.

The negative coefficient of WFSCHOOL, which is significant at the .05 level seemingly does not support the "Michael Neutral" assumption that education has an equal effect on productivity in all productive endeavors, be they in the home, on the farm, or in wage employment. Human

capital theory suggests that education increases productivity of labor in farming activity relatively more than in market wage work. Most certainly the 'credential effect' is not operative for females. The fact that the size of the negative coefficient almost exactly matches the positive coefficient in the on-farm equation may indicate a compensatory withdrawal from wage employment in favor of self-employment.

YNGCHILD is significant at the .01 level and the negative sign conforms to the expectation that an off-farm job would require absence from the home where child care and development are the commodities in need of production ala the Household-Production Function model.

WFWAGEST is positive and significant at the .01 level, again illustrating that an increase in the market wage rate does elicit an increased labor supply as predicted by economic theory.

The negative sign for OPWAGINC, which is significant at the .15 level, confirms the expected dependence of the wife's labor supply decisions upon the husband's employment status.

INVSTINC has the expected negative sign but is not significant at the .15 level.

The negative sign for SMSACNTY, which is significant at the .01 level, is a surprise in that it was thought residence in or near a Standard Metropolitan Statistical Area would increase the likelihood of off-farm work in terms of greater wage employment opportunities and shorter commuting distances

to off-farm jobs that would be compatible with home production and child rearing responsibilities. It should be noted that the magnitude of the variable is reduced from a -512 to -244 when the indirect effect of SMSACNTY expressed through WFWAGEST is accounted for. Still, the negative sign is not explained.

Netting the effect of the explanatory variables in the on-farm and off-farm equations in order to arrive at the total labor supply gives signs that are not contrary to theoretical expectation. As with male operators, the estimated wage had the greatest effect on labor supply for a one unit change in the explanatory variable.

b. Farm-Business Model

i. Male Labor Supply

The explanatory power of the on-farm labor supply equation of the Farm-Business model, found in Table V-4, is $\bar{R}^2$ = .24 which is almost twice that registered by the Personal-Household model. This increase can be attributed to the effect of two variables, farm assets (FRMASSET) and acres rented in (ACRENTIN), which were both significant at the .01 level.

An increase in FRMASSET was found to be positively related to on-farm labor supply, which means that as farmland ownership and equipment investment is increased, it draws in more operator labor.

The positive sign for ACRENTIN indicates that as operating farm size is increased additional work effort is

Table V-4. Male labor supply estimations[a] of farm-business model.

Explanatory Variables	On-Farm Hours	Off-Farm Hours	Total Hours
Intercept	955.6193 (633.7976)	-1573.1472 (549.9097)	-617.5279
OPSCHOOL	222.9907 (172.8185)	-80.8064 (144.2885)	142.1843
HOMCHILD	120.0333****[b] (45.9010)	-8.0340 (38.7787)	111.9993
OPFARMYR	27.3574**** (7.2647)	-10.0505** (6.1580)	17.3069
OPWAGEST	-211.6258 (146.4165)	780.7794**** (125.7287)	569.1536
WFWAGINC	-4.5964* (3.1541)	.0930 (2.6912)	-4.5034
INVSTINC	-23.9408**** (6.2421)	-5.2331 (5.2523)	-29.1739
SMSACNTY		140.8260 (133.5147)	
FRMASSET	5.6631**** (2.1388)	.8903 (1.9460)	6.5534
FARMDEBT	-8.1165 (8.2052)	14.4141*** (6.7922)	6.2976
ACRENTIN	12.2448**** (2.6399)	-2.0621 (2.1668)	10.1827
FARMINC		-31.2952**** (10.3818)	
R^2	.28	.41	
$\bar{R}^2$	.24	.37	
n	188	190	

Table V-4. (Continued)

[a] Coefficients are reported with standard errors in parentheses.

[b] Significance level: **** = .01; *** = .05; ** = .10; * = .15 for the null hypothesis that the parameter equals zero.

required.

Farm debt (FARMDEBT) was not significant at the .15 level. The negative sign was not expected as it suggests that an increase in farm debt, presumably due to land and equipment acquisition, would call forth less rather than more labor on the farm. Potential explanations include: increased farm debt is not due to acquisition but to bad management of existing assets and/or adverse product market conditions; the addition of advanced technology allows for a less labor intensive production function; refinancing the mortgage to achieve increased cash flow for non-farm investment income. Other interpretations are certainly possible.

Although the significance levels of the Personal-Household variables included in the Farm-Business model change, the signs remain the same. OPSCHOOL and OPWAGEST lose significance and WFWAGINC becomes significant at the .15 level or better.

The explanatory power ($\bar{R}^2$) of the off-farm labor supply equation for males is only slightly increased (from .33 to .37) with the addition of the Farm-Business variables to the Personal-Household model. Of these only FARMDEBT and gross farm income (FARMINC) are significant at the .05 and .01 levels respectively.

The positive sign for FARMDEBT suggests the need for off-farm income as a source of capital input to pay off liabilities incurred with the farming operation.

The negative sign for FARMINC implies less reliance upon

off-farm work to earn a livelihood.

The accumulation of FRMASSET does not have any significant effect with a coefficient less than one in value.

ACRENTIN has the expected negative association with off-farm hours of work, but is not significant at the .15 level or better.

In comparing the status of variables common to the Personal-Household model and the Farm-Business model, the signs change only for HOMCHILD which becomes negative. OPFARMYR and OPWAGEST remain the only variables that have coefficients significant at the .15 level or better.

Netting the effect of the explanatory variables in the on-farm and off-farm equations in order to arrive at the total labor supply of males gives signs -- with one exception -- that are not contrary to theoretical expectation. The negative sign for WFWAGINC does suggest the possibility of non-independence of male labor supply decisions with spouse employment activity.

ii. Female Labor Supply

The explanatory power of the Farm-Business model's on-farm labor supply equation for females in Table V-5 remains virtually unchanged ($\bar{R}^2$ = .07 versus .08) compared with the Personal-Household model. The signs of the common variables stay the same, though WFSCHOOL enters significance at the .10 level.

FRMASSET is the only Farm-Business variable significant at the .15 level or better. The positive sign indicates

Table V-5. Female labor supply estimations[a] of farm-business model.

Explanatory Variables	On-Farm Hours	Off-Farm Hours	Total Hours
Intercept	222.0467 (396.9871)	-696.1490 (223.2408)	-474.1023
WFSCHOOL	338.9064**[b] (184.6125)	-234.4152*** (105.4219)	104.4912
YNGCHILD	134.0574 (126.5907)	-224.4471**** (71.2398)	-90.3897
WIFARMYR	13.2434** (7.4030)	1.5397 (4.2162)	14.7831
WFWAGEST	-26.2198 (131.6090)	805.9528**** (85.5574)	779.7330
OPWAGINC	-4.2608**** (1.6095)	-1.8629*** (.9346)	-6.1237
INVSTINC	-15.0693**** (5.9217)	-2.7806 (3.4030)	-17.8499
SMSACNTY		-563.1185**** (104.3429)	
FRMASSET	3.4831* (2.2354)	-.7367 (1.3426)	2.7464
FARMDEBT	2.3044 (7.5685)	-1.9476 (4.2502)	.3568
ACRENTIN	-1.5774 (2.5383)	2.4621** (1.3740)	.8847
FARMINC		-12.5137** (6.8212)	
R^2	.13	.41	
$\bar{R}^2$	.08	.38	
n	169	174	

Table V-5. (Continued)

[a] Coefficients are reported with standard errors in parentheses.

[b] Significance levels: **** = .01; *** = .05; ** = .10; * = .15 for the null hypothesis that the parameter equals zero.

that wives increase their on-farm labor contribution as the value of land, buildings and equipment investments grow.

FARMDEBT and ACRENTIN have quite small coefficients and are not significant at the .15 level or better.

The off-farm labor supply equation for females in the Farm-Business model finds the variables common to the Personal-Household model unaltered with respect to the coefficient signs and significance at the .15 level or better. The explanatory power ($\bar{R}^2$) increases a bare .03 to .38 with the model expansion.

Neither FRMASSET or FARMDEBT are significant, and their coefficients are quite small.

ACRENTIN is significant at the .10 level and has a positive sign. One possible explanation for this somewhat unexpected result can be found in the rural sociology literature reviewed in Chapter II, wherein a study [Wilkening 1968, pp. 2-3] showed that "as the size of farm enterprises increases the wife is less involved in both work and decision making roles in the farm area." Thus, an increase in ACRENTIN would mean an increased size of operation, which would free up the wife to undertake more home production or off-farm work. This result could imply that larger farms require more specialized roles and therefore more highly developed skills, which wives are not inclined to develop vis a vis pursuit of traditional skills in home production or of marketable skills for off-farm sector employment.

FARMINC is also significant at the .10 level. The

negative sign suggests that increases in income from non-wage market sources enables wives to reduce hours of work supplied to the off-farm labor market.

Netting the effect of the explanatory variables in the on-farm and off-farm equations in order to arrive at the total labor supply gives signs that are not contrary to theoretical expectation. As with male operators, the estimated wage had the greatest effect on labor supply for a one unit change in the explanatory variable.

B. INTERPRETED FINDINGS

In this section the overall findings reported above for sex aggregates are examined to see whether labor supply theory is verified in the main and whether the empirical results are consistent with those of similar studies.

1. THEORETICAL CONFORMITY

Generally speaking, the Personal-Household model is more effective in explaining the variation in off-farm hours-of-work than on-farm labor supply. The $\bar{R}^2$ was .33 versus .14 for males and was .35 versus .07 for females. But, as the Personal-Household model is extended to include Farm-Business variables, the $\bar{R}^2$ of the on-farm labor supply equations dramatically approach the explanatory power of this same model for off-farm hours-of-work by husbands and wives.

The Personal-Household model variables all had the expected signs, except for YNGCHILD for female on-farm labor

supply which has a non-significant positive (instead of negative) sign, OPSCHOOL for male off-farm labor supply which has a non-significant negative (rather than positive) sign, WIFARMYR for female off-farm labor supply which has a non-significant positive (as opposed to a negative) sign, and SMSACNTY for female off-farm labor supply which has a significant negative (in place of a positive) sign.

A brief review of this model's seven variables of level of schooling, number of children, farming experience, own-wage rate, spouse wage income, investment income, and county residence tends to confirm expectations derived from economic theory regarding their relationships with labor supply both to on-farm self-employment and off-farm wage employment.

The fact that on-farm hours-of-work increased for males and females with graduation from high school is consistent with the "Michael Neutral" assumption that education increases labor productivity in all endeavors equally. However, even though possession of a high school diploma enhances one's employability in the wage market, off-farm hours-of-work declines for both sexes which would seem to suggest that the expected 'credential effect' is not present for either sex.

The number of children in a household, which indicates additional male responsibility for goods-intensive consumption, is associated with an increase in on-farm and off-farm hours worked -- presumably in order to earn more income with which to purchase such goods. The effect of young children

is also in accordance with theoretical expectation in that women are constrained from participating in labor away from their residence.

The work experience variable for years farming supposedly reflects human capital accumulation (as well as taste factors) which predicts that increased experience raises productivity. The estimated effects are significant and positive for on-farm labor supply by males and females, and a significant negative relation with off-farm work by males. A positive relation occurred for off-farm female labor supply, but the coefficient was less than half the size of the standard error.

The estimated wage rate has the expected positive sign for off-farm labor and negative sign for on-farm work which is what theory suggests is the logical relationship.

Spouse income in the male labor supply function was not expected to have any effect, given the independence of the husband's wage market decisions. On the other hand, wives are classified as secondary workers whose labor force participation and hours-of-work are conditional upon the husband as the primary worker in the household. Indeed, the results bear this out with operator's wage income being negatively associated with female labor supply both on-farm and off-farm.

Investment income reduced on-farm and off-farm labor supply for both sexes as theory suggests, although this variable was significant only for on-farm labor supply of

both sexes -- which may be due to the effect of acres rented out being a component of investment income.

Finally, while residence in a S.M.S.A. county has a positive effect for male off-farm labor supply as would be expected with the increased job opportunities available, the sign is unexpectedly negative and significant for female off-farm labor supply.

The Farm-Business model results show the variables to have the expected signs with the exception of FARMDEBT for on-farm male labor supply and FRMASSET for off-farm male labor supply, neither one of which had the value of its coefficient exceed the standard error."

Farm assets is positively related to on-farm labor supply for both sexes and negatively related to off-farm labor supply for females; and these results are consistent with theory. The positive sign for male off-farm labor supply, while not expected and not significant at the .15 level or better, may be explained in terms of financing farm expansion with off-farm earnings.

Farm debt, contrary to expectation, has a negative but insignificant sign for on-farm labor supply -- perhaps attributable to poor management or unfavorable market conditions instead of reflecting capital investment in the farm. However, as expected it was positively related to male off-farm labor supply and significant at the .05 level thereby indicating the importance of cross subsidization of farm activity by off-farm sector income.

Acres rented in is positive and significant for male on-farm labor supply, as an expanded operation implies. The positive significant sign for female off-farm labor supply suggests that larger farms may result in more specialized activity by male operators, but less for females who may elect not to develop the expertise involved and accordingly who supply less labor to the farm (negative, non-significant coefficient) and more to the wage market sector for which she has salable skills.

Finally, gross farm income is negatively related to off-farm labor supply of both the male and female heads of household, which is what theory would predict in terms of a leisure preference choice.

2. EMPIRICAL CONSISTENCY

The main studies with which the research results are most directly comparable involve the Illinois farm studies by Sumner [1978] for both on-farm and off-farm hours-of-work and by Sexton [1975] and Barros [1976] for off-farm labor supply. The R.I.M.E. studies [Kerachsky 1975; Primus 1975] with their emphasis on the experimental effects of income transfers are less comparable.

a. On-Farm Labor Supply

Sumner's male labor supply equations had R^2s of .10 and .18 for equations comparable to the two models estimated herein [Sumner 1978, p. 74]. This represents a somewhat lower explanatory power than the results reported in this study for the Personal-Household (.16) and the Farm-Business

(.28) models. Sumner's equations include age, education, imputed wage, health, total family income, farm assets, and regional location measures.

With respect to variables common and comparable in measure to both studies, the estimated market wage rate showed a negative relation to on-farm labor supply in both studies. Similarly, farm assets have a positive association with on-farm hours in Illinois and Michigan. Therefore, the results of the two studies are consistent with each other.

b. Off-Farm Labor Supply

The imputed wage rate was positively related to off-farm work in Sumner [1978, p. 74] and Sexton [1975, p. 91] as in this study. The non-employment income variables of Sexton and Barros [1976, p. 66] were negative, as is the sign for investment income herein. Farm assets had a negative sign in Barros and a positive sign in this study, but neither were significant at the .15 level or better. Years of farming experience has negative coefficients for Barros and the results reported here. Education, measured continuously in years, had a positive sign in Sumner and a negative sign in Sexton; the binary measure of schooling used in this study has a negative coefficient. So once again the results are generally similar for all four studies on comparable variables for farmer operators in neighboring states where agriculture is not too dissimilar.

The explanatory power (R^2 values) for the three studies was .58 for Sexton's equation, .19 to .27 for Sumner's

specifications, and .35 to .47 for the models reported herein. Barros did not report an R^2 value for his equation.

SUMMARY

The findings reported for on-farm self-employment and off-farm wage work by both male operators and their spouses were stable across progressively extended equations that involved additional regressors of the Farm-Business model beyond those of the standard Personal-Household model. For the most part the hypothesized relations prevailed with expected signs occuring. Moreover, the coefficients on many of these variables were significant at the .01, .05, .10 or .15 level.

An examination of theoretically specified variables of the Personal-Household model conformed with human capital theory (i.e., imputed wage function) and consumer choice theory (i.e., labor supply function). Furthermore, a comparison of the findings reported herein were found to be consistent with similar farm household studies conducted on Illinois data for both on-farm and off-farm hours-of-work.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This concluding chapter presents a brief overview of the research conducted (section A), an evaluation of the results with respect to confirmation of hypotheses and the accuracy of the findings (section B), and finally some closing suggestions for improved data gathering and estimation procedures (section C).

A. RESEARCH SYNOPSIS

1. PROBLEM AND HYPOTHESES

The problem under investigation was the determination of what Personal-Household attributes and Farm-Business characteristics are associated with annual hours-of-work on-farm and off-farm by operators and their spouses belonging to low farm-income households. A review of relevant theory and empirical literature in conjunction with deductive reasoning about farming operations led to the formulation of hypothesized associations between the aforementioned classes of explanatory variables and the response variable of hours-of-work on-farm and off-farm (Table IV-1).

2. THEORY AND MODEL

Consumer choice theory underlies labor supply analysis, and human capital theory provides the foundation for labor productivity analysis and the specification of wage earnings functions.

The household production function model was used to understand the interdependent relationships among individual members of a single household. In particular its application to allocation-of-time decisions among alternative uses of wage market work, self-employment farming, home commodity production, and leisure provided a conceptual framework for examining labor supply of farm families.

This led to the specification of two labor supply models or equations: Personal-Household and Farm-Business.

3. SAMPLING AND ESTIMATION

The data used were from a stratified random sample from Michigan's lower peninsula. A total of 243 low farm-income households located in ten different counties were included in the survey conducted in 1974 [Thompson 1975]. These households were selected to be representative of small farms, which were defined to have under $20,000 annual gross agricultural sales.

Estimation of the labor supply functions involved the use of an imputed wage rate for the entire sample in order to avoid sample censorship that would occur if only the actual reported wage rate was used. By assigning an estimated wage rate to non-workers they were included in the analysis.

The labor supply equations were then estimated using OLS.

This instrumental variable technique is also less sensitive to measurement error and specification error than is the alternative of using a simultaneous equations model, which is designed to cope with potential endogenous relationships among variables.

B. GENERALIZED RESULTS

1. HYPOTHESIS CONFIRMATION

The hypothesized relations between the Personal-Household and Farm-Business explanatory variables and the hours-of-work response variables for on-farm self employment and off-farm wage employment of operators and their spouses prevailed for the most part, with coefficients for many variables significant at the .01, .05, .10, and .15 levels. The results for the aggregate sample by sex are summarized in Table VI-1 and may be compared with the hypothesized variable relations originally formulated in Table IV-1. Table VI-1 also reports the sign and significance levels for the animal and crop variables of the Ag-Enterprise model, the results of which are presented in Appendix D.

In appraising the findings according to the criteria of whether they conformed to theoretical expectation and whether they were consistent with the findings of similar empirical investigations, these results generally satisfied both criteria. The models as specified are judged adequate to the task, although incomplete to the extent that greater

Table VI-1. Estimated on-/off-farm variable associations by sex.

EXPLANATORY VARIABLES	RESPONSE VARIABLES			
By General Categories	On-Farm Labor		Off-Farm Labor	
	operator	wife	operator	wife
PERSONAL-HOUSEHOLD[a]				
Education Level (Binary)	+ (.10)[d]	+	-	- (.05)
Children At Home	+ (.01)	x	+	x
Young Children	x	+	x	- (.01)
Farming Experience	+ (.01)	+ (.10)	- (.01)	+
Off-Farm Wage Rate	- (.15)	-	+ (.01)	+ (.01)
Spouse Wage Income	-	- (.01)	+	- (.15)
Investment Income	- (.01)	- (.01)	-	-
S.M.S.A. Residence (Binary)	x	x	+	- (.01)
FARM-BUSINESS[b]				
Assets	+ (.01)	+ (.15)	+	-
Debts	-	+	+ (.05)	-
Acres Rented In	+ (.01)	-	-	+ (.10)
Gross Income	x	x	- (.01)	- (.10)
AG-ENTERPRISE[c]				
Layer Hens	+ (.01)	+ (.01)		- (.05)
Dairy Cows	+ (.01)	+ (.01)	- (.01)	
Feed Cattle	+	+ (.01)		
Silage Corn	+ (.01)	+ (.01)		
Grain Corn	+ (.05)	+		
Soybean	+ (.15)	+		
Wheat			+ (.05)	
Hay/Alfalfa			+ (.10)	
Fruit	+ (.05)	+		

Symbols: + indicates positive relation.
- indicates negative relation.
x indicates omission from model.

Table VI-1. (Continued)

[a] Estimations from Personal-Household Model in Tables V-2 and V-3.

[b] Estimations from Farm-Business Model, inclusive of Personal-Household variables, in Tables V-4 and V-5.

[c] Estimations from Ag-Enterprise Model, inclusive of Personal-Household and Farm-Business variables, in Tables D-1 and D-2.

[d] The level at which the coefficient of the explanatory variable is statistically significant in the respective models estimated.

explanation of the response variable might have been achieved had the survey data contained information on additional variables of relevance to labor supply analysis.

The results of the empirical analysis showed that for both sexes in on-farm labor supply the Farm-Business model is only moderately better than the Personal-Household model in explaining the variation in hours-of-work. The differences are less pronounced for the off-farm equations. The $\bar{R}^2$ values for the on-farm labor supply equations of these two respective models are .24 and .14 for males and .08 and .07 for females. The values of $\bar{R}^2$ for the off-farm labor supply equations of these same two models are .37 and .33 for males and .38 and .35 for females. These figures also point up the fact that the Farm-Business and Personal-Household models were better in accounting for the variation of off-farm compared to on-farm hours-of-work. Generally speaking, the explanatory power of these models compares favorably with those of similar cross-section studies of farm family labor supply to on-farm and off-farm activities.

The principal findings and conclusions of this empirical study are summarized below: first for on-farm labor supply, then for off-farm labor supply, and finally for life cycle variations thereof. Discussion is limited to those variables for which the coefficients were significant at the .15 level or better as reported in their respective models.

For males the variation in hours-of-work <u>on-farm</u> was found to be a function of several variables. Those operators

completing high school, supporting a larger number of children, having more farming experience, possessing greater assets, and renting in acres were found to supply more labor to their farming activities. Those with investment income, including rent from acres rented out, supplied less labor on-farm.

For females fewer variables were significant at the specified levels. Thus we are limited to stating with any confidence that spouses of households where the husband's wage income increases and investment income rises supply less labor to the farm. They supply more labor to the farm as additional farming experience and farm assets are acquired.

Off-farm labor supply of males is positively affected by a higher market wage rate and increased farm debts. Less hours are supplied to the off-farm sector when years of farming experience accumulate and gross farm income rises.

Increased female labor supply to the off-farm sector is associated with a higher market wage rate and an increased size of operation due to additional acres being rented in. Fewer hours-of-work are supplied off-farm for those spouses who completed high school, care for additional young children in the home, live in or near a Standard Metropolitan Statistical Area, and enjoy greater farm income.

An Ag-Enterprise model is also estimated for farm operators and their spouses, but it is relegated to Appendix D since there is no sound theoretical basis for the inclusion of crop and animal enterprises and there is good

reason to believe these variables may be endogenous with labor supply decisions. Briefly, the results indicate, as might be expected, that those enterprises characterized as labor intensive are positively associated with on-farm hours-of-work and negatively related to off-farm labor supply. The $\bar{R}^2$ of both the male and female equations increased substantially, relative to the Farm-Business model, with the addition of the agricultural enterprise variables.

Life cycle variations in the labor supply of farm operators and their spouses are estimated and analyzed in Appendix E. In attempting to determine whether life cycle effects are demonstrated by the results it is observed that while the magnitude and signs of the coefficients for some variables do change across age groups, conclusive evidence in the form of significant coefficients at the .15 level or better in at least two age groups, is generally lacking. Only for the male off-farm equation is there support for the presence of life cycle effects; while the male on-farm, female on-farm, and female off-farm equations are inconclusive on this matter.

2. INFERENCE LIMITATIONS

The purpose of any research study based on a scientific sample is to make generalizations about the population from which the sample was drawn. Section F of Chapter III discussed the difficulties of obtaining accurate estimates.

With respect to potential sampling error the possibility of this was minimized by the nature of the sampling design

and sample size utilized.

However, the potential bias from non-sampling error is not so easily dismissed. The possibility of an unrepresentative sample due to the probable missed households of agricultural sales under $2,500 means that the results reported herein cannot safely be generalized to the extreme bottom end of the distribution of low farm-income households.

Measurement error is an obvious problem when mentioning the effect of wage rates on labor supply since imputed wage rates were assigned to all household members. In particular, the estimated wage rates are probably overestimated for the non-wage market participants.

Farming experience reported jointly for husband and wife is another potential source of measurement error -- especially for the wives. Resulting estimated effects must be viewed with some skepticism; although this variable was only significant for on-farm labor supply of wives.

Investment income should have been confined to stocks, bonds, and savings and have excluded rent from farmland rented out for the purposes of examining labor supply on-farm; this would lessen the chance of endogeneity with hours of work.

Missing observations are by far the most serious source of potential bias. It has already been discussed in considerable detail. Suffice it here to reaffirm the notion that with the loss of cases for analysis it is difficult to infer the results herein to the entire population when

undetected patterns of exclusion from the sample may have occurred. Cass county households, for instance, were effectively excluded by virtue of the pervasive missing data problem created by interviewers in that area. Assuming that the missing observations occurred randomly throughout the sample (as was apparently the situation with the possible exception of Cass county) inference can be made, albeit not with full confidence as to the accuracy of the coefficients in terms of efficiency.

Certain variables were omitted from the analysis of labor supply for lack of data, though none of them was especially crucial to the analysis with respect to economic theory. Race, health status, work experience, and the unemployment rate are the principal variables that might have helped to better explain the variation in on-farm and off-farm hours-of-work.

With these cautionary notes in mind, the results can be generalized to the population of low farm-income farmers in Michigan's lower peninsula.

C. FURTHER RESEARCH

The preceding limitations suggest improvements that could be made in replicating and extending this study. First and foremost there is the data. Ideally, the data analyzed in future research would be comprehensive in nature with respect to information on all variables prescribed by theory -- but especially those comprising the Personal-Household

model -- and to measurements of all variables that are theoretically correct and correspond to similar empirical research. This would facilitate the construction of a more complete and accurate model. In this study the lack of data on individual health status, on-farm and home production wage rates, commuting distance to the nearest S.M.S.A., local unemployment rates, career occupational work experience, etc. limited the scope of the models.

Given the missing observation problems due to reporting and recording errors that blemish this research, improved data collection procedures and coding systems are also of paramount importance.

So, too, are more accurate measurements of variables critically important -- particularly estimates of on-farm labor supply for which the use of respondent's recall of annual hours-of-work is less than satisfactory in terms of reliability.

Longitudinal data is also preferred for analysis of life cycle effects. Obviously, high collection costs preclude the gathering of such data exclusively for household studies and necessitate reliance upon existing longitudinal data sets -- the nature and scope of which labor economists and policy makers might endeavor make more relevant to their professional and public concerns. Stratification of the sample by age groups is a poor substitute for historical data on individuals. At the very least a sufficiently large number of observations for each age group

in cross-section analysis is desirable so as not to have the results open to question as is the case herein with the under 35 year old group.

With such improvements in data more thorough analyses could be conducted (e.g., estimating the probability of off-farm labor force participation using LOGIT), potential biases could be minimized (e.g., sample censorship) and the necessity for additional compensatory estimation procedures could be eliminated (e.g., imputing a wage rate for the non-working sub-sample). In connection with the last point the avoidance of the instrumental variable technique would have permitted the inclusion of the key variables of age and work experience in the labor supply equations; they were dropped because of their high correlation with the imputed wage rate. Additionally, better data might justify the use of more sophisticated estimation techniques that are computationally complex and thus more costly (e.g., the three step Heckman approach or the two step TOBIT procedure), but which would help overcome truncation bias due to the concentration of observations at zero for off-farm hours-of-work.

To the extent that these aforementioned improvements remain elusive and labor supply studies are not standardized, disparity of judgements by researchers will continue to make comparability of empirical findings difficult as alluded to in the below quotation.

> Estimation of this (labor-leisure) model requires that researchers make many often arbitrary assumptions. These include choices among sample populations, alternative measures of the

> variables whose relationships are to be estimated, and different estimation techniques. Differences in the judgements of labor supply researchers are in part responsible for a range of parameter estimates far too large to be of much use to policy makers trying to choose among alternative income maintenance programs. However, because the methodologies of these studies have varied in several ways simultaneously, it is difficult to pinpoint the exact causes of divergence in their empirical results. [Da Vanzo, DeTray, Greenberg 1976, p. 313]

Turning to the matter of additional investigations future researchers might want to concern themselves with, consideration should be given to a comparison of the labor supply responses of farm operator sub-groups such as those employed full-time off-farm, half-time off-farm, and not employed off-farm. Another subject of interest would be the redefinition of the response variable as total labor supply adding the on-farm and off-farm hours in an effort to verify labor supply theory. This would help reconcile any conflict of coefficient signs for a variable in the on-farm and off-farm labor supply analyses. And finally, although the importance of household production was revealed in the literature review discussion of the "new home economics," a formal incorporation of this alternative outlet for labor into labor supply models is vital to allocation of time studies -- particularly in the determination of the wife's reservation price with respect to her participation in on-farm and off-farm activity.

In sum this study of labor supply decisions of low-farm income households in Michigan by and large confirms what

other researchers have found in their studies of farm populations in other states. Taken in conjunction with these analyses, this research could well serve as a basis for further investigation of labor time allocation decisions of low farm-income families.

APPENDICES

APPENDIX A

MICHIGAN SURVEY QUESTIONNAIRE

CONFIDENTIAL

SMALL FARM FAMILY PROGRAM

SURVEY INFORMATION

Respondent

Name _____

Mailing Address _____
(Street or Rural Route)

_____
(City) (Zip Code)

Telephone No. _____

Farm Location

County _____

Township _____

Directions to Farm _____

_____

Interviewer

Name _____

Date _____

In a research project at Michigan State University, we are interested in your suggestions and opinions regarding the needs of families living on small farms. We would like to obtain information about your family and farm operation. The information you give will be kept confidential. It will be summarized with that from other families and used to obtain a better understanding of the problems on a small farm and programs to solve problems.

Before a schedule is completed, determine whether the farm qualifies as a small farm according to the following definition.

Definition of a small farm — 10 acres or more of land and enterprises smaller than:

Dairy - 25 milk cows + feed crops
Cash grain - 200 tillable acres
Beef cattle feeding - 100 feeders + feed crops
Beef cow and calf - 80 cows + feed crops
Farrow and finish swine - 30 sows - 2 litter system + feed crops
Feeder pig production swine - 60 sows - 2 litter system + feed crops
Feeder pig finish swine - 500 feeders + feed crops
Poultry - 3,500 laying hens + feed crops
Fruit - 40 acres

CONFIDENTIAL -1- Card 1 (Col.)

Card 1 — 1

County Code _____ 2

Farm No. _____ 3-5

First, I will ask questions about your family.

A. Family Data (Circle answer)

1. What are the ages of all persons in the family?

a) Husband — 6

None 0
Under 25 1
25-34 2
35-44 3
45-54 4
55-64 5
65 & over 6

b) Wife — 7

None 0
Under 25 1
25-34 2
35-44 3
45-54 4
55-64 5
65 & over 6

c) Children under 5 years old (Number) _____ 8

d) Children 5-8 years old (Number) _____ 9

e) Children 9-13 years old (Number) _____ 10

f) Children 14-17 years old (Number) _____ 11

g) Children 18 years old or over (Number) _____ 12

h) Other related adults _____ 13

2. How many children are living at home? (Number) _____ 14

3. Was the living situation during school years of the husband and/or wife in a rural area? (Farm, country, small town, etc.) — 15

Neither 0
Husband 1
Wife 2
Both 3

Card 1 (Col.)

4. What was the level of formal education attainment for the husband? — 16

College grad 5

8 years or less	1
9-11 years	2
Completed high school	3
Some college or technical training	4

5. What did the husband's high school education emphasize: — 17

No high school education	0
General	1
Agricultural	2
Home economics	3
Business/secretarial	4
Vocational - other	5
College preparation	6

6. What was the level of formal education attainment for the wife? — 18

College grad 5

8 years or less	1
9-11 years	2
Completed high school	3
Some college or technical training	4

7. What did the wife's high school education emphasize: — 19

No high school education	0
General	1
Agriculture	2
Home economics	3
Business/secretarial	4
Vocational - other	5
College preparation	6

B. Family Living Information

1. Do you have a vegetable garden each year? — 20

Yes	1
No	2

2. Do you can or freeze vegetables for year round use? — 21

Yes	1
No	2

3. What percent of home consumed meat is produced on the farm? — 22

0%	0
1-50%	1
51-99%	2
100%	3

Card 1 (Col.)

4. What percent of home consumed milk is produced on the farm? — 23

0%	0
1-50%	1
51-99%	2
100%	3

5. What percent of home consumed eggs are produced on the farm? — 24

0%	0
1-50%	1
51-99%	2
100%	3

6. Approximately how many dollars of monthly income does your family need to achieve a satisfactory or comfortable living with prices at their present (March, 1974) level. $_____ (Hundred's dollars) — 25-26

7. What is the minimum monthly income needed to support the family? $_____ (Hundred's dollars) — 27-28

8. How many years have you and your spouse lived on your present farm? _____ (years) — 29-30

9. How many years have you and your spouse continuously farmed? _____ (years) — 31-32

10. What are your reasons for living in a rural community? — 33

_____

_____

For employment reasons	0
For retirement	1
Farm opportunity	2
Disdain for urban life	3
Appreciation for rural life	4
For health reason	5
Raise family	6
Other	7

C. Next, I will ask questions about your farm

1. How many acres do you own? _____ — 34-36

2. Of the owned land, how many acres are tillable? _____ — 37-39

Card 1 (Col.)

3. What is the major soil type? _____ 40

_____

Sand	1
Sandy-loam	2
Clay	3
Clay-loam	4
Loam	5
Loamy-sand	6
Muck	7

4. How many tillable acres did you rent in 1973? _____ 41-43

5. If land was rented, what type of lease arrangement was used on rented land? 44

Cash rent	1
Share rent	2
Cash and share rent	3
Other _____	4

6. How many tillable acres of owned land did you rent out in 1973? _____ 45-47

7. If land was rented out, what type of lease arrangement was used on rented land? 48

Cash rent	1
Share rent	2
Cash and share rent	3
Other _____	4

8. How many acres of the following crops did you harvest in 1973?

a)	Alfalfa, clover or other hay harvested _____	49-51
b)	Corn for silage _____	52-54
c)	Corn for grain _____	55-57
d)	Wheat _____	58-60
e)	Other grain (i.e.: Oats, rye) _____	61-63
f)	Soybeans _____	64-66
g)	Pasture _____	67-69
h)	Fruit _____	70-72
i)	Diverted or idle _____	73-75
j)	Other cash crops (Kind _____ _____ _____ _____) _____	76-78
k)	Other feed crops (Kind _____ _____ _____ _____) _____	79-80

-5-

Card 2 (Col.)

Card 2 — 1

County Code _____ — 2

Farm Number _____ — 3-5

9. What were the 3 year average yields per acre from the following crops?

a) Alfalfa, clover or other hay harvested (Tons) _____ (one decimal place) — 6-7

b) Corn for silage (Tons) _____ — 8-9

c) Corn for grain (Bu.) _____ — 10-12

d) Wheat (Bu.) _____ — 13-14

e) Soybeans (Bu.) _____ — 15-16

Ask questions about livestock production for the type of livestock on the farm in 1973. If 1973 livestock production was not typical, obtain the information for a typical year during the last three years.

10. Beef Cow-Calf

a) How many beef cows were in your herd? (Number) _____ — 17-18

b) How many calves were born? (Number) _____ — 19-20

c) How many calves were sold? (Number) _____ — 21-22

d) What was the selling weight of calves per head? (lbs) _____ — 23-25

11. Feeder Cattle

a) How many feeders were purchased? (Number) _____ — 26-27

b) What was the ave. weight of feeders purchased per head? (lbs.) _____ — 28-30

c) How many feeders were sold? (Number) _____ — 31-32

d) What was the ave. selling weight per head (cwt.) _____ — 33-35

12. Swine

a) How many litters were farrowed during the year? (No.) _____ — 36-37

b) What was the ave. number of pigs weaned per litter? _____ (One decimal place) — 38-39

c) How many feeder pigs were sold? (Number) _____ — 40-42

d) How many feeder pigs were purchased? (Number) _____ — 43-45

e) How many market hogs were sold? (Number) _____ — 46-48

13. Poultry

a) What was the average number of laying hens? _____ — 49-52

b) How many dozens of eggs were sold per hen? _____ — 53-54

[Note: ESTIMATE TOTAL NUMBER OF DOZENS SOLD _____ ÷ AVERAGE NUMBER OF LAYING HENS _____]

Card 2 (Col.)

14. Dairy

a) What was the average number of milk cows in your herd? (Number) _____ 55-56

b) Were you on a Grade A or B market? Grade A 1 / Grade B 2 — 57

c) What was the average annual milk production per cow? (Cwt.) _____ 58-60

[Note: USE ONE OF THE FOLLOWING TO ESTIMATE PRODUCTION]

Lbs. sold in 1973 _____ ÷ Average number of cows milking and dry _____

OR

Lbs. shipped on typical day _____ ÷ Average number of cows milking and dry _____ X 365

OR

DHIA, Owner Sampler or other record

15. Other Livestock

a) Kind _____

b) Number _____

c) Production _____

DO NOT CODE

16. During 1973 what has been the total labor hours of farm work by the:

(Estimate on weekly bases if necessary to arrive at yearly total)

	Hours/year (Hundred's Hours)	
a) Husband	_____	61-62
b) Wife	_____	63-64
c) Other family members	_____	65-66
d) Hired	_____	67-68

D. Off-Farm Employment Information for 1973

If the husband had off-farm work

1. What kind of work was done? _____ 69

None	0
Professional or Technical	1
Manager, official or proprietor	2
Clerical	3
Sales	4
Craftsman or foreman	5
Operatives (semi-skilled)	6

(cont.)

-7-

Card 2 (Col.)

	Nonfarm laborer	7	
	Service	8	
	Farm	9	
2.	Ave. number of hours worked per week? _____		70-71
3.	Number of weeks worked in 1973? _____		72-73
4.	What is your regular hourly wage?		
	0-2.50	0	74
	2.51-3.00	1	
	3.01-3.50	2	
	3.51-4.00	3	
	4.01-4.75	4	
	4.76-5.50	5	
	5.51-6.25	6	
	6.26-over	7	
5.	How many <u>years</u> have you worked at the present occupation? _____		75-76
6.	How many <u>miles</u> do you drive to your present job? (one way) _____		77-78
7.	Are any of the following fringe benefits received?		
	a) Life insurance — Yes	1	79
	a) Life insurance — No	2	
	b) Health/Hospital Insurance — Yes	1	80
	b) Health/Hospital Insurance — No	2	

Card 3 (Col.)

	Card 3		1
	County Code _____		2
	Farm Number _____		3-5
	c) Paid vacation time — Yes	1	6
	c) Paid vacation time — No	2	
	d) Retirement (not social security) — Yes	1	7
	d) Retirement (not social security) — No	2	
	e) Other (specify)		
	_____		
	_____		

If the wife had off-farm work

8.	What kind of work was done? _____	8
	_____	

-8-

Card 3 (Col.)

	None	0	
	Professional or Technical	1	
	Manager, official or proprietor	2	
	Clerical	3	
	Sales	4	
	Craftsman or foreman	5	
	Operatives (semi-skilled)	6	
	Nonfarm laborer	7	
	Service	8	
	Farm	9	

9. Ave. number of hours worked per week? _____ 9-10

10. Number of weeks worked in 1973? _____ 11-12

11. What is your regular hourly wage?

0-2.50	0	13
2.51-3.00	1	
3.01-3.50	2	
3.51-4.00	3	
4.01-4.75	4	
4.76-5.50	5	
5.51-6.25	6	
6.26-over	7	

12. How many <u>years</u> have you worked at the present occupation? _____ 14-15

13. How many <u>miles</u> do you drive to your present job? (one way) _____ 16-17

14. Are any of the following fringe benefits received?

a) Life insurance	Yes	1	18
	No	2	
b) Health/Hospital Insurance	Yes	1	19
	No	2	
c) Paid vacation time	Yes	1	20
	No	2	
d) Retirement (not social security)	Yes	1	21
	No	2	
e) Other (specify)			

_____

_____

15. Did anyone else in your household work off-farm in 1973? Yes 1, No 2 — 22

_____

_____

Card 3 (Col.)

E. Now, I would like to obtain an indication of changes in the farm or off-farm employment.

1. Over the next two to three years, what changes would you like to make in your farming operation? _____ 23

_____

_____

None	1
Do less farming	2
Expand farming operation	3
Retire from farming	4
Other _____	5

Ask questions 2-3 only if item 3 was checked in question 1 above

2. What changes would you like to make in expanding the farm operation? (Detailed as possible - No. acres, kind and number of livestock, etc.) 24

_____

_____

Don't know	1
Increase crop yields	2
Increase acres farmed	3
Increase livestock production	4
Increase livestock numbers	5
Other _____	6

3. How many additional hours of labor per year are available by the family for this expansion? _____ (Hundred's Hours) 25-26

ASK EVERYBODY

4. What net cash farm income are you attempting to achieve? $_____ (Hundred's Dollars) 27-29

If changes in off-farm work is anticipated by the husband ask question 5-8.

5. What kind of a job would you like to have in off-farm employment? 30

_____

_____

Don't know	0
Professional or Technical	1
Manager, official or proprietor	2
Clerical	3
Sales	4

(cont.)

Card 3 (Col.)

Craftsman or foreman	5	
Operative (Semi-skilled)	6	
Nonfarm laborer	7	
Service	8	
Farm	9	

6. How many hours would be worked per week? _____ 31-32

7. How many weeks per year? _____ 33-34

8. What income is desired per year? $_____ (Hundred's Dollars) 35-37

If a change in off-farm work is anticipated by the wife ask questions 9-12.

9. What kind of a job would you like to have in off-farm employment? 38

_____

_____

Don't know	0
Professional or Technical	1
Manager, official or proprietor	2
Clerical	3
Sales	4
Craftsman or foreman	5
Operative (Semi-skilled)	6
Nonfarm laborer	7
Service	8
Farm	9

10. How many hours could be worked per week _____ 39-40

11. How many weeks per year? _____ 41-42

12. What income is desired per year? $_____ (Hundred's Dollars) 43-45

F. Capital Investment In Farm Business

1. What is the estimated selling price for your land and buildings? $_____ (Thousand's Dollars) 46-48

2. What is the approximate value of your machinery, on Jan. 1, 1974? $_____ (000) 49-51

3. What is the approximate value of your livestock on Jan. 1, 1974? $_____ (000) 52-54

Card 3 (Col.)

4. What is your approximate amount of debt for the farm and farm personal property on Jan. 1, 1974? $_____ (000) — 55-57

5. What is your approximate debt for consumer items on Jan. 1, 1974? (Cars, furniture, appliances, etc.) $_____ (000) — 58-59

G. Family Income

1. What was the average per year gross agricultural sales for the past two years? $_____ (000) — 60-61

2. What was your average per year cash farm expenses for the past two years? $_____ (000) — 62-63

3. What was your family income from transfer payments in 1973? (i.e.: Social security, welfare, etc.) $_____ (Hundred's Dollars) — 64-66

4. What was your family income from investments in 1973? (i.e.: farm rent, savings accounts, stock, bonds, etc.) $_____ (Hundred's Dollars) — 67-69

5. Other family income in 1973? (i.e.: pensions) $_____ (Hundred's Dollars) — 70-72

H. 1. State your suggestions and opinions regarding the needs of families living on small farms. _____

2. State any other comments or observations.

APPENDIX B

MISSING DATA ADJUSTMENTS

The summary tally of responses to the survey questionnaire [Thompson 1975] indicated the presence of significant numbers of non-responses to certain items on the instrument. Because these became 'blank' when recorded on the computer cards, potentially serious missing data problems arose for some variables. That is, if just one variable (e.g., age) of many variables (e.g., work experience, income, etc.) for a particular case (i.e., Michigan small-farm household) had a blank instead of a zero or positive value, then the whole case had to be discarded with a resulting loss of information on all other variables of that household for which data was recorded.

In examining the format of the questionnaire and the computer print-out of the raw data, it was determined that logical consistency checks and reasonable assumptions could be used to convert blanks to zeroes for most, but not all, variables selected for use in this study. The nature of the data correction and the change in the number of missing data will be briefly explained for each affected variable. In all conversions blanks were changed to zeroes.

Consistency Checks

1) OPFARMHR (Operator's Farm Hours -- card 2, col. 61-2) 10 blanks changed to zero; 25 remained.

   Criteria: If no operator is present in the household, and if schooling is left blank, or if tillable acres rented out equals tillable acres owned, or if gross agricultural sales equals zero.

   Logic: Self explanatory.

2) WIFARMHR (Wife's Farm Hours -- card 2, col. 63-4) 11 blanks changed to zero; 31 remained.

   Criteria: If no wife is present; otherwise same as for OPFARMHR.

   Logic: Self explanatory.

3) OPSCHOOL (Operator's Schooling Years -- card 1, col. 16) 4 blanks changed to zero; none remained.

   Criteria: If no operator present in household.

   Logic: Self explanatory.

4) WFSCHOOL (Wife's Schooling Years -- card 1, col. 18) 14 blanks changed to zero; 3 remained.

   Criteria: If no wife present; otherwise same as for OPSCHOOL.

   Logic: Same as for OPSCHOOL above.

5) HOMCHILD (Children at Home -- card 1, col. 14) 16 blanks changed to zero; none remained.

   Criteria: If no children are listed as present in any of the various age groups under 18 years.

   Logic: Self explanatory.

6) YNGCHILD (Children under 5 -- card 1, col. 8) 24 blanks changed to zero; none remained.

Criteria: If wife is over 54; if no wife is present, and if operator is over age 54; if total number of children at home is zero or left blank.

Logic: A woman over 54 is beyond child bearing age; it is unlikely that a widower or bachelor over age 54 would have young children; it is presumed that a blank for HOMCHILD really means zero due to interviewer error, as this is not a sensitive question to which the interviewee would be reluctant to respond.

7) OPMRKTYR (Operator's Year in Market Work -- card 2, col. 75-6) 94 blanks changed to zero; 7 remained.

Criteria: If no job is presently held, or if a blank is recorded for work experience.

Logic: The questions on present off-farm employment, hours per week, weeks per year, wage rate, and community miles immediately precede the question on OPMRKTYR; and an inspection of the computer print-out of raw data indicates a consistent pattern whereby if the initial question was left blank, all succeeding related questions were also left blank. The presumption here is that the interviewer meant the blanks to mean zeroes. However, it should be noted that this particular question on how many years the individual has worked off-farm in his occupation is actually independent of current employment, but may have been interpreted to refer to

the current job even though a separate question on this was on the questionnaire.

8) WFMRKTYR (Wife's Years in Market Work -- card 3, col. 14-5) 183 blanks changed to zero; 1 remained.

Criteria: Same as for OPMRKTYR above.

Logic: Same as for OPMRKTYR above.

9) OPWAGINC (Operator's Wage Income -- card 2, col. 70-71 · 72-73 · 74) 77 blanks changed to zero; 17 remained.

Criteria: If each of the components of this constructed variable is blank (i.e., hours per week, weeks per year, wage rate).

Logic: See explanation for OPMRKTYR.

10) WFWAGINC (Wife's Wage Income -- card 3, col. 9-10 · 11-12 · 13) 182 blanks changed to zero; 6 remained.

Criteria: Same as for OPWAGINC above.

Logic: See explanation for OPMRKTYR.

11) OPJOBHR (Operator's Off-Farm Job Hours -- card 2, col. 70-71 · 72-73) 80 blanks changed to zero; 6 remained.

Criteria: If no job is presently held; or if blanks are recorded for current job and commuting miles.

Logic: Same as for OPMRKTYR above.

12) WFJOBHR (Wife's Off-Farm Job Hours -- card 3, col. 9-10 · 11-12) 182 blanks changed to zero; 3 remained.

Criteria: Same as for OPJOBHR above.

Logic: Same as for OPJOBHR above.

Remedial Assumptions

1) OPFARMHR (Operator's Farm Hours -- card 2, col. 61-2) 16 blanks changed to zero; 9 remained.

   Criteria: If the operator works 35 or more hours a week for 48 or more weeks per year off-farm.

   Rationale: Given a full time, year long wage job it is likely that with commuting time added on little if any labor was supplied to these farms. It is recognized that the assigned zero values may understate the true value of on-farm labor, but this was judged preferable to the loss of information on other relevant variables for these 16 cases had they been left blank.

2) WIFARMHR (Wife's Farm Hours -- card 2, col. 63-4) 17 blanks changed to zero; 14 remained.

   Criteria: Same as for OPFARMHR above.

   Rationale: Same as for OPFARMHR above.

3) FRUIT (Fruit Enterprises -- card 1, col. 70-72) 227 blanks changed to zero; none remained.

   Criteria: Recode blanks to zeroes.

   Rationale: Examination of the raw data, print-out indicated that zero values were not recorded. The presumption is that interviewers meant blanks to signify zero values.

4) DAIRY (Dairy Enterprise -- card 2, col. 55-56) 209 blanks changed to zero; none remained.

   Criteria: Recode blanks to zeroes.

   Rationale: Same as for FRUIT above.

5) LAYERHEN (Layer Hen Enterprise -- card 2, col. 49-52)

207 blanks changed to zero; none remained.

Criteria: Recode blanks to zeroes.

Rationale: Same as for FRUIT above.

6) CROPNDEX (Index of Crop Enterprises -- card 1, col. 49-51 + 52-54 + 55-57 + 58-60 + 61-63 + 64-66 + 76-78)

166-201 blanks changed to zero; none remained.

Criteria: Recode all crop enterprises to zero.

Rationale: Same as for FRUIT above.

7) BEEFNDEX (Index of Beef Livestock Enterprises -- card 2, col. 17-18 + 26-27) 177-191 blanks changed to zero; none remained.

Criteria: Recode all beef enterprises to zero.

Rationale: Same as for FRUIT above.

8) HOGNDEX (Index of Swine Livestock Enterprises -- card 2, col. 36-37 + 46-48) 217-218 blanks changed to zero; none remained.

Criteria: Recode all swine enterprises to zero.

Rationale: Same as for FRUIT above.

It should be noted that for some variables no consistency checks or remedial assumptions are possible; namely, FARMYR (20 blanks), INVSTINC (11 blanks), and FARMDEBT (30 blanks). In the case of farm experience it must be presumed that a positive non-zero value should have been recorded. For investment income the blanks might be zeroes, but they could also reflect respondent reluctance to answer a sensitive question. Likewise for eight cases of farm debts where

people may have been unwilling to divulge what could be considered privileged information. The remaining twenty-two blanks of this variable are genuine because no Cass county household was asked about farm debts on the pretest questionnaire used.

APPENDIX C

IMPUTED MARKET WAGE ESTIMATION

This appendix is comprised of 3 sections: a discussion of the instrumental variable technique, a description of the estimated wage function, and a report on the imputed wage results.

INSTRUMENTAL VARIABLE TECHNIQUE

Essentially, a wage function is estimated for the employed sub-sample* using ordinary least squares (OLS). Multiple regression analysis is run on a few critical independent variables suggested by human capital theory and previous empirical work [Mincer 1974], plus others as the researcher's judgement dictates. The main instrumental variables are age, educational level, work experience, and health status -- all of which reflect labor productivity. Variables like sex and race can also be included to reveal the influence of such market forces as employer wage discrimination policies [Boskin 1973]. A locational variable is sometimes used to reflect suspected differences in offered

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* A wage function can also be estimated using an alternative data source based on the same approximate population, if personal characteristics and labor market conditions are similar [Sexton 1975, pp. 141-42].

wage rates across regional labor markets [Da Vanzo, DeTray and Greenberg, 1973, p. 111]. Then, using the coefficients of the wage function, the specific values of each individual's personal characteristics in terms of these variables (for both the non-employed and employed subpopulations) are plugged into the wage function to calculate their appropriate "imputed" (i.e., estimated, predicted, potential) wage, which in turn is to be inserted into the labor supply function.

Econometrically speaking, the first step of this two-step IV procedure involves regressing the endogenous variable (i.e., wage rate) on a set of predetermined variables thought to be statistically independent of the disturbances. This first step generates estimated values of the explanatory endogenous variable, known as a 'reduced-form estimate' or an 'instrumental variable estimate,' that unlike the endogenous variable in its original form, is not correlated with the disturbance term. In the second step the dependent variable (i.e., hours-of-work) is regressed on the reduced-form estimate of the hitherto endogenous explanatory variable (i.e., wage rate) and whatever other predetermined variables are specified to directly affect the dependent variable. Although IV estimators are consistent, their variances are larger than those of corresponding OLS estimators. OLS estimators have a smaller dispersion than IV, but it is around an asymptotically biased mean [Da Vanzo and Greenberg 1973, pp. 48-49].

This widely used technique addresses the complications that can arise in labor supply studies with regard to the inclusion of the theoretically important wage rate variable in the labor supply function. Measurement error often exists in wage rates [Hall 1973, p. 109]. This can be due to the necessity for survey respondents to convert annual income or monthly salary into the requested hourly wage rates. Reporting errors can also occur when respondents signify only the range within which their wages fall. Both of these situations prevail with respect to the M.S.U. Small Farm Survey data. When such errors in the measurement of wages do exist, the classical estimation procedures are inappropriate because the wage variable and the error term are likely to be correlated. In this situation "the least squares regression leads to biased, even inconsistent, estimates" of the beta coefficient [Boskin 1973, p. 166].

Second, wage rates are not observed for individuals who are not working in the labor force. Omitting the data for these persons would probably cause a downward bias in the estimated wage response, because the omitted observations are likely to have negative disturbances [Hall 1973, p. 109]. This, too, is a problem characteristic of the M.S.U. Small Farm Survey respondents, many of whom did not report having a job.

Third, construction of an imputed wage rate is less subject to life cycle effects (whereby a changing wage rate is positively correlated with age and work experience) than

actual wage rates, which in a long run model of behavior are endogenous to the system. That is, past decisions regarding education, training, and work experience will be reflected over time in current market wage offers [T. P. Schultz 1975, p. 13]. Hence, "it is the lifetime average (permanent) wage, not the current wage, that is theoretically correct" [Da Vanzo, DeTray, Greenberg 1973, p. 65].

Fourth, the imputed wage mitigates against transitory influences on current actual wage rates. To illustrate, the wage rate reported during a particular survey period may be atypical of the respondent's normal work situation. For example, a temporary disequilibrium in hours worked can cause a lowering of the wage rate (as with part-time employment and/or moonlighting jobs) or a raising of the wage rate (as with seasonal employment and/or jobs requiring much overtime work with time and a half pay) [Greenberg 1972, p. 41].

Fifth, if the wage rate is recognized as not being wholly exogenous in nature and determined jointly with hours of work by such other factors as human capital investment decisions, choice of residence, selection of occupation, then the instrumental variable can minimize the biases caused by these interdependencies [Greenberg 1972, p. 48].

These, then, are the major justifications and advantages of using the instrumental variable technique to impute wage rates. However, its success in empirical use is less than satisfactory, as much of the literature reveals. Still, for

lack of an alternative approach that is not computationally complex and expensive, this remains a standard technique in labor supply studies. Some of the principal drawbacks associated with the use of the instrumental variable technique are set forth in the paragraphs that follow.

First of all, imputing hourly renumeration for work with a wage rate function is susceptible to variation attributable to variables not included in the regression equation such as unobserved and unmeasurable taste factors or differences in the productivity of time in non-market activities [Greenberg 1972, p. 49]. Moreover, "the variables that are included account for only a small fraction (15%) of the variation in reported wages" [Cain and Watts 1973, p. 360]. And much of that variation is attributable to age and formal education which constitutes a "rather convincing case for the instrumental variable often being little more than an education variable scaled in wage units" [Greenberg 1972, p. 49]. In fact, the R^2 values are low for such equations. Studies on the general population ranged from .16 to .29 for males and from .15 to .22 for females [Da Vanzo, DeTray, and Greenberg 1973, pp. 111-23; T. P. Schultz 1975, pp. 81-86]. Farm household studies using this same technique have obtained even lower R^2s -- .05 [Sexton 1975], .09 [Barros 1976] and .17 [Sumner 1978] for Illinois. In another state where farming is not too dissimilar from Michigan -- Iowa -- the R.I.M.E. study [Kerachsky 1975] obtained R^2s of .30 for husbands and .36 for wives; however, the use of over 20

variables in the wage function (compared to the usual four to six) probably pushed the value upwards. Additionally, since these empirically estimated equations tend to account for such a moderate proportion of the variation in observed wages, there is a substantial risk that in using imputed wages we are throwing away useful information in the form of the unexplained residual. Some of this unexplained variation in wages could probably be traced to such factors as quality of education and nature of experience, for which adequate measures are lacking [Da Vanzo and Greenberg 1973, p. 35].

Second, simultaneity bias may occur with the use of actual/observed reported wage rates in the labor supply equation. This is because it is entirely possible for wage rates to be a function of hours worked, instead of visa versa! That is, an employer who rationally takes into consideration his fixed costs of employment (i.e., manpower recruitment, personnel processing, job orientation and training, benefits administration, etc.) may elect to pay part-time labor less than full-time workers in order to recoup those expenses [Greenberg 1972, pp. 40-41; Greenberg and Hosek 1976, p. 9]. Since the M.S.U. Small Farm Survey data reveals a mixture of full-time and part-time off-farm job holding, the instrumental variable technique "may overestimate the wages facing part-time employees and/or underestimate those of full-time employees" [Boskin 1973, p. 167, fn. 1].

Third, selectivity bias may result from the sample

censorship that necessarily occurs when using the employed sub-sample (who have reported wage rates) as the basis for imputing wages to the entire sample of working and non-working individuals. Such sample selection bias can cause an overestimation of the actual wage offers non-labor force participants are likely to face [Shisko and Rostker 1976, p. 304, fn. 13; DeTray 1973, pp. 32-35; Gronau 1972; Da Vanzo, DeTray, Greenberg 1973; Greenberg and Hosek 1976]. Moreover, a person faces not one wage rate, but a distribution of wage rates for the same bundle of characteristics. Those job seekers finding high wage offers will work, those receiving low wage offers relative to their asking/reservation wage will choose not to work. (It should be noted that it is entirely possible that a non-worker will have a greater potential wage than a worker, yet stay out of the labor force due to an even higher value of marginal product in household production. No attempt was made to estimate the unobserved home wage rate.) In imputing wages we only observe the high wage rates offered to the employed -- hence a likely truncated wage offer distribution. That is, the mean wage offer of the observed truncated distribution probably exceeds the 'true' mean wage offer. The magnitude of the bias will be negatively related to the labor force participation of the group under study [Da Vanzo and Greenberg 1973, pp. 34-35]. However, the importance and extent of this bias has been somewhat minimized as a result of a comparative analysis of alternative wage estimation

procedures using only education and work experience as independent variables. "The effect of sample censoring, which would bias the OLS estimate toward zero, appears to be trivial" for education, although "it appears that selectivity bias has a substantial effect" for labor market experience [Cogan 1975, p. 30].

Of course, one can assume away selectivity bias by stating that all persons with a given set of market related attributes face identical wage offers, which would thereby ensure consistent and unbiased labor supply estimates [Cogan 1975, pp. 17-18]. On one hand this seems not to be an unrealistic proposition, given the relative homogeneity of the sample under study herein -- low farm-income operators and spouses. On the other hand it conveniently ignores the fact that certain individuals with a given set of characteristics choose to work while others with apparently the same characteristics do not work [DeTray 1973, p. 32]. Furthermore, these differences in work patterns between the working and non-working sub-samples are probably "prima facie evidence of important differences in the potential wage rates of the two groups" [Greenberg 1972, pp. 48-49]. And, to the extent that selectivity bias does exist the parameter estimates of the instrumental variable market wage equation do not provide a consistent or asymptotically unbiased basis to infer market wage offers for the population of workers or non-workers [T. P. Schultz 1975, p. 14].

ESTIMATED WAGE EQUATION

The wage function used by this researcher is restricted to those variables which human capital theory suggest. Accordingly, the wage equation is specified identically for both sexes:

$$LN(OPWAGE) = m_0 + m_1\ OPAGE + m_2\ OPAGE^2 + m_3\ OPEDUCYR + m_4\ OPEDUCYR^2 + m_5\ OPMRKTYR + m_6\ SMSACNTY + s$$

$$LN(WFWAGE) = w_0 + w_1\ WFAGE + w_2\ WFAGE^2 + w_3\ WFEDUCYR + w_4\ WFEDUCYR^2 + w_5\ WFMRKTYR + w_6\ SMSACNTY + t$$

Taking the natural logarithm of the actual wage of those working is fairly standard practice in the literature because it tends to give a higher R^2.

In terms of the variables used, age is thought to affect earnings as a reflection of "vitality, dexterity, and responsibility that vary over the life cycle" [Kalachek and Raines 1970, p. 182]. And in the absence of a health status variable, it is likely to pick up the expected effect of increasing disability with advancing age. Age is also entered as a squared term to account for a non-linear relationship whereby over time pay may rise to a maximum and not increase with age or may even decline after age 45 with respect to possible depreciation of human capital [Becker 1964, pp. 138-44]. The age variable may also pick up the effect of on-the-job training which accumulates as human capital with extended work experience, if the work experience variable is omitted from the equation. (NOTE: The age variable is a continuous measure of age range category

midpoints.)

The education variable should be indicative of the economic value of additional schooling. This variable is occasionally entered as a squared term, since beyond generally recognized levels of achievement (i.e., high school diploma, college degree) additional years of formal education, short of the next highest credential, are not thought to be linearly related to wage increases. (NOTE: The education variable is a continuous measure of midpoints of the years of schooling category.)

The experience variable is often included to account for on-the-job training and skill acquisition that occurs while working; although there is no guarantee that is what is being measured. This job experience variable is theoretically important, because it is through work experience that one informally accumulates human capital over time. The presumed higher productivity of such labor would likely result in higher wage rates for that individual, ceteris paribus. Nevertheless, some farm household studies have omitted it from their estimated wage equations [Kerachsky 1975; Sexton 1975].

The last variable specified is the locational measure indicating proximity to a Standard Metropolitan Statistical Area where wage rates may generally be higher for similar occupations compared to rural areas. This is a binary variable assigning 1 to counties classified as in or adjacent to a S.M.S.A.

IMPUTED WAGE RESULTS

In Tables C-1 and C-2 the results of the multiple regression analysis of the wage equations are reported for male and female heads of households respectively. The wage model was run using both the linear and natural log form of the dependent variable as well as excluding and including the square of education as a variable.

The signs of the coefficients yielded by the basic equations for both male and female conform to theoretical expectations; but addition of the education variable as a squared term does alter some of them.

With the exception of SMSACNTY, all the explanatory variables in the male equations are significantly different from zero at a reasonable level of significance (i.e., .01, .05, .10). By contrast, only the WFMRKTYR and SMSACNTY variables show up significant in the female equations.

The explanatory power (R^2) of the female wage equations is double that of the males in both linear and log form with and without the squared term for education. These R^2 values fall well within the range of other national and farm household studies. It would appear that the wage market work experience variable is the most significant contributor to explanatory power for both males and females; but the locational variable SMSACNTY adds considerably to the explanatory power of the female equation. It may be that for the type of work available for women in the S.M.S.A. counties (holding constant human capital qualities) the wage

Table C-1. Imputed market wage estimations[a] for males[b].

Explanatory Variable Name	OLS-Linear OPWAGE 1	OLS-Log LN(OPWAGE) 2	OLS-Linear OPWAGE 3	OLS-Log LN(OPWAGE) 4
Intercept	1.3865 (1.2432)	.6698 (.3148)	8.2483 (2.5488)	2.0703 (.6532)
OPAGE	.0877**[c] (.0476)	.0229** (.0120)	.0792** (.0463)	.0212** (.0118)
$OPAGE^2$	-.0010*** (.0005)	-.0002*** (.0001)	-.0010*** (.0004)	-.0002*** (.0001)
OPEDUCYR	.0957*** (.0450)	.0241*** (.0114)	-1.1290**** (.4031)	-.2258*** (.1033)
$OPEDUCYR^2$			.0543**** (.0177)	.0111*** (.0045)
OPMRKTYR	.0255*** (.0102)	.0057*** (.0025)	.0248*** (.0099)	.0056*** (.0025)
SMSACNTY	.1602 (.1762)	.0657 (.0446)	.2554* (.1738)	.0851** (.0445)
R^2	.12	.13	.18	.17
n	141	141	141	141
Mean wage[d]	4.24[e]	4.12	4.26	4.13

Table C-1. (Continued)

[a] Coefficients are reported with standard errors in parentheses.

[b] Estimated for 239 husbands. The undercount from n = 243 households is due to absence from the household (4 husbands).

[c] Significance levels: **** = .01; *** = .05; ** = .10; * = .15.

[d] Imputed wage is assigned to only 233 male operators due to 6 missing observations on explanatory variables in the wage equation.

[e] Mean of reported wage is $4.48 for the employed male subsample of 146.

Table C-2. Imputed market wage estimation[a] for females[b].

Explanatory Variable Name	OLS-Linear WFWAGE 1	OLS-Log LN(WFWAGE) 2	OLS-Linear WFWAGE 3	OLS-Log LN(WFWAGE) 4
Intercept	-.3629 (2.6100)	-.0066 (.9652)	.1256 (2.7299)	.2613 (1.0040)
WIFAGE	.0469 (.0926)	.0053 (.0342)	.0342 (.0951)	-.0016 (.0350)
$WIFAGE^2$	-.0007 (.0010)	-.0001 (.0003)	-.0006 (.0010)	-.0001 (.0003)
WFEDUCYR	.1546 (.1123)	.0562 (.0415)	.1691* (.1151)	.0642* (.0423)
$WFEDUCYR^2$			-.0025 (.0039)	-.0014 (.0014)
WFMRKTYR	.0736****[c] (.0227)	.0296**** (.0084)	.0712**** (.0231)	.0282**** (.0085)
SMSACNTY	.7169*** (.3490)	.3605**** (.1290)	.7402*** (.3529)	.3733**** (.1297)
R^2	.28	.32	.28	.34
n	54	54	54	54
Mean wage[d]	2.34[e]	2.20	2.32	2.16

Table C-2. (Continued)

[a] Coefficients are reported with standard errors in parentheses.

[b] Estimated for 231 wives. The undercount from n = 243 households is due to absence from the household (12 wives).

[c] Significance levels: **** = .01; *** = .05; ** = .10; * = .15.

[d] Imputed wage is assigned to only 225 wives due to 6 missing observations on explanatory variables in the wage equation.

[e] Mean of reported wage is $2.94 for the employed female subsample of 54.

rates are probably higher than in rural counties. However, this difference is apparently not as important in determining male wage rates.

In deciding which specification and form of the equation to use in generating estimated wage rates for the entire sample, the following criteria were employed: high explanatory power (R^2) and dispersion of the estimated wages. With respect to the first the R^2 for the log form was higher than the linear. This same phenomenon is reported in the literature, which may be the reason why the log form is conventionally used.

With regard to the second criterion it can be seen that mean wages for alternative specifications remain virtually unchanged with only a penny or two difference. However, inclusion of the quadratic of education achieves closer correspondence between the estimated wage and the reported wage at the high and low ends of the wage distribution of those working off-farm.

The choice between the linear and the log form of this particular specification again centers on the variability of the estimates across individuals. While the linear form estimates are slightly closer to actual wage rates at the higher end of the earnings distribution, at the lower end the linear form gives estimates considerably higher than the reported wage rates. And since it has been assumed that those not participating in the wage market labor force are probably at the lower end of the distribution, use of the

linear estimates may over-estimate their wage rates compared to the log form. Hence, the log form of the equation, specified to include the square of education, was selected to impute the wage rates for both the wage earning and non-wage market subsamples.

APPENDIX D

AGRICULTURAL ENTERPRISE MODEL

Animal and crop enterprises have been added to the Farm-Business model under the assumption that the selection of such enterprises implicitly reflect use of time in those farm activities having the highest marginal value product of labor; accordingly, the agricultural enterprises can be viewed as proxies for the on-farm wage rate, for which no reported values exist and none could reasonably be imputed.

One other farm household study [Sumner 1978] included agricultural enterprises in on-farm and off-farm labor supply functions, wherein they were considered to "measure several effects which are not readily separable ...: 1) specific production functions with different demands for labor, skill, etc.; 2) price and yield conditions in [a given year] relative to expected; 3) inherent riskiness; 4) degree of specialization; 5) seasonality." However, "the variables used have only gross indicators and have obvious deficiencies for measuring any of the effects listed" [Sumner 1978, p. 44].

The specific agricultural enterprises examined were: (1) animal: layer hens (LAYERHEN), milking cows (DAIRYCOW), beef cow (BEEFCOW), feeder cattle sold (FEEDCATL), hogs

sold (HOGSOLD), and feeder pigs farrowed (FEEDPIG) -- all measured in actual numbers; and (2) crop: fruit (FRUIT), hay and alfalfa (HAY/ALFA), grain corn (GRNCORN), silage corn (SILCORN), wheat (WHEAT), rye and oats (RYE/OAT), soybeans (SOYBEAN), and miscellaneous cash crops (MISCROP) -- all measured in acres harvested. Consistent with the MVP_L criteria, it is expected that those enterprises earning the most revenue for the least amount of labor will be pursued by multiple-job-holders while the more labor intensive enterprises will be less characteristic of part-time farmers.

ESTIMATION OF MODEL

The inclusion of these agricultural enterprise variables in the labor supply equations does raise the question of whether farmers take agricultural enterprises and their labor requirements as a given and then allocate some of their remaining time to off-farm work (e.g., part-time versus full-time, temporary versus permanent, seasonal versus annual) or whether farmers take their off-farm job and its labor requirements as a given and then choose the type and level of agricultural enterprises whose labor intensities (e.g., grain versus livestock, and beef cows versus dairy cows) are congruent with the permanently held off-farm job.

Despite the potential for endogeneity of decision making, the feasibility of the simultaneous equations model has not been fully demonstrated in previous related empirical work -- witness the inconclusive results of Schaub's [1978] farm household study reviewed in Chapter IV, section A-1b

"Farm-Business Model" as well as the sensitivity of simultaneous equations models to specification error and measurement error discussed in Chapter IV, section B-2a "Jointly Determined Relations."

With the aforementioned in mind a simplifying assumption is made for this cross section study -- with supporting evidence -- that in the short run farmers are fixed in their particular type of farming by virtue of family tradition, personal preferences, technical knowledge, farming experience, soil type, machinery specialization, market outlets, etc. that limit their flexibility of switching among various agricultural enterprises. In other words, farmers are thought to take their agricultural enterprises and corresponding labor requirements as given and then over the course of a year they allocate their remaining time among off-farm work, household production, and leisure activities. This assumption is backed up by a previous study [Loomis 1965, p. 4] of Michigan full-time, low farm-income operators and part-time, multiple-job-holding farmers, wherein two-thirds of the latter group reported no change in their farm operation resulting from work off the farm. Moreover, "nearly two-thirds [of these part-time farmers] said they worked off-farm because farming did not yield sufficient income" [Loomis 1965, p. 8] and "off-farm income enabled them to have more and better machinery than when they were farming full-time" [Loomis 1965, p. 4]. Furthermore, the 'money income preference' for farming expressed by part-time

operators indicates that the amount of income farmers would be willing to forego to farm only (i.e., quit non-farm job) is less than the income they would be willing to sacrifice to work at a non-farm job only (i.e., quit farming) [Loomis 1965, p. 10]. Thus, it would appear that off-farm work is instrumental to agricultural self-employment, which -- even if the secondary occupation in terms of the number of hours worked -- is considered by multiple-job-holding farmers to be the primary and initially determined labor activity.

Another potential estimation problem is the so-called 'perfect fit' that results from a deterministic relationship between two variables. That is, for a given time budget, the selection of a particular type and specific level of agricultural enterprise activity would automatically determine not only the amount of on-farm labor supply but also indirectly the number of hours worked off-farm as a residual. However, while it is true that on-farm and off-farm hours are not independent of each other, neither are they a perfect fit. Besides the reasons for this already explored in the context of possible endogeneity of the farm-income variable with off-farm labor supply in Chapter IV, section A-1b "Farm-Business Model" (e.g., the influence of other forces on labor supply on and off the farm; the flexibility of time allocation over a year; and the existence of household production and leisure activity from which time might also be subtracted in pursuit of increased work on or off the farm), it should additionally be pointed out that measurement

error in reporting labor supply hours on-farm and off-farm as well as different productivities of time in various agricultural enterprises across individuals in the sample mitigate against a perfect fit.

A final quandary centers on the selection of an appropriate measure for agricultural enterprise variables: binary, percentage, or continuous. A binary measure, essentially a qualitative indicator, ignores magnitude such that subsistence levels of enterprise activity are not distinguishable from commercial levels. A percentage measure [Sumner 1978] of the relative size of one enterprise to another or to total farm activity also ignores magnitude since base levels will vary across farms such that a higher percentage for one farm relative to another could actually constitute a lower absolute level of activity. Moreover, it is not simple to construct a common denominator for diverse enterprises (e.g., animal, crop). A continuous quantity measure, the third alternative, was chosen because it most accurately reflects the magnitude of the enterprise, although the hours of work required by the enterprise may vary across individual farm operators -- depending upon the production function (i.e., labor versus capital intensive) and upon the differential labor efficiencies of the household members.

RESULTS OF MODEL

The Ag-Enterprise model for <u>males</u> in Table D-1 doubles the explanatory power of the Farm-Business model for on-farm labor supply ($\bar{R}^2$ = .24 to $\bar{R}^2$ = .52) but only slightly

Table D-1. Male labor supply estimations[a] of Ag-Enterprise model.

Explanatory Variables	On-Farm Hours	Off-Farm Hours	Total[c] Hours
Intercept	884.8531 (532.4200)	-1534.6243 (530.6973)	-649.7712
OPSCHOOL	226.7624*[b] (145.4126)	-86.3958 (139.9527)	140.3666
HOMCHILD	58.7097* (37.3664)	-11.6091 (37.0843)	47.6091
OPFARMYR	17.1845**** (5.9685)	-10.7272** (6.0080)	6.4563
OPWAGEST	-155.3044 (117.2978)	772.9419**** (121.1305)	617.6375
WFWAGINC	-3.9424* (2.5656)	.9830 (2.6007)	-2.9594
INVSTINC	-15.1840**** (5.0894)	-4.6289 (5.0232)	-19.8129
SMSACNTY		55.9020 (129.8469)	
FRMASSET	-.4907 (1.9814)	.0437 (1.8718)	-.4470
FARMDEBT	-6.1812 (6.6418)	14.6166*** (6.5594)	8.4354
ACRENTIN	5.1737*** (2.3885)	-3.4790* (2.3994)	1.6947
FARMINC		-23.9588*** (11.6587)	
LAYERHEN	6.5722**** (2.3854)		
DAIRYCOW	72.7891**** (10.8481)	-41.6006**** (11.6590)	31.1885
FEEDCATL	8.2942 (5.9357)		

Table D-1. (Continued)

Explanatory Variables	On-Farm Hours	Off-Farm Hours	Total[c] Hours
FRUIT	16.8441*** (7.5130)		
SOYBEAN	7.9797* (5.0706)		
GRNCORN	7.8840*** (3.2715)		
SILCORN	27.8877**** (6.3839)		
WHEAT		10.9787*** (5.5129)	
HAYALFA		6.7528** (3.5829)	
R^2	.56	.47	
$\bar{R}^2$	.52	.42	
n	188	190	

[a] Coefficients are reported with standard errors in parentheses.

[b] Significance levels: **** = .01; *** = .05; ** = .10; * = .15 for the null hypothesis that the parameter equals zero.

[c] The total hours coefficient is the sum of the on-farm and off-farm coefficients.

increases it for off-farm work ($\bar{R}^2$ = .37 to $\bar{R}^2$ = .42). With the exception of FRMASSET in the on-farm equation all variables common to the two models retained their signs for on-farm, off-farm and net total labor supply. In terms of significance levels HOMCHILD and ACRENTIN become less significant while FRMASSET is no longer significant at the .15 level for on-farm labor supply. The farm asset variable is probably diluted in its effect by the inclusion of the agricultural enterprises. In the off-farm labor supply equation ACRENTIN becomes significant at the .15 level.

The final equations of the Ag-Enterprise model include only those farm activities that showed up significant at the .15 level or better first in the on-farm equations of either sex, and second in either the male or female off-farm equations. This was done to facilitate a comparison of the male operator and spouse with respect to agricultural enterprises that were significant for at least one of the two heads of household. Consequently, BEEFCOW, HOGSOLD, FEEDPIG, RYE/OAT, and MISCROP were eliminated in preliminary regression analyses.

As might be expected for the on-farm hours-of-work equation, all the included enterprise variables had positive signs. LAYERHEN and DAIRYCOW are significant at the .01 level. Their positive association with on-farm hours-of-work is consistent with the labor intensive nature of these two enterprises. The fact that SILCORN is also significant at the .01 level may reflect a complementary relationship

of silage corn with a dairy operation for home grown feed. GRNCORN and FRUIT production are significant at the .05 level; and SOYBEAN is significant at the .15 level.

In the off-farm equation the DAIRYCOW variable is significant at the .01 level and the negative sign merely confirms the time intensive nature of that enterprise and its lack of seasonality such that off-farm work is not practical. Other explanations point up the stability of yield and price and the economies of scale achieved up to a full-time dairy operation [Sumner 1978, p. 57]. Two crops that never appeared in the on-farm equations for lack of anything approaching significance are in fact positively related to off-farm employment. WHEAT and HAY/ALFA are significant at the .05 and .10 levels respectively. The inherent nature of cultivating these crops may require little in the way of regular care (i.e., time) vis-a-vis other crops, thus permitting farm operators free time to pursue work off-farm.

As with the Ag-Enterprise model for males, the female on-farm labor supply equations in Table D-2 register a substantial increase in the explanatory power compared with the Ag-Business model ($\bar{R}^2$ = .08 to $\bar{R}^2$ = .33) while the off-farm hours equation remains virtually the same ($\bar{R}^2$ = .38 to $\bar{R}^2$ = .39). For the on-farm and off-farm labor supply the signs of the variables common to both models remain as before, though the variables that were significant at the .15 level or better in the on-farm equation lose that status with

Table D-2. Female labor supply estimations[a] of Ag-Enterprise model.

Explanatory Variables	On-Farm Hours	Off-Farm Hours	Total[c] Hours
Intercept	236.8586 (342.9707)	-732.7665 (221.7743)	-495.9079
WFSCHOOL	159.9552 (164.6181)	-268.4359**** (105.6967)	-108.4807
YNGCHILD	31.7781 (111.7545)	-196.7266**** (71.8226)	-164.9485
WIFARMYR	5.3206 (6.5013)	1.7134 (4.1758)	7.0340
WFWAGEST	-39.9949 (115.3889)	830.1158**** (85.5334)	790.1209
OPWAGINC	-1.2462 (1.4797)	-1.7996*** (.9259)	-3.0458
INVSTINC	-6.9854 (5.2285)	-2.6454 (3.3703)	-9.6308
SMSACNTY		-561.6714**** (103.3243)	
FRMASSET	-.6984 (2.1978)	-.8601 (1.3308)	-1.5585
FARMDEBT	-2.6931 (6.7583)	-2.4587 (4.2160)	-5.1518
ACRENTIN	-7.8296****[b] (2.4471)	3.0074*** (1.3862)	-4.8222
FARMINC		-9.5039 (6.9116)	
LAYERHEN	10.4138**** (2.7500)	-3.6806*** (1.7922)	6.7332
DAIRYCOW	48.4416**** (12.6124)		
FEEDCATL	22.0207**** (6.2492)		

Table D-2. (Continued)

Explanatory Variables	On-Farm Hours	Off-Farm Hours	Total[c] Hours
FRUIT	9.4464 (7.7091)		
SOYBEAN	3.7945 (5.4122)		
GRNCORN	2.9260 (3.4222)		
SILCORN	23.8481**** (6.5734)		
R^2	.39	.43	
$\bar{R}^2$	.33	.39	
n	169	174	

[a] Coefficients are reported with standard errors in parentheses.

[b] Significance levels: **** = .01; *** = .05; ** = .10; * = .15 for the null hypothesis that the parameter equals zero.

[c] The total hours coefficient is the sum of the on-farm and off-farm coefficients.

the addition of Ag-Enterprise variables. In the off-farm equation WFSCHOOL, ACRENTIN, and FARMINC change their level of significance.

In the on-farm labor supply equation the agricultural enterprises LAYERHEN, DAIRYCOW, and SILCORN are all significant at the .01 level. Since these were also equally significant for the male operators it would appear that these enterprises by their labor intensive nature may involve joint participation on the part of the couples. Observations of some Michigan small farms are consistent with such empirical results. Additionally, the number of young cattle fattened and sold in feeder cattle operations (FEEDCATL) is positively related to the wife's on-farm hours-of-work at the .01 level.

Only one variable, LAYERHEN, was at or even near significance in the off-farm labor supply equation. The negative sign for the coefficient is compatible with the labor intensive nature of this enterprise and the high level of involvement wives have in such an operation.

SUMMARY

The Ag-Enterprise model explains substantially more of the variation in hours-of-work than either the Farm-Business or the Personal-Household models. The Ag-Enterprise model was more effective in explaining the variation in on-farm than off-farm labor supply as evidenced by the $\bar{R}^2$ value of .52 and .33 for the males and females respectively on-farm

compared with .42 and .39 for men and women respectively off-farm. The principal findings are as follows: first for on-farm and then for off-farm labor supply. Males involved with such enterprises as layer hens, dairy cows, fruit production, soybeans, grain corn, and silage corn were found to supply more labor to their farming operation. Females supplied more labor on-farm when layer hen, dairy cow, feed cattle, and silage corn enterprises are pursued. Off-farm the growing of wheat and hay plus alfalfa is associated positively with male labor supply, whereas an increase in the number of dairy cows is negatively associated with wage market work. Females who raise layer hens are found to supply fewer hours-of-work to wage sector employment.

APPENDIX E

LIFE CYCLE LABOR SUPPLY ANALYSIS

Labor supply literature suggests the distinct possibility that present labor supply decisions are made in a lifetime framework, whereby the goals of individuals and households with respect to consumption patterns and asset accumulation change over the years; and so too does the value of time change as human capital skills are acquired and then depreciate with age. Thus, it is thought that during the early periods of one's work life, when a person is attempting to get on his/her financial feet, he/she will supply more labor to the work force compared to later periods in the life cycle* by which time the consumption of market goods is less imperative (i.e., goods-intensive children have grown up and the desire for consumer durables is satisfied if not saturated).

In terms of agriculture these periods roughly correspond to the "entry or establishment" stage, the "growth and survival" stage, and the "exit or disinvestment" stage of life [Boehlje 1973, p. 23]. During the first stage the

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* See section A-1c "Life Cycle Allocation" in Chapter II for a more detailed exposition of the theoretical framework for this subject.

farmer evaluates the opportunities in farming compared with other occupational alternatives and determines whether or not an agricultural occupation is preferred. The new entrant concentrates on acquiring capital resources and managerial ability in an effort to establish a viable economic unit that will generate a competitive income and good growth potential. The second stage conforms to the "growth and survival" years when the entrepreneur strives to extend his resource constraints and achieve increased production efficiency by expanding sales and reducing costs. The third stage is characterized by "exit or disinvestment," either through retirement from production and management activities while maintaining control over income earning assets, or through intergenerational transfer sale of the farm. These three stages have been marked off in this study by the following age groups: stage one, 34 years old and under; stage two, 35 to 54 years of age; stage three, 55 years and over. This means altogether twelve life cycle regression equations will be estimated -- a set of three age category equations each for farm operators' on-farm and off-farm labor supply and another set of three age category equations each for spouses' on-farm and off-farm labor supply. The use of age to stratify the sample precludes its use as an explanatory variable in the on-farm labor supply function, in which it would likely be correlated with other variables reflecting life cycle decisions of the farm firm (e.g., asset accumulation, investment income, farm size-tillable

acres) and life cycle phenomena of the farm operator (e.g., off-farm and on-farm work experience, health status, age and number composition of children).

Multiple regression analysis was used with the Ag-Enterprise model, inclusive of the Personal-Household, and Farm-Business variables. Those Ag-Enterprise variables that were not statistically significant at the .15 level were dropped from each equation. Thus, there are some differences in the variables included in the several equations estimated. On-farm and off-farm labor supply results are reported first for husbands and then for wives.

a. On-Farm Labor Supply (Male Age Groups)

Because the farm experience variable is time related it was dropped from the equations for the age groups. Other than this one variable, the Personal-Household and Farm-Business components of the Ag-Enterprise model are identical to those used in the analysis of the aggregate samples for operators and spouses. The findings are reported in terms of age group comparisons for each variable.*

In Table E-1 an examination of the male age groups shows that the middle and older age groups correspond with each other in terms of coefficient signs for all common variables save one, FRMASSET; but it is not significant at the .15 level for either group. Similarly, when comparing

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* it should be noted that tests of differences between coefficients were not made.

Table E-1. Life cycle on-farm labor supply estimations[a] of males.

Explanatory Variables	Age Group under 35	Age Group 35-54	Age Group over 54
Intercept	-115.4050	2445.2321	1889.6325
	(1153.6215)	(943.8749)	(862.4703)
OPSCHOOL	-813.9606***[b]	198.6447	190.5045
	(377.9354)	(188.0747)	(220.2309)
HOMCHILD	156.4520**	53.7126	255.7305**
	(90.9777)	(42.9323)	(144.2728)
OPWAGEST	237.0403	-420.5120***	-334.5008
	(251.5096)	(204.2059)	(862.4703)
WFWAGINC	-4.6422	-4.2776	-5.2386
	(8.3981)	(3.3061)	(4.4127)
INVSTINC	-52.6779***	-7.3729	-14.0888***
	(23.0071)	(7.4093)	(6.8157)
FRMASSET	13.1612****	-.0867	2.3589
	(4.2529)	(2.5881)	(2.8281)
FARMDEBT	-28.0546***	-.9763	-27.7212
	(13.2274)	(7.7981)	(21.3259)
ACRENTIN	.7873	6.3965***	23.0093****
	(5.2666)	(2.6634)	(7.9999)
DAIRYCOW	91.2344****	35.1769***	94.9826****
	(28.1094)	(15.4171)	(17.9164)
LAYERHEN		8.6565***	9.1521****
		(3.7849)	(3.4629)
SILCORN		27.7869****	32.1132***
		(9.3735)	(15.4132)
GRNCORN		9.6699***	
		(3.9313)	
MISCROP			-24.6267***
			(10.7487)
HOGSOLD			78.0335****
			(18.7696)

Table E-1. (Continued)

Explanatory Variables	Age Group under 35	Age Group 35-54	Age Group over 54
R^2	.70	.53	.74
$\bar{R}^2$	.57	.46	.68
n	31	88	68

[a] Coefficients are reported with standard errors in parentheses.

[b] Significance levels: **** = .01; *** = .05; ** = .10; * = .15 for the null hypothesis that the parameter equals zero.

the 35-54 and 55 + age groups with the aggregate sample, the signs of the coefficients match for all the variables with the exception again of FRMASSET, for which the coefficient is positive for the oldest age group.

The under 35 group differs from the other age samples and from the male aggregate results with regards to the schooling and imputed wage rate variables. OPSCHOOL has a negative coefficient significant at the .05 level. And the coefficient for OPWAGEST is positive, but not significant at the .15 level. These results would seem to suggest that within the youngest group the completion of high school may indeed have a 'credential effect' -- except that no corresponding positive sign occurred in the off-farm estimation for this age group (Table E-2). Thus, it may be that for this generation, the completion of high school leads to the continuance of post-secondary schooling, a taste for more leisure time, or even higher labor productivity, ala human capital theory, such that less hours are required to farm efficiently. Then, too, with such a small sample 'noise,' not rationality, might better explain the results.

The same may be said of the imputed wage rate. Its positive non-significant sign for on-farm labor supply, coupled with its negative significant sign at the .10 level for off-farm labor supply (Table E-2) leads this researcher to conclude that the unobserved on-farm wage rate must be higher than the off-farm wage rate and/or the taste for farm work has a stronger counter influence than off-farm earning

Table E-2. Life cycle off-farm labor supply estimations[a] of males.

Explanatory Variables	Age Group under 35	Age Group 35-54	Age Group over 54
Intercept	3422.2210 (919.5644)	-1267.0922 (903.6100)	-4225.4048 (804.5753)
OPSCHOOL	-225.4936 (327.1347)	-225.7749 (175.1857)	42.6325 (188.6845)
HOMCHILD	-192.8210***[b] (75.9617)	9.5062 (39.1228)	-272.6566*** (118.6677)
OPWAGEST	-367.4366** (197.7977)	653.9609**** (197.5507)	1473.9679**** (240.0469)
WFWAGINC	2.2194 (7.2379)	-1.3116 (3.2233)	5.5418* (3.7972)
INVSTINC	27.8223* (18.6788)	4.1548 (6.7459)	-8.5387* (5.8607)
SMSACNTY	748.3919**** (235.6811)	323.3533** (173.9521)	-310.6883* (191.3419)
FRMASSET	-1.6146 (4.4921)	4.7334** (2.5613)	-2.4982 (2.5338)
FARMDEBT	40.7507**** (12.0935)	-1.8204 (7.0608)	48.5801*** (19.9145)
ACRENTIN	10.1017*** (4.2551)	-4.1851* (2.5921)	-4.8007 (7.1009)
FARMINC	-28.9282* (17.6904)	-49.8635**** (17.9610)	1.6321 (15.2717)
DAIRYCOW		-45.1156**** (14.6383)	-48.0752**** (15.9368)
SILCORN	-16.0208* (10.4359)	18.5298*** (8.9955)	25.3676*** (12.2324)
SOYBEAN		-21.2027**** (7.6133)	
HAY/ALFA		8.7128*** (4.0360)	

Table E-2. (Continued)

Explanatory Variables	Age Group under 35	Age Group 35-54	Age Group over 54
OAT/RYE			-25.5225*** (10.1373)
MISCROP			30.1175**** (8.2051)
R^2	.74	.57	.63
$\bar{R}^2$	.59	.49	.54
n	31	89	70

[a] Coefficients are reported with standard errors in parentheses.

[b] Significance levels: **** = .01; *** = .05; ** = .10; * = .15 for the null hypothesis that the parameter equals zero.

capacity.

Aside from the aforementioned two differences the only other life cycle comparisons worthy of mention are differences in significance of the coefficients for variables across age groups. In particular, INVSTINC is significant at the .05 level for the young and old age group, but not significant at the .15 level for the middle age group. Since acres rented out may be a substantial part of this variable measure, it would appear that older farmers may be part-retired and younger farmers may not be ready, willing or able to fully utilize their land resources, whereas for middle age farmers rental of land out to neighbors is less likely.

FARMDEBT is another variable having a negative coefficient that is significant at the .05 level. Thus, as farm debts increase among young farmers in their initial "entry and establishment" stage they supply less labor to the farm and correspondingly more labor to off-farm work (Table E-2). Apparently, off-farm work is a capital generator for this age group.

Interestingly, only one agricultural enterprise, DAIRYCOW, is significant at the .15 level or better for the under 35 age category. In sum, life cycle variations are not really in evidence for male on-farm labor supply when considering those variables that are significant at the .15 level or better.

b. Off-Farm Labor Supply (Male Age Groups)

A comparison among male age groups for off-farm labor supply reveals differences with respect to coefficient signs for every one of the Personal-Household and Farm-Business variables, although for many the coefficients are not significant at the .15 level or better.

Concentrating on the variables whose coefficients are significant, an increase in HOMCHILD decreases the work off-farm for the youngest and oldest age groups, but not for the middle age group.

OPWAGEST has positive coefficients significant at the .01 level for the middle and older age groups, but a negative sign that is significant at the .10 level for the youngest age group. While no additional explanation for this latter group is offered besides those mentioned under on-farm labor supply, the results for the two older age groups are as expected.

The coefficients for INVSTINC are significant at the .15 level for the youngest and oldest age groups, but with opposite signs. The positive coefficient for the under 35 age group suggests that as farm land is rented out the operators supply more hours off-farm to further increase their capital accumulation efforts, but that for older operators such investment income enables them to "retire" by cutting back their off-farm work. These results are consistent with the life cycle hypothesis.

Residence in or near a S.M.S.A. for the young and middle

age groups has a positive sign and is significant at the .01 and .10 levels respectively. Close proximity to job centers does not increase off-farm labor supply for the oldest age group, which has a negative sign that is significant at the .15 level. Given the possibility of pensioned retirement from off-farm jobs held in preceding life cycle stages these results are consistent with each other.

Only for the middle age group is the FRMASSET variable significant -- at the .10 level and positive. The idea that an increase in assets would be associated with an increase in off-farm labor supply is unexpected. A possible explanation is that since our sample is limited to small farms, an increase in off-farm hours is compatible with operating a larger farm. Alternatively, farm assets are being partially paid for by off-farm wage employment income.

The positive coefficients for FARMDEBT at the .01 and .05 levels for the youngest and oldest age groups respectively, suggest that regardless of the life cycle stage an increase in debts brings forth an increase in labor supply off-farm, perhaps to help reduce their liability position as they are getting started and as they approach retirement after which mortgage payments on land relative to declining income become a financial burden.

ACRENTIN is significant at the .05 and .15 level for the young and middle age groups, though with opposite signs. While the negative sign is expected and occurs for the middle age group, increased acreage for the youngest group is

surprisingly associated with an increase in off-farm employment. Possible explanations include the necessity of off-farm work in order to finance expansion of their operation, which is not so great within the limits of a small farm to preclude increased involvement in both sectors. Or, the results may be meaningless given the small sample and possibility of 'noise.'

As expected the sign is negative for FARMINC and significant at the .15 and .01 level for the young and middle age groups. Thus, as more on-farm labor is required to generate more agricultural product sales revenue, operators supply less hours of work to the off-farm sector.

Some interesting results occurred with the agricultural enterprise variables. SILCORN, HAY/ALFA, and MISCROP have significant positive signs for the middle and older age groups. These results suggest that these activities may not be particularly time consuming on a regular basis (as is the case with DAIRYCOW which has the expected negative sign) and thus may be compatible with the holding of off-farm jobs which provide vacations that can be timed to coincide with peak labor requirement periods of planting and harvesting.

In sum, some life cycle variations do seem to occur for male labor supply off-farm, but the evidence is not strong.

c. On-Farm Labor Supply (Female Age Groups)

A comparison of the younger, middle, and older age groups for females in Table E-3 reveals identical signs of the coefficients for most of the common variables. In only

Table E-3. Life cycle on-farm labor supply estimations[a] of females.

Explanatory Variables	Age Group under 35	Age Group 35-54	Age Group over 54
Intercept	1092.1822 (654.9304)	245.9791 (481.3534)	323.3717 (386.5340)
WFSCHOOL	243.3957 (373.6863)	320.3521 (228.2465)	283.0465 (265.6667)
YNGCHILD	34.4017 (96.7501)	200.4110 (336.4399)	
WFWAGEST	-357.3267*[b] (230.2204)	-24.6965 (158.8172)	170.6664 (257.5102)
OPWAGINC	-.0982 (2.2767)	-3.9684** (2.0349)	-4.0270 (3.2897)
INVSTINC	-19.5734* (13.0015)	-4.3478 (7.7066)	-4.8536 (7.5241)
FRMASSET	2.8717 (3.5042)	3.4981 (2.7834)	-6.7912* (4.1180)
FARMDEBT	-21.9154*** (9.6399)	-13.1068** (7.8933)	-.0240 (17.0307)
ACRENTIN	-2.9587* (1.9132)	-7.2127** (4.5204)	-14.3788 (8.6816)
LAYERHEN	5.9466*** (2.3937)		15.1244**** (5.5914)
DAIRYCOW		84.7132**** (18.5493)	
FEEDCATL		27.5519**** (6.4685)	
FRUIT	21.6705**** (5.1019)		
SILCORN			79.6146**** (13.4207)
WHEAT		41.9063**** (16.3308)	

Table E-3. (Continued)

Explanatory Variables	Age Group under 35	Age Group 35-54	Age Group over 54
MISCROP		-64.8975**** (22.7215)	
SOYBEAN			14.8808** (8.8658)
R^2	.55	.54	.55
$\bar{R}^2$	.38	.46	.45
n	37	79	54

[a] Coefficients are reported with standard errors in parentheses.

[b] Significance levels: **** = .01; *** = .05; ** = .10; * = .15 for the null hypothesis that the parameter equals zero.

two instances, both for the over 54 age class compared to the middle age and young groups, are the signs opposite. WFWAGEST has a negative sign, though not significant at the .15 level or better. FRMASSET has a negative sign on the coefficient and is significant at the .15 level, which is consistent with the previously mentioned findings of sociologists that as farm operations become larger the wife tends to withdraw her participation while the male increasingly specializes in farming activity.

In comparing the results for age groups with the aggregate sample, the signs on the coefficients are the same for all age groups save for WFWAGEST in the older age group equation and FRMASSET for the younger and middle age groups. In neither case are the variables significant at the .15 level or better.

Of the many animal and crop enterprises that enter significance at the .15 level or better, only LAYERHEN is significant for more than one age category -- the youngest and oldest.

As with male age groups on-farm labor supply, female age groups do not demonstrate any life cycle variation for those variables entering significance at the .15 level or better.

d. Off-Farm Labor Supply (Female Age Groups)

For females there is consistency of signs across age groups for the various Personal-Household and Farm-Business variables found in Table E-4. In no instance do we

Table E-4. Life cycle off-farm labor supply estimations[a] of females.

Explanatory Variables	Age Group under 35	Age Group 35-54	Age Group over 54
Intercept	-6705.2844 (893.4800)	-528.3698 (352.3498)	-692.7713 (196.9022)
WFSCHOOL	-521.6264**[b] (294.2171)	-444.5163**** (148.8329)	-65.8271 (136.5498)
YNGCHILD	-53.2623 (69.7319)	28.4456 (228.7764)	
WFWAGEST	3704.2688**** (466.2718)	917.5406**** (125.3151)	911.3572**** (133.8844)
OPWAGINC	-.5499 (1.7406)	-3.8040*** (1.7288)	.5897 (1.6962)
INVSTINC	-14.7572* (9.8599)	-3.2358 (5.2364)	1.3913 (4.0762)
SMSACNTY	-3221.1810**** (464.6645)	-624.1094**** (158.1994)	-649.6326 (141.2763)
FRMASSET	4.0011 (2.8462)	.5011 (2.1487)	-4.0512*** (1.8426)
FARMDEBT	-17.1963*** (8.1223)	-6.1568 (5.4264)	.7084 (8.5055)
ACRENTIN	-.4935 (2.0203)	2.8511 (3.1139)	6.1094 (4.2841)
FARMINC	-15.2651 (10.9379)	-16.9616 (13.2879)	-5.5568 (9.2411)
LAYERHEN		-13.9494**** (4.3532)	
PIGLITTR	-34.6721** (17.9886)		
FEEDCATL	31.2780*** (13.8952)		
BEEFCOW			-15.5127* (9.5440)

Table E-4. (Continued)

Explanatory Variables	Age Group under 35	Age Group 35-54	Age Group over 54
SOYBEAN		-10.5073* (6.4527)	
R^2	.80	.53	.62
$\bar{R}^2$	.70	.45	.54
n	38	80	57

[a] Coefficients are reported with standard errors in parentheses.

[b] Significance levels: **** = .01; *** = .05; ** = .10; * = .15 for the null hypothesis that the parameter equals zero.

find coefficients significant at the .15 level or better but with different signs for different age groups. Moreover, the signs on these variables match those for the aggregate female sample. Hence, life cycle variations are not so much in evidence for females as for males in off-farm employment.

SUMMARY

The life cycle estimations of representative farm operators and their spouses by age group categories was disappointing in that little variation among the under 35, 35 to 54, and over 54 years old classes was observed except for the off-farm male operators. Here we found that for residence in or near a S.M.S.A. the young and middle age groups supplied more labor off-farm but the older group supplied less. A higher market wage rate was associated with increased labor supply for the middle and older groups, but less hours for the young group. Increased investment income resulted in an increase in labor supply for the young age group but a decrease for the older group. Additional acres rented in is associated with an increased labor supply for the under 35 group, but a decrease for the 35 to 54 years of age class. And finally, increased size of the silage corn enterprise resulted in a decrease in labor supply for the young males and an increase in labor supply off-farm for the older males. Since all of the life cycle differences involve a comparison of the young age group with either the middle or older age groups, the reader is

cautioned that because of the small sample size of the young males (i.e., 31) the results may reflect more noise than substance, thereby calling into question the validity of even these life cycle results.

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