THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

HOUSEHOLD DEMAND: A SYNTHESIS OF INTERDISCIPLINARY THEORY AND EMPIRICISM

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

JOHN M. CAMPBELL, JR.

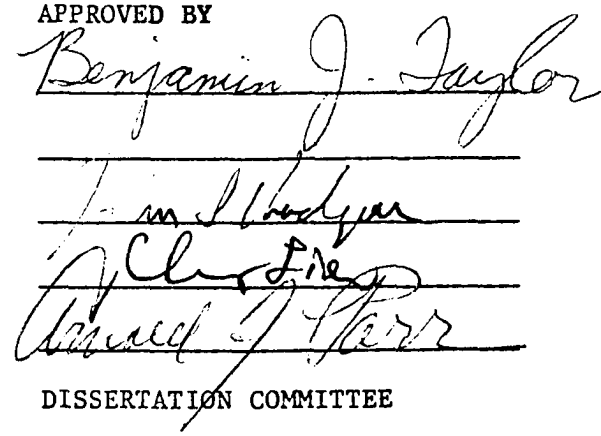
Norman, Oklahoma

1975

HOUSEHOLD DEMAND: A SYNTHESIS OF INTERDISCIPLINARY

THEORY AND EMPIRICISM

APPROVED BY



DISSERTATION COMMITTEE

DISSERTATION

HOUSEHOLD DEMAND: A SYNTHESIS OF INTERDISCIPLINARY THEORY AND EMPIRICISM

Resurgence of social scientists' concern with household demand has created intradisciplinary disputes within economics over the exact interaction of the economic determinants of marriage, labor force participation, and fertility. Also interdisciplinary arguments have arisen among social scientists over each discipline's contribution to the explanation of these phenomena. To test the validity of opposing views, a theoretical model of household utility maximization is developed initially and then tested empirically using a novel data base and several estimation procedures.

In Chapter II a mathematical model of household demand is developed to test two propositions: 1) are individual household member utility functions independent? and 2) are average wage rates an accurate proxy for time value in general and nonworking mothers in specific? In Chapter III, five equations--marriage discriminant, assortive mating, labor force discriminant, hours worked, and fertility--are estimated by ordinary least squares using detailed microeconomic data from the National Longitudinal Survey. In addition, these estimations are referred to as the traditional model because traditional wage rate time valuation and analysis of covariance measures of racial differences are used along with the traditional ordinary least squares estimation

procedures.

In Chapter IV the elements comprising the traditional model are dropped in favor of a general time valuation procedure, Tobit and Twin Linear Probability estimation procedures, and separate samples for blacks and whites. In general the results of Chapters III and IV make the following tentative observations: 1) average wage rates are an inadequate proxy for general time value, 2) racial differences in household demand cannot be accurately measured by analysis of covariance estimation procedures, 3) ordinary least squares are generally inferior to the Tobit and Twin Linear Probability estimation procedures, 4) contrary to Willis's and the new household demand school of thought's belief, individual family member utility functions are not independent, and most importantly, 5) competing views within economics and other social scientists contributions reinforce each other when all are included simultaneously as household demand determinants.

In summary, this research finds that consideration of sociological and psychological demand determinants along with the traditional economic factor enhances the explanatory ability of all these measures. Specifically, each of the social science disciplines appears to complement the explanatory variables obtained from the other disciplines.

ACKNOWLEDGMENT

The common procedure in the acknowledgment secion is extension of a student's appreciation for the efforts put forth on his behalf by various faculty members for their contribution to his academic training. The faculty members involved in my classroom education and dissertation preparation added substantially to this training, but more importantly they imparted professional attitudes and opinions in our interactions which were not part of their classroom responsibilities. Further, they did so in an environment of friendship. While I am grateful for the educational experiences they provided, their efforts to add the extra dimensions of professionalism and friendship to my training can never be repaid. On my dissertation committee at the University of Oklahoma, Dr. Benjamin J. Taylor, Dr. Chong Liew, Dr. Arnold Parr, and Dr. John Hodgson have each contributed equally to my academic education and personal advancement. At the University of Houston, Dr. Paul Gregory and Dr. Bill Thomas made helpful contributions to the content of this manuscript. I would also like to convey special appreciation for the efforts of Dr. Taylor's extra work in preparation of this research and Dr. Gregory for introducing the author to this line of research.

Perhaps the greatest sufferers in graduate school are the student's wife and children. Specifically, I would like to formally thank my wife, Linda, and my children--Jeffrey, Jennifer, and Mark--for understanding when they saw little of their husband and father. More

importantly, they provided real world inputs into the study of marriage, female labor force participation, and fertility. Finally, the persons responsible for starting this entire process--my parents--deserve recognition for their support throughout my life.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

HOUSEHOLD DEMAND: AN OVERVIEW

I. Introduction

From the inception of Becker's seminal article which demonstrates that the total cost of a product should include the opportunity cost of consuming the good, as well as the nominal purchase price, economists have applied the time cost concept to studies on fertility, education, housing, housing location, commuting patterns, marriage, divorce, and labor participation.[1] The early evidence from these studies indicates that opportunity cost theory increases our understanding of household demand formation. At the same time, criticisms concerning this theory have been raised from both economic and non-economic sources. Within economics, the basic objection questions time value's importance as a factor in household demand determination. Also, the question is whether time value is a measurable, and therefore useful, concept. A more fundamental challenge to this line of economic thought originates from both non-economists and economists alike. In their view opportunity cost theory ignores the fundamental "truth" that attitudes are a major, if not the primary, household demand determinant; therefore, economic analysis should focus its attention upon attitude formation.

---

[1]Gary Becker, "A theory of the Allocation of Time," Economic Journal, 75 (September 1965):493-517.

In the initial section of this study a theoretical framework which can be used as a basis for measuring the magnitude of these problems is developed. A theoretical life-cycle demand maximization model for just the wife is formulated initially to test each position's respective merits. After the necessary and sufficient conditions for utility independence are derived, detailed microeconomic and attitudinal information are taken from the 1967 National Longitudinal Survey to shed some light on the contending theories disagreement. Specific attention is given to disagreements over the proper time value measure and its endogeneity, the relative importance of sociological-psychological versus economic demand determinants, and racially imposed differential response patterns for household demand.

To promote a better understanding of these problems, the major goals and criticisms of existing research are reviewed in the following section. In each case detailed mathematical and statistical reviews are delayed until the discussion reaches the respective chapters.

II. Survey of the Literature

The following section contains a fairly extensive survey of past research dealing with the indirect pricing concept's impact upon household demand theory. As some studies using a general equilibrium approach have shown,[2] a significant interrelationship exists between elements of

---

[2]R. Willis, "A New Approach to the Economic Theory of Fertility Behavior," Journal of Political Economy, 81 (March/April 1973):14-69; Paul Gregory, John Campbell, and Ben Cheng, "A Simultaneous Equation Model of Birth Rates in the United States," Review of Economics and Statistics, 57 (November 1972):57-64; Dennis De Tray, "Child Quality and the Demand for Children," Journal of Political Economy, 81 (March/April 1973):70-95; Yoram Ben-Porath, "Economic Analysis of Fertility in Israel," Journal of Political Economy, 79 (August 1969):390-401.

choice in the household decision-making process. Although this survey initially subsumes these studies into a partial equilibrium approach, the results of the general equilibrium approach are brought forth later.

A. Fertility Survey

Application of economic analysis to the study of fertility patterns was popularized by Becker's demonstration that fertility behavior can be studied under the general theory of utility maximization when children are treated in a manner analogous to other consumer durables, and that the primary elements of fertility behavior are amenable to empirical testing.[3] Despite the outpouring of theoretical and empirical research to support or disprove individual facets of Becker's seminal article, utility maximization within the confines of time theory analysis continues to form the foundation for empirical studies of fertility patterns. The first fertility studies applied single equation regression analysis or analysis of variance procedures to aggregate cross-sectional and time series data to test the sign and significance of the income effect[4] and the influence of the business cycle.[5] Later more sophisticated procedures were used to measure the interaction of costs,

---

[3]Gary S. Becker, "An Economic Analysis of Fertility," in Demographic and Economic Change in Developed Countries, National Bureau Conference Series 11 (Princeton: Princeton University Press, 1960).

[4]Irma Adelman, "An Econometric Analysis of Population Growth," American Economic Review, 53 (June 1963):314-39; and R. Weintraub, "The Birth Rate and Economic Development, An Empirical Study," Econometrica, 40 (October 1962):36-42.

[5]Richard A. Easterlin, Population, Labor Force, and Long Swings in Economic Growth: The American Experience, General Series 56 (New York: National Bureau of Economic Research, 1968).

income, and education by using simultaneous equation model specifications and detailed microeconomic data.[6] The current thrust of fertility research deals with four unanswered issues. These are: 1) what are the appropriate costs of children? 2) what is the relevant income concept? 3) how can quality and quantity expenditures be separated? and 4) how important are sociological and psychological fertility determinants relative to their economic counterparts? These issues are discussed in order.

Child care costs are measured as either the market wage foregone in bearing and rearing children by the woman,[7] or the amount of time lost from labor force participation.[8] The time cost proxy is criticized by Mincer as being the inverse of fertility because both are thought to be determined by the same economic variables,[9] and by Gregory as ignoring the variability in the value of time devoted to children of different ages.[10] The wage rate child cost measure is likewise criticized by

---

[6]T. Paul Schultz, "An Economic Model of Family Planning and Fertility," Journal of Political Economy, 77 (March/April 1969):153-80; Y. Ben Porath, op. cit., p. 390; Jacob Mincer, "Labor Force Participation of Married Women," in Aspects of Labor Economics, ed. Gregg Lewis (Princeton: Princeton University Press, 1962); R. Willis, op. cit., p. 22; Glen G. Cain, Married Women in the Labor Force (Chicago: Chicago University Press, 1966); and Paul Gregory, John Campbell, and Ben Cheng, "A Cost Inclusive Simultaneous Equation Model of Birth Rates," Econometrica, 63 (July 1972):36-44.

[7]J. Mincer, op cit., pp. 44-46; R. Willis, op. cit., pp. 33-34; and Y. Ben Porath, op. cit., pp. 390-401.

[8]T. P. Schultz, op. cit., pp. 153-80; P. Gregory, et al., op. cit., pp. 29; and J. Campbell and D. Conger, "Population Dynamics," paper presented at the 1974 meetings of the Western Economics Association, Las Vegas, June 1974, pp. 18-19.

[9]J. Mincer, op. cit., p. 48.

[10]Paul Gregory, "A Stock Adjustment Model of Fertility: The White and Non-White U.S. Population (1946-1970)," University of Houston, Houston, June 1973. (Mimeographed.)

Gregory because it assumes market goods and services have zero substitutability. Both time value measures are also circumspect as a result of Gronau's demonstration that market wages understate the true opportunity cost of time for non-working women. Because market wages fail to attract some women into the labor force, Gronau concludes that a more appropriate time value measure of non-working women's time is their "reservation wage."[11]

The theoretical basis for the alternative child cost measure stems from one group's belief that this cost can be analyzed as the trade-off between the number of children and time devoted to various activities.[12] Conversely, the alternative proposition asserts that the value of marginal commodity inputs better represents the fertility cost of children.[13] The latter position restates Duesenberry's criticisms of Becker's original work in arguing that the trade-off between children and time is unimportant because parents cannot separate their standard of living from those of the children living at home. The absence of

---

[11]R. Gronau, "The Effect of Children on Housewife's Value of Time," Journal of Political Economy, 81 (March/April 1973):168-99; and Reuben Gronau, "The Intra-Family Allocation of Time: The Value of the Housewife's Time," American Economic Review, 63 (September 1973):633-51.

[12]T. Espenshade, "The Cost of Children in the Urban United States" (Ph.D. dissertation, Princeton, 1972); R. Michael and P. Lazear, "On the Shadow Price of Children," Econometric Abstracts (February 1972), p. 57; and C. Hill and F. Stafford, "Allocation of Time to Preschool Children and Educational Opportunity," Econometric Abstracts (February 1972), p. 58.

[13]James Duesenberry, Comment on "An Economic Analysis of Fertility," by Gary Becker, in Demographic and Economic Change in Developed Countries, National Bureau of Economic Research Conference Series 11 (Princeton: Princeton University Press, 1960); and P. Gregory, op. cit., p. 39.

consistent empirical support for either position keeps the issue of child costs open.

Equally as important in fertility, as well as general demand, is the proper measurement of income. Two alternative measures related to current income have been proposed. First, fertility decisions may be made upon a basis of expected long-run earning capacity.[14] Thus a permanent income concept free from cyclical and transitory effects is presumed to be a better measure of the families long-run human and financial wealth. Although Schultz argues that cross-sectional income differences may be a proxy for permanent income, no a priori reason exists to expect the transitory income component to "wash out" over the long-run.[15] A variation from the expectation approach follows Becker's argument that family expenditure and fertility patterns reflect the result of its work-leisure decision by valuing home activity at the market wage rate in such a way as to create a potential earnings stream of money, or full income in Becker's terminology. Empirically, potential income is defined as the sum of wage income, assuming both spouses are employed full time at their opportunity cost wage, plus non-wage income.[16] Though the full income concept may be able to fill the void in our knowledge of the exact relationship between income and fertility, empirical applications of the full income measure have not yet verified this premise.

---

[14]T. P. Schultz, op. cit., pp. 153-80; P. Gregory, et al., op. cit., pp. 57-64; G. Cain, op. cit., pp. 141-44; and M. Friedman, A Theory of the Consumption Function (Princeton: Princeton University Press, 1957).

[15]T. P. Schultz, op. cit., pp. 153-80.

[16]G. Becker, op. cit., pp. 2-5; R. Willis, op. cit., pp. 14-69; and P. Gregory, op. cit., pp. 2-6.

The third issue in the economic literature concerns itself with the debate between child quantity and quality, and the significance of the division for economic analysis of fertility. Proponents of the separation between the two expenditures divide child expenditures into costs associated with raising and producing a child of a given quality and those costs incurred to raise the quality of a given child. Separation of expenditures into quality and quantity components produces dual effects upon traditional fertility theory: first, the usually positive, significant income elasticity of demand with respect to quantity may become insignificant or negative; and second, any increase in the commodity bundle may represent a rise in only quality expenditures, and not direct costs.[17]

Opponents of the quality school of thought counter with the argument that rising real expenditures may only signify a rising cost of children as the family adjusts expenditure patterns to higher standards of living, and not discretionary quality expenditures. This approach, first suggested by Duesenberry and later quantified by Gregory, suggests evaluating child costs on a marginal expenditure per child basis on the grounds that child quality is a by-product of family quality and therefore not subject to discretionary decision-making.[18]

Failure to resolve the aforementioned issues in intradisciplinary economic debate by economists has overshadowed the interdisciplinary disagreement over the relative importance of sociological, psychological,

---

[17]R. Willis, op. cit., pp. 14-69; and G. Becker, op. cit., pp. 279-88.

[18]J. Duesenberry, op. cit.; and P. Gregory, op. cit., p. 39.

and economic fertility determinants. Characteristic of one criticism of new household demand theory is Ryder's statement that Willis "studies the economics of household decision-making by destroying the family."[19] On the same vein Jacobsen believes that economists have provided an empirically verifiable, but basically sterile, body of knowledge by ignoring the fundamental factors that motivate human behavior in order to appeal to other quantitative scientists.[20] In essence, some economists doubt that time costs application to fertility is anything more than "academic rubbish."

The combined scope of these four disputed areas cover the entire spectrum of fertility demand analysis: the choice and measurement of cost and income, the appropriate dependent variable, and even whether the entire line of research is useful.

B. Marriage Survey

Economic concern with the decision to form multi-member households and the manner in which assortive mating occurs is an outgrowth of the realization that fertility, secondary labor force participation, and other forms of household demand do not become operative until an individual decides to marry. Examples of how marriage acts as one initial assumption in economic analysis can be seen in the definition of an unmarried woman as being in the primary labor force until she enters into such a union or studying fertility demand only within the framework

---

[19]N. Ryder, "A Comment," Journal of Political Economy (March/April 1973), pp. 68-71.

[20]Paul Jacobsen, ed., An Anthology of Society (New York: McGraw-Hill, 1970).

of married women. Since the majority of children are born to married women with husbands present, determining the individual's motives for marriage should be the first step in explaining subsequent fertility and labor force decisions. In spite of marriage's pivotal position in explaining household demand, economists have only recently begun to apply the tools of their discipline to study marriage determinants.

The complete literature on mating and its determinants consists of the initial article by Gronau and the work of Freiden and Becker.[21] Each study operates on the assumption that marriage, being mostly voluntary, contributes positively to the individual's level of utility, and can be analyzed according to the tenets of economic theories of preference. Secondly, a marriage market is assumed to exist where each individual attempts to select the best mate contingent upon their resource limitations and conditions in the market.

The essence of the economic argument for marriage involves calculation of the gains and losses from alternative marital statuses. According to Becker, a single individual will join with another person when the full income of the newly formed household is greater than the sum of the individuals' full incomes--full income being defined as nominal income plus the value of each member's time plus the gains in time value from specialization of husband and wife into those activities in which their marginal productivity is the greatest. This gain in realized full income is attributed to the substitutability of activities,

---

[21]Alan Freiden, "A Model of Marriage and Fertility" (Ph.D. dissertation, University of Chicago, 1972); G. Becker, "A Theory of Marriage," Journal of Political Economy, 83 (October 1973):1-36.

such as cleaning house, caring for children, household repair, and income provision between the household members. The actual magnitude of the gains from marriage are associated with economies of scale, and are seen to depend upon the elasticity of substitution between market goods and time inputs as well as the relative efficiency of each household member in the production of household commodities.

Of special importance to the study of marriage is the point made originally by Freiden and later by Becker that the economies of scale argument in itself does not justify marriage in that two or more males or females can combine to form a household to capture these benefits. For instance, in cleaning house, earning a living, mowing the lawn, and taking care of the children, men and women are highly substitutable. However, in areas such as fertility, husband and wife become perfect complements. To Becker, it is this situation which distinguishes the single gender from the husband-wife household.

Past fertility and secondary labor force research has, with a few exceptions, failed to consider marriage's impact upon these demand schedules. Instead, marriage theory--relieved of its role as a tool for weeding out undesirable observations in empirical studies--should increase our understanding of the individual demand schedule determinants.[22]

C. Female Labor Supply

The literature on the response of the secondary labor force to changing market conditions has become voluminous. This volume necessitates that the review be limited to only those studies dealing with the

---

[22]For an exception, see John Campbell and Darius Conger, "Population Dynamics," paper presented at the 1974 meetings of the Western Economics Association, Las Vegas, June 1974.

indirect pricing concept. However, all studies follow two basic approaches to the study of labor force participation. The first--identified with Tella and Dernburg-Strand[23]--argues that the labor force participation rate varies inversely with the unemployment rate, and is referred to as the "discouraged worker" hypothesis. Objecting to the omission of the possibility of a work-leisure trade-off and the assumption of a completely inelastic labor supply curve, Mincer uses neoclassical analysis to show that potential labor force entrants respond to job opportunities and not the wage rate attached to the job. This theory is labelled the "additional worker" hypothesis.

Further research in this area follows either a macroeconomic or microeconomic approach. In the macro approach theories applied to aggregate consumption are modified to explain labor force participation. Among the adaptations are relative versus permanent wages by Wachter (from the Duesenberry versus Friedman conception of consumption), money illusion or inflation by Wachter (from monetary theorists in general, and Friedman in specific), and family assets or wealth by Barzel-McDonald (from a variety of sources). In each case neither the discouraged worker nor the additional worker approach adequately explains women's labor force participation.

The micro approach builds on the theoretical foundations laid by Mincer with the tools developed in Becker's theory of time. According to this view women enter the labor force when their marginal productivity

---

[23]A. Tella, "The Relation of Labor Force to Employment," Industrial and Labor Relations Review, 19 (April 1964):454-59; and T. Dernburg and K. Strand, "Hidden Unemployment 1953-1962: A Quantitative Analysis by Age and Sex," American Economic Review, 56 (March 1966):71-95.

at work exceeds their home productivity and leave the labor force when this condition is reversed. The unsettled issue at this time is caused by the uncertainty over how homemakers value their time.

The first time proxy adopted was total family size (a stock concept), followed by the flow of children, and then the stock of pre-school children in the family. In the flow variable, ignoring the presence of other children obviously understates the mother's time contribution in the home. Similarly, the total child stock measure also understates time value because it assumes the value of a mother's time inputs per child are constant regardless of age of children and number of children.

In short, the burden children place on a potential working mother is their impact on her value of time. Though a child under one year requires more marginal time from the mother than more self-reliant older children, the flow of children proxy by itself understates her total value of time. Conversely, error attributed to total family size depends on the number and age distribution of the children. For instance, a family composed of teenage children will demand different amounts of their mother's time than one with the same number of pre-school children. In the former situation the aggregate family size variables values the mother's time equally with the young children family. Regardless of the actual magnitude and direction of error, no a priori reason exists to accept equal time value in this example. Assuming that the peak time costs of children occur in the early stages of growth and decline thereafter, Gregory uses the number of pre-school children in the household. Theoretical and empirical support for Gregory's position can be found in

Gronau's demonstration that the value of a mother's time decreases with the age of children and increases with their number.

Another problem plaguing labor force participation research is proper sample selection and definition of family income. The samples concentrate upon married women on the grounds that unmarried women are either supported by their parents, or, are forced to participate in the work force.[24] In actuality, the decision to enter the labor force is closely tied to three possible decisions regarding participation in the marriage market: 1) to enter the labor force and not the marriage market, or 2) to enter just the marriage market and depend upon external forces for support, or 3) to enter both markets simultaneously. If either choice 2 or 3 is followed and a marriage occurs, the female is again faced with three alternatives: 1) participate in the labor force, or 2) concentrate on the production of household goods, or 3) perform each activity on a part-time basis.

Section II, part B, on marriage explained that the decision to marry is based on a shift in the production possibilities of the partners, and that the eventual choice of partner determines the magnitude of the production possibilities curve shift. This actual change in production possibilities is the primary determinant of the housewife's time, which in turn is taken as the major factor affecting the labor force activity of married women. If this reasoning is valid, concentrating on samples of married women to the exclusion of the reasons for

---

[24]As always, exceptions to the general model exist, such as divorcees and widows. Though these cases are small relative to the total secondary labor force supply, and therefore minimizes subsequent biasses in conclusions based on samples of married women, the rising absolute number of these situations deserves further attention.

forming the household and the resultant characteristics of the household ignores, perhaps, the most important explanation of labor force participation. Further, this may be the most important determinant of labor activity by married women.

Corollary to this same problem is the use of family full income and family assets, i.e., non-human wealth, for exactly the same reason. The process involved in the decision to marry and the characteristics of the eventual spouse explains a considerable portion of full income and non-human wealth. Thus, the decision to enter or leave the labor force depends partially upon the decision to marry and choice of spouse. Once again, exclusion of the marriage decision from labor force analysis subsumes an important labor force determinant into a criteria for sample selection.

As in the fertility and marriage surveys, the secondary labor force literature began with pure economic variables, added measures of family responsibility, and then proceeded to recognize the possibility of causal relationships. These causal relationships include time value and child costs, the reverse effect impact of child costs upon time, and the simultaneous relationship between fertility and both time and child costs.

The single theme underlying the first three surveys is the positive price for deriving household full income and costs. Section ii, part D, looks at time theory apart from these applications.

D. Theory of Time

Since Becker's formal introduction of the theory of time into

economic analysis, authors have expended great effort in applying the concept to the household decision-making process. As is the situation with a new theory, imperfections existed and were corrected as they came to the attention of the profession. The initial weakness detected in the theory of time was its failure to discuss in detail the importance of substitution effect and the source of this effect.[25] Later, the needlessly strong assumption of zero substitutability between market goods and time is relaxed through the introduction of a time consumption constraint by DeSerpa. A time consumption constraint differs from the time resource constraint in that the resource constraint refers to the physical amount of time available for use in a day, while the consumption constraint puts a lower bound on the amount of time needed to produce a home good. Examples of binding constraints on time consumption are a round of golf, meals, speed limits, reading a book, etc. in which the form of constraint may be physical, such as reading ability, or institutional, such as speed limits. In either case, time and market goods become substitutes of varying degrees depending upon the nature of the good and the minimum amount of time required to consume it.

An alternative technique for incorporating a substitution effect is to assume that hours of work are flexible rather than fixed. Once the amount of work is allowed to vary, changes in the price of time--taken as the wage rate or any other measure--produces three effects: 1) a compensated cross-price effect, 2) an own price effect, and 3) a

---

[25]Becker does discuss the implications for his model from dropping the assumption of fixed factor proportions upon his preceding analysis in a normative manner, but passes over these implications for his numerical solutions.

Slutsky income effect.[26] An urban commuting study by Mankin illustrates that the absence of cross-price effects in household demand models will produce significantly different conclusions from those models where factor inputs can be substituted.[27] The relevant part of this lesson to family decision-making studies is the importance of allowing the household to substitute time for market goods in the household production function in both the conceptual and empirical models.

A second weakness observed in Becker's original work involves the proper time cost measure. Becker, and everyone else except Gronau, adopts the average wage rate as the appropriate variable for conversion. To justify the wage rate time valuation approach for housewives, its advocates typically provide the following rationale. Accordingly, if one believes that housewives and female laborers with similar socioeconomic characteristics have equal time values, the housewife's value of time can be imputed from women's market wage rates. When a woman's labor supply is the mirror image of her derived demand for time at home, then her price of time corresponds to her "entry wage"--the wage at which she is ready to supply the first unit of labor. By estimating women's labor supply schedule, one can derive the homemaker's value of time by calculating the entry wage. To estimate the impact of income or children on time value, one only has to observe supply function shifts as these factors affect the "entry wage."

---

[26]For a formal discussion of this theory, see Mankin-Campbell, and Mankin for an application to urban commuting.

[27]W. Mankin, "A New Look at the Muth Model," American Economic Review, 77 (September 1973):470-74.

Gronau evaluates this approach by saying, "This method, so alluring in simplicity runs into overwhelming difficulties." These difficulties are identified as finding the true dimensions of labor supply: weekly hours, weeks worked, annual hours, and so on, and the proper mathematical function to describe the labor supply function. The problem is that time value estimates are sensitive to both the nature of the dependent variable and choice of the functional form. Also, the underlying assumption that working women and non-working women with similar characteristics are not fundamentally different is tenuous. Their various reactions to labor force stimuli indicates that there are some unobserved, or perhaps misunderstood, fundamental differences between the two groups, and these differences may be related to the price women assign to their time.

The extension of time value theory by Gronau and Ben-Porath to admit the existence of time preferences is a positive addition to our stock of knowledge. However, Hall observes correctly that, "a better way to account for variations in preferences would be to consider that the size of family and the labor force participation of wife are jointly determined." This comment by Hall merely underscores the results of the previous literature surveys, and supports a modification of Gronau's revisions to include the possibility of simultaneous determination.

E. Partial Versus General Equilibrium Approaches

The predominant stress of past theoretical and empirical research has been on the partial equilibrium approach. Thus the fertility

decision is viewed in the context of a single fertility equation. In this manner, the interaction of fertility and labor market decision-making is ignored along with other interactions. Thus the partial single equation approach tends to create specification error and estimation bias --a point made aptly by Okun.[28] Exceptions to this general trend are Willis largely at the theoretical level, Gregory, et al., Gregory, Campbell-Conger, and Campbell at the empirical level, and to some extent Ben-Porath, who works implicitly with the reduced form model. In this regard it should be noted that the literature on female labor force participation has long noted the impact of fertility in terms of family size upon labor participation rates but has failed to complete the circle and investigate the reverse impact of the labor market upon fertility decisions--something done to some extent in Gregory, et al., Gregory, Campbell-Conger, and Campbell.

III. Method of Approach

The task of incorporating all of the advances in the theory of household demand takes place in two stages. The first stage develops a general conceptual framework from which inferences about these interrelationships can be made. Next, the implications and validity of this paradigm are tested empirically.

A. Theoretical Model

The recurring message in each topic survey was the need for a

---

[28]B. Okun, Trends in Birth Rates in the United States since 1870, studies in Historical and Political Science, series 77 (Baltimore: Johns Hopkins Press, 1958).

model which recognizes the interdependencies between female participation, fertility, marriage, and time value. Past theoretical models require two major changes to satisfy these requirements. First, a separate function determining time value must be added. Besides adding information about the interrelationship between time value and household demands, the theoretical time value function is a necessary first step in formulating an empirically meaningful time value measure. Second, Becker's household demand function must be modified to include a substitution effect if theoretical models are to become more representative of the household decision-making process.

The general approach adopted here follows Willis's lead in optimizing utility levels subject to appropriate constraints within a neoclassical utility function framework. Both the first and second order total differentials are checked to insure that the optimality conditions are satisfied. Further, the model's demand components are analyzed to test their consistency with actual events and the manner in which these demands are related. If these conditions are satisfied, then the theoretical model will provide a solid basis for deriving empirically testable hypotheses.

B. Empirical Model

The true value of the theoretical model and its ability to explain the family decision-making process requires formal testing. Past models have estimated these relationships from aggregate time series data or median cross-section data using single equation techniques to accomplish this goal. The approach adopted here deviates from the

traditional methods in two ways. First, comprehensive information on women 30-44 and their families for 1967 from the National Longitudinal Survey is used in order to minimize the aggregation errors common to time series and median cross-sectional data. A second modification involves estimating these non-linear demand curves with twin linear probability and Tobit analysis because the high degree of interdependence between the variables within the theoretical model, estimation of the relationship between these variables by ordinary least squares is inconsistent from a logical viewpoint and leads to a significant statistical bias in the parameter estimates.

A further challenge to the model's comprehensibility involves testing it against black and white culture in order to check for major demand differences between the races. Two techniques are used to measure culturally imposed demand variations. The simplest of the two approaches merely estimates a separate model for each sample culture. The weakness of this approach is our inability to test for significant parameter differences between equations except under restrictive circumstances. An alternative approach--analysis of covariance--captures slope and intercept effects among the various cultural groups through the use of dummy variables. The limitations on each technique are discussed in more detail in a later chapter.

IV. SUMMARY

Although Becker precipitated the ever increasing study of household demand, Cain suggested that a better approach is to assume that,

"the whole pattern of family life--marriage and divorce rates, the number and timing of births, decisions about schooling and decisions to retire--has been affected by, and in turn affects, the large increase in market employment of wives." Partial fulfillment of this change is the goal of this research. While the theory section moves a long way toward satisfaction of this end by specifying the nature of the interrelationship among the components of household demand, the empirical section falls behind the theoretical formulation of the model as the result of the inability to quantify important variables. The failure of the empirical work to keep pace with theory is consistent with the normal relationship between theory and empiricism. Despite this limitation, this quantitative research extends our understanding of household demand determinants.

Chapter II discusses details of previous neoclassical analysis of households, develops the extended model and the reasons for the specific formulation, calculates the necessary and sufficient conditions for maximization, and interprets the results. Appendix A to Chapter II generalizes the model developed in Chapter II. Chapter III modifies the paradigm in Chapter II to permit estimation, discusses the specification of equations, how they relate to the theoretical model, estimates the equations, and interprets the results for a traditional specification of the problem. Chapter IV modifies the traditional approach by including a general value of time measure and estimating the equations via the twin linear probability model and Tobit analysis. Chapter V summarizes the results.

CHAPTER II

OPTIMIZATION OF HOUSEHOLD DEMAND

I. Introduction

Acknowledged confusion existing within household demand theory over the proper value of time and the assumption that family members' utility levels are independent inhibits economic theory in its search for a better understanding of household demand determination. In specific, original criticism by Johnson of the approach equating time value and wage rates has recently been shown to also hold for non-workers and part-time workers alike by Gronau and Willis, respectively. In the former instance wage rates understate time value and overstate it in the latter. Further, the assumed independence among the respective family member utility levels disturbs economists and non-economics alike because it implies that individuals marry and have children solely to increase their consumption of tangible goods and services. Instead, these critics maintain that increased consumption is not necessarily the only factor nor the dominating influence in demand determination. This chapter incorporates these criticisms of existing household demand theory into one model to test the validity of the disputed wage rate time valuation procedure and utility independence assumption.

Section II, part A, reviews previous utility function specifications and equation constraints, and part B illustrates the reasons

and methods for switching to an alternative time value measure. Section III defines a unified model of family demand and formation. In Section IV the model is solved for its first and second order conditions for equilibrium and its major characteristics are discussed. The final section summarizes the major conclusions.

II. Previous Specifications and Alternatives

A. Previous Models

1. Utility Functions

The basic approach to utility formulation follows Becker's lead in specifying utility as a function of home produced goods, or $U = U(Z)$, where Z = home produced goods. An equivalent method makes home produced goods a function of market goods, X, and time inputs, T_Z. Inserting $Z = Z(X,T_Z)$ into the utility equation gives $U = U[Z(X,T_Z)] = U'(X,T_Z)$ where U' is a composite function of the functions U and Z. Though the general tendency is to follow the original approach of Becker or its modification, others subdivide both market goods and time into their alternative uses to allow for closer inspection of individual household demand determination. For example, Willis believes that valid conclusions regarding fertility policies depend upon separating the utility generating aspects of children into quality and quantity components. Similarly, Gronau includes market goods, home goods, and leisure for both husband and wife to compute the value of time, while Ben Porath limits the utility producing arguments to market goods and child quality. For exposition a summary of these and other postulations are summarized in Table 2.1 by author and purpose.

TABLE 2.1

ALTERNATIVE SPECIFICATIONS OF THE UTILITY FUNCTION

Functional Forms*	Author
1. $U = U_1(X;T) = U(Z)$ when $Z = f(X,T)$, so $U(Z) = U(f) = U(ZX;T)$	De Serpa, Becker (65), Gregory, Lindert, Becker, Michael, Gronau (73)
2. $U = U_2(X;Z;L_M;L_F)$	Gronau
3. $U = U_3(X,C) = U_3(N,S) = U_3(X,N,Q)$	Ben-Porath, Willis, Becker (73)
4. $U = U_5(Z,C)$	DeTray

*The meaning of each variable is as follows: X = market goods, T = time, Z = household goods and services produced by combining market goods and services and household time, L_M = leisure time of the male, L_F = leisure time of the female, N = number of children, Q = average quality of children, C = child services, S = parents' level of consumption.

As is always the case, the limitations and strengths of each functional form depends upon their respective purposes. Here the study of the simultaneous interaction among the components of household demand suggests combining certain elements of each approach in Table 1 into a general formulation. To this end, Gronau's recognition of utility interdependence between the husband, wife and children and leisures contribution to utility seems to be a good starting point. One failing of Gronau's approach follows from his assumption that time spent in the

labor force produces neither utility nor disutility,[29] and the incorporation of individual family members into the utility function limits the usefulness of the Samuelson-Bergson theorem of multi-member utility maximization (to be explained later).

Following Gronau's specification and its limitations, an alternative formulation of utility determination is found in equation (2.1):

$$U = U(X,Z,L,S,N) \tag{2.1}$$

where U = utility, L = leisure, S = characteristics of the marital partner, N = number of children, and X,Z are defined as before. The addition of the only different variable from those listed in Table 2.1, S, accounts for satisfaction derived from the marriage partner and follows from the criticisms of current population research by Norman Ryder in specific, and other non-economists in general. Ryder in a formal appraisal of Willis's studies that also applies to all economic studies of population says,

> Willis presents a model within a framework of the economic theory of the family, but he proceeds about this important task by systematically destroying the idea of the family. The family in its skeleton form consists of a flow of person-years through time, encompassing the adult lifetime of one male and one female and the non-adult lifetimes of a varying number of children (including zero). The members of the family are bound to each other

---

[29] Gronau recognizes the deficiency of this assumption and its ability to significantly alter his conclusions, but still adopts this approach.

> by contract, with clear specifications, inter alia, of the directions and amounts of flows of resources and services from one to another member. Willis has combined time into the instant of initial decision, he has defined the children as objects and parents as subjects, he has denied the members the right to take satisfaction of others, he has merged the husband and wife into a single utility function of the individual type--in short, he has solved the problems of family economics by dissolving the family. To give one specific example: there is no characteristic of the child save perhaps the requirement of the expenditure of time as well as other resources that makes the model any different from one concerned with any other purchase.

Although Ryder's misunderstanding of economic modeling in the neoclassical tradition is acknowledged, his evaluation of the economic approach to family economics contains valid observations. Of these, the inability of the husband or wife to draw satisfaction from the other opens formal household demand analysis to a multidisciplinary group of critics.

In essence, Ryder argues that the success and/or failure of one family member directly affects the satisfaction of other family members. Examples familiar to most readers are a wife's increase in satisfaction when her husband completes his doctoral requirements, publishes his first research paper, presents his first paper at some meeting, etc. With regard to children, their first steps, their initial speech, entrance into school, their first date, and graduation from high school and college are all sources of reward to the parents.[30] In an opposite manner both children and mates can also act in a way which offsets their positive contributions to utility.

---

[30]Willis's justification for adopting a family utility function in lieu of summing the individual utility functions is his appeal to Samuelson's proof of the equivalence of the two approaches when there is no joint consumption and no interdependency in utility. Willis argues further that the family responds systematically to changes in the position of constraints and therefore the interdependency assumption is valid for many situations.

One way to answer Ryder's criticisms is by viewing the utility maximization decision from the individual's or wife's perspective and including the mate and children as determinants into the utility function. Approaching the question of utility maximization from this vantage point minimizes the interdependency problem by permitting direct analysis of the possible utility interdependency.[31]

2. Type of Constraints

a) Income constraint

Presently, income constraints are specified as opportunities foregone by both the husband and wife in the labor market plus non-wage income in the general form of equation (2.2):

$$I = T_F \cdot W_F + T_M \cdot W_M + V \qquad (2.2)$$

where I = full income, V = non-wage income, T_F = total amount of time available for wage earning activity by the female, W_F = potential wage rate (or a measure of opportunity cost), W_M = potential male wage rate, and T_M = total amount of male's time allocated for wage earning activity. Equation (2.2) is the standard one found in household demand models, but I, defined as full income rather than nominal income, represents potential income realizable from working the biological number of hours per day, and this time is normally assumed to be greater than the actual work day.

---

[31] One assumption consistent with past research is the exclusion of hours worked from the utility function to prevent the impact of making time value endogenous from being confused with a multitude of changes. After these implications are explored, hours worked is inserted into the utility function in Appendix A.

In order to incorporate an endogenous time value measure the wage rate time value measure, W, in equation (2.2), is replaced with a general time value approximation, V_T, in equation (2.3). This change is illustrated by:

$$I = T_F \cdot V_T^F + T_M \cdot V_T^M + V \qquad (2.3)$$

where all the variables are defined as before, V_T^M = permanent male time value, and V_T^F = permanent female time value. Full income defined in equation (2.3) differs from the traditional full income definition in equation (2.2) by the magnitude, $V_T - W$, which varies directly with the difference between primary work force wages and marginal productivity in home production.

Although the modification in equation (2.3) is minor, its impact upon a system of total differentials will be major.[32] For this reason, a precise definition of V_T awaits the detailed discussion of time value in part B of this section.

b) Home production constraint

Following Becker, the distinguishing household demand feature is the Marshallian utility maximization process in which goods and services produced for individual consumption directly affect the optimal utility level. Although one household production constraint takes

---

[32]Because the components of household demand are closely interrelated, small variations in time value do not necessarily produce small impacts upon family consumption patterns after the changes work themselves through the system.

market goods and services and time inputs as the primary determinants, a commonly adopted modification separates the time contributions into separate male and female components and includes a measure for efficiency in the production process. Equation (2.4) details an example:

$$Z = Z(X, T_Z^F, T_Z^M, p) \tag{2.4}$$

where Z = array of household produced goods, p = an efficiency parameter, T_Z^M = time spent producing Z by the male, and T_Z^F = time spent producing Z by the wife.

An alternative method for expressing home production popularized by Willis converts the production function in equation (2.4) into a cost function. The dual of the production function has several advantages for utility maximization work. First, the cost concept fits easily into the income identity. Secondly, the scale and shadow price parameters allow for substitution among the factor inputs. Further, the dual allows us to separate expenditures into their fixed and variable cost portions. All of these factors are summarized below.

Assuming that the cost of any home produced good is composed of endogenous and exogenous components, P_Z can be divided into two elements:

$$E_Z = [P_Z + P_Z(V_T, S)] \cdot Z \tag{2.5}$$

where all of the variables are defined as before. In this comparative static framework, the exogenous portion of costs, P_Z, are illustrated by

fixed costs or depreciation charges in durable goods usage. The endogenous cost portion, $P_Z(V_t,S)$, arises from valuing time used in home production valuation in a determined--not a predetermined--manner.[33] For comparison with standard wage rate time valuation procedures, equation (2.5) reduces to Willis's expenditure function whenever wage rate time valuation and V_T are equivalent.[34]

The second factor explaining home goods cost, S, reflects the spouse's partial control over the home produced goods composition and quality. Existence of alternative preferences among mates for home produced goods forces the primary producer--the wife--to alter the products quality to satisfy these demands. Optimal spouse selection thus requires equating a woman's home production capabilities with the potential mate's demands. For instance, a woman may find marriage to a rich husband desirable in every way except for her inability to satisfy his home produced good demands. Although this reasoning seems spurious, marriages where the husband interacts with other upper income or moves in well educated circles and his wife cannot operate there for whatever reason are rare. In essence, the rarity of Liza Doolittles indicates that potential mates do relate home production capabilities with demand.

Because recent fertility studies have separated child production from home production in order to study the specific differences between

---

[33]For a more detailed explanation of the logic behind equation (2.5), see Mankin, op. cit., pp. 470-74.

[34]Willis argues that the linear relationship between wage rate and time value justifies the former's use, but in light of Gronau's theoretical and empirical research, this conclusion must be questioned.

child quantity and quality determinants, the latest debate in fertility theory concerns the quality-quantity function determinants and income elasticities. Included as well are all of the difficulties associated with quality measurement in general economic theory. The quality-quantity advocates claim that the potential high elasticity of substitution between quality and quantity justifies this separation. To emphasize this point Willis, Becker-Lewis, and others cite the observed smaller family sizes among high income groups as representative of this group's attempt to maximize child services through reductions in child quantity and increases in average quality. At the same time lower income groups are believed to sacrifice average quality per child in order to increase child quantity.

Counterarguments to the quality-quantity position--originally suggested by Duesenberry and later adopted by Gregory and Leibenstein--propose a low elasticity of substitution since most major quantity expenditures are provided free (in the form of education) or are insignificant (in marginal food and clothing costs for additional children). The combined effect of these factors is presumed to affect only the income and substitution elasticity magnitudes--not the choice of fertility determinants.

To specify the quality-quantity determinants, Willis first computes full income. Then full income, along with the shadow prices for children and the composite good, is inserted into the three cost functions determining child quality, child quantity, and child services (child quantity time quality). Willis's two step process is discarded

here partly because quality-quantity details can be analyzed equally as well with one cost function, but also because income is actually a constraint upon the entire expenditure function--not just a child service determinant. Both points can be illustrated by referring to equation (2.6):

$$E_N = P_N(V_T, P_X; N) \tag{2.6}$$

where E_N = total expenditures for children and the remaining variables are previously defined. Equation (2.6) conforms to the traditional cost function formulation with the output scale function, N, and the shadow prices, V_T and P_X. The general output scale parameter accounts for Willis's quantity considerations, and likewise, quality is found by observing the price input levels for any given quantity of children. To illustrate, two families--both with the same number of children--will produce different quality children if one family expends a relatively larger amount of mother's time or market goods upon the children. Quality is thus determined by the intensity of factor inputs when quantity is held constant for any income level.

Although the approach specified in equation (2.6) simplifies existing theoretical quality-quantity demand studies, the inability to measure child quality prevents a direct empirical test of Becker's assertion that the child quality elasticity exceeds unity and the quantity elasticity is positive, but approaches zero. A further problem involves determining the extent to which child expenditures vary with income. If income and child expenditures are closely related, then the

constraint placed upon total family expenditures by full income in equation (2.6) still fails to provide an empirical measurement of quality-quantity income elasticity differences.

c) Time resource constraint

Addition of a time constraint to the household maximization model limits time allocation to total time available over any specified horizon, usually the 24 hours in a day, T_0, by equating total available time with all possible time uses. For example, some possible time uses are defined in equation (2.7) as:

$$T_0 = T_W + T_N + T_L + T_Z \cong 24 \qquad (2.7)$$

where T_0 = total time available, T_W = time spent working, T_L = time spent on leisure, T_N = time spent on children, and T_Z = time spent on home produced goods. Here the unsettled issue involves a dispute over the proper definition of T_0. The biological group argues that human sleep requirements prevent T_0 from equalling 24 hours. Countering this position is the belief that these biological needs are incorporated into the specific time uses in equation (2.7). Because both results produce the same results, this study uses 24. However, proponents of a biological constraint upon time activity may replace T_0 for 24 without changing the model's interpretation.[35]

---

[35]Another constraint proposed by De Serpa to restrict time spent consuming goods and services is not discussed here because Mankin demonstrates how the same effect can be introduced by making hours of work flexible.

B. Time Value

The failure of wage rates to attract housewives into the labor force, and the wage rate time value measures disregard for diminishing marginal utility for labor force participants from working, supports the arguments by Gronau, Willis, Johnson, and De Serpa for development of an alternative time value measure. In specific, a non-working woman's underestimated time value can be corrected by using her reservation wage instead of an "expected wage rate." Correction of labor force participants' overestimate of time value by wage rates requires information on the number of hours worked, availability of overtime work, the overtime pay schedule, and the number of hours required before the employee is eligible for overtime pay, and upon alternative employment opportunities. These correction factors are combined to form an alternative time value measure, V_T.

Time value correction factors for full time and part-time employed women as well as non-workers are illustrated in equation (2.8) by:

$$V_T = \begin{cases} RW; & \text{if not in the labor force} \\ WR(HW/40) + \Theta \cdot WR(HW/40 - 1); & \text{if employed} \end{cases} \tag{2.8}$$

where RW = the woman's reservation wage, WR = her wage rate, HW = her hours worked, Θ = overtime pay schedule, and V_T = her resultant time value. Reservation wage, RW, corresponds with Gronau's suggested replacement for wage rate time valuation of non-working women. The second element in equation (2.8) represents a synthesis of existing proposals

for measuring employed workers' time value that includes wage rates. Wage rate time valuation is shown to be a special case of V_T by noting that women working 40 hours per week (HW = 40) and paid straight time overtime (O = 0) have a time value which equals to her wage rate, or $V_T = WR(40/40) + 0 \cdot WR(40-40)/40 = WR$. In an opposite manner, changing the work week to 60 hours and assuming the same overtime pay schedule gives $V_T = WR(60/40) + 0 \cdot WR(60-40)/40 = WR \cdot 1.5$, or V_T exceeds wage rate time valuation by 50%.

Similarly, part-time workers' time value is approximately half of the wage rate valuation approach when double time overtime pay (O = 1) and a 20 hour work week are assumed, or $V_T = WR(20/40) + 2 \cdot WR(20-40)/40 = 0.5 \cdot WR$. In this instance, as in the preceding ones, nominal wage rates only equal the general time value measure when a 40 hour work week and straighttime overtime are found.

Because equation (2.8) is unsuitable for a Lagrangian maximization procedure, its common elements are synthesized into the implicit functional form described in equation (2.9) as:

$$V_T = V_T(WR, HW, \Theta) \tag{2.9}$$

where all the variables are defined above. The advantage of equation (2.9) over traditional wage time valuation arises from the greater use of information about the individual's market activity.

In defense of theoretical time value studies, their time value measure is really the "potential" wage rate, not the actual wage rate usually assumed in empirical studies.

The derivation of equation (2.9) will permit formal measurement of errors in household demand analysis as a result of wage rate time valuation.

III. The Model

The household demand model maximized below makes several distinct deviations from existing household demand models. First, wife's demand is maximized in a setting in which the husband becomes one utility determining element in order to weigh the validity of the utility independence assumption by Willis and others. Spouse characteristics are formally entered into the utility function and various expenditure functions to directly test the spouse's impact upon the female's demand pattern. If this impact is significant, then the utility independence assumption becomes untenable for future household demand research. More importantly, a positive demonstration that family member utility interdependence can be properly handled mathematically supports social scientists' attempts to organize the complex household demand behavior pattern into formal analytical models and provides hope for extending the household demand model to include this interaction within a jointly determined framework.

Secondly, making wage rate time valuation a special case of a more general time valuation procedure produces a more accurate measure of the elements in the utility functions respective responses to changes in the value of time. For example, Willis's and Becker-Lewis's assertion that time value is a linear function of wage rates leads them to the rationale for equating the two. To the extent that the shadow price

of children can be associated with the mother's time value (as it is in the quality arguments), a one unit increase in wage rates will not necessarily produce a corresponding one unit increase in the shadow price of children here. As explained above, this difference depends upon hours worked and overtime pay rates as well as the market wage rate.

A. Formulation of the Model

Following the reasoning set down in Section II, the woman's utility level is maximized via application of Lagrangian analysis to the utility function and constraining equations depicted in equation (2.10):

$$L = U(X,Z,S,L,N) + \lambda\{24[V_T(\Theta,WR) + V_T^S(S)] + Y + Y^S(S)$$

$$- P_X \cdot X - [P_Z + P_Z(V_T(\Theta,WR),S)] \cdot Z - P_N[V_T(\Theta,WR),P_X;N]$$

$$- L \cdot V_T(\Theta,WR) - L_S(S) \cdot V_T^S(S)\} \qquad (2.10)$$

where all of the variables are defined in Section II, except for L^S = the husband's leisure time.

One major change in equation (2.10) drops HW from the V_T determining function in order to minimize an already complex mathematical notation. For convenience Θ can be redefined to include the composite interaction of overtime pay and hours worked without a significant information loss in subsequent analysis. Another deviation from the usual formulation combines more detailed income and cost components into one budget constraint. Instead of dividing costs into household and child costs and combining all income factors into one component,

equation (2.10) separates income into human and non-human capital income and divides costs into their detailed sources.

Comparison of the first and second order maximization conditions for equation (2.10) with the ones derived in Willis's model should substantiate or disprove current economic opinion that family utility levels are independent and time value can be equated with wage rates. If either opinion is found to be incorrect, together or separately, then future household demand methodologies must also be altered to include more viable assumptions.

B. Calculations

1. Necessary Conditions

Taking the partial of the Lagrangian function in equation (2.10) with respect to X, Z, L, S, N, V_T, λ, and after setting them equal to zero, the first order conditions become:

$$\begin{aligned}
\partial L/\partial X &= U_X - \lambda P_X = 0 \\
\partial L/\partial Z &= U_Z - \lambda\{P_Z + P_Z[V_T(\Theta,WR),S]\} = 0 \\
\partial L/\partial L &= U_L - \lambda \cdot V_T(\Theta,WR) = 0 \\
\partial L/\partial S &= U_S - \lambda \cdot [24(\partial V_T^S/\partial S) + \partial Y^S/\partial S - (\partial P_Z/\partial S)\cdot Z \\
&\quad - (\partial L^S/\partial S)\cdot V_T^S(\Theta,WR) - (\partial V_T/\partial S)\cdot L^S] = 0 \\
\partial L/\partial N &= U_N - \lambda(\partial P_N/\partial N) = 0 \\
\partial L/\partial V_T &= \lambda[24 - (\partial P_Z/\partial V_T)\cdot Z - (\partial P_N/\partial V_T) - L] = 0 \\
\partial L/\partial \lambda &= 24\cdot[V_T(\Theta,WR) + V_T^S(S)] + Y + Y^S(S) - P_X\cdot X \\
&\quad - [P_Z + P_Z\cdot(V_T(\Theta,WR),S)]\cdot Z - P_N[V_T(\Theta,WR),P_X;N] \\
&\quad - L\cdot V_T(\Theta,WR) - L^S(S)\cdot V_T^S(S) = 0
\end{aligned} \tag{2.11}$$

and setting $P_X = 1$ as the numeraire, the marginal conditions for equilibrium are found to be:

$$U_Z/U_X = P_Z + P_Z[V_T(\Theta,WR),S)] \tag{2.12}$$

$$U_L/U_X = V_T(\Theta,WR) \tag{2.13}$$

$$U_S/U_X = 24(\partial V_T^S/\partial S) + (\partial Y_S/\partial S) - (\partial P_Z/\partial Z)\cdot Z - (\partial V_T^S/\partial S)\cdot L^S - (\partial L^S/\partial S)\cdot V_T^S(\Theta,WR) \tag{2.14}$$

$$U_N/U_X = \partial P_N/\partial N \tag{2.15}$$

$$24 - L = (\partial P_Z/\partial V_T)\cdot Z - (\partial P_N/\partial V_T) \tag{2.16}$$

In summary, equation (2.12) says the marginal rate of substitution between the composite good, X, and the home produced good, Z, equals the sum of the exogenous and endogenous home produced good prices, or $MRS_{Z/X} = \{P_Z + P_Z[V_T(\Theta,WR),S]\}$. Similarly, equations (2.13)-(2.15) show that the marginal rate of substitution between leisure, spouse, and children with the composite good is, respectfully $V_T(\Theta,WR)$, $[24(\partial V_T^S/\partial S) - (\partial P_Z/\partial S) - (\partial V_T^S/\partial S)\cdot L^S - (\partial L^S/\partial S)\cdot V_T^S(\Theta,WR)]$, and $\partial P_N/\partial N$. Finally, equation (2.16) illustrates the standard rise in expenditures to match a corresponding increase in income. Further, following Willis, equations (2.12)-(2.16) can be combined to insure a local equilibrium position by forcing the individual to consume units of each product until the ratio of marginal utility to price equals the marginal utility of money, $1/\lambda$, for all specified commodities.

Because the impact of pertinent exogenous variables upon the total system cannot be determined from equations (2.12)-(2.16), these equations are converted into total differentials to formally test the impact of a few determining variables, specifically wage rates, upon the sufficient conditions for equilibrium.

2. Total Differential Test for Sufficiency

Examples of converting first order conditions into total differentials can be found in Henderson-Quandt, and is therefore performed here without explanation except to note that the total differential permits formal explication of the spouse's effect upon final equilibrium utility level and the extent to which the general time value approximation dictates a different equilibrium position than the traditional wage rate approach. In summary, the second order conditions for equilibrium are given in Table 2 within the usual bordered Hessian matrix form.

To simplify the bordered Hessian matrix, time value, family size, and spouse selection equations are converted into their reduced form equations equivalents by applying Cramer's rule to Table 2.

$$\begin{aligned} dV_T/dWR = \{\lambda[(\partial P_Z/\partial V_T)(\partial V_T/\partial WR)\cdot D_{26} + VAL_3\cdot D_{46} \\ + (\partial V_T/\partial WR)\cdot D_{36} + VAL_4\cdot D_{56} + VAL_5\cdot D_{66}] \\ - VAL_6\cdot D_{76}\}/D \end{aligned} \tag{2.17}$$

TABLE 2.2

SECOND ORDER CONDITIONS FOR EQUILIBRIUM

$$
\begin{vmatrix}
U_{XX} & U_{XZ} & U_{XL} & U_{XS} & U_{XN} & 0 & -P_Z \\
U_{ZX} & U_{ZZ} & U_{ZL} & U_{ZS} & U_{ZN} & -\lambda(\partial P_Z/\partial V_T) & -\{P_Z - P_Z[V_T(\theta,WR);S]\} \\
U_{LX} & U_{LZ} & U_{LL} & U_{LS} & U_{LN} & -\lambda & -V(\theta,WR) \\
U_{SX} & U_{SZ} & U_{SL} & U_{SS} & U_{SN} & 0 & VAL_1 \\
U_{NX} & U_{NZ} & U_{NL} & U_{NS} & U_{NN} & 0 & -(\partial P_N/\partial_N) \\
0 & -\lambda(\partial P_Z/\partial V_T) & -\lambda & 0 & 0 & VAL_2 & 0 \\
-P_X & -\{P_Z - P_Z[V_T(\theta,WR);S]\} & -V_T(\theta,WR) & VAL_1 & -(\partial P_N/\partial_N) & 0 & 0
\end{vmatrix}
\cdot
\begin{vmatrix} dX \\ dZ \\ dL \\ dS \\ dN \\ dV_T \\ d\lambda \end{vmatrix}
=
\begin{vmatrix}
\lambda \cdot dP_X \\
\lambda \cdot dP_Z + \lambda(\partial P_Z/\partial V_T)(\partial V_T/\partial WR)dWR \\
\qquad + \lambda(\partial P_Z/\partial V_T)(\partial V_T/\partial\theta)\cdot d\theta \\
\lambda \cdot (\partial V_T/\partial WR)\cdot dWR + \lambda(\partial V_T/\partial\theta)\cdot d\theta \\
\lambda \cdot VAL_3 \\
\lambda \cdot VAL_4 \\
\lambda \cdot VAL_5 \cdot dWR + \lambda \cdot VAL_9 \cdot d\theta \\
VAL_6 \cdot dWR + VAL_7 \cdot d\theta + VAL_8
\end{vmatrix}
$$

Where:

$VAL_1 = 24(\partial V_T^S/\partial S) - (\partial P_Z/\partial S)\cdot Z - (\partial L_S/\partial S)V_T^S - 2(\partial L_S/\partial S)(\partial V_T/\partial S) - (\partial V_T/\partial S)\cdot L_S + \partial Y^S/\partial S$

$VAL_2 = -\lambda(\partial^2 P_Z/\partial V_T^2)\cdot Z - (\partial^2 P_N/\partial V_T^2)$

$VAL_3 = (\partial^2 P_Z/\partial S\partial V_T)(\partial V_T/\partial WR)dWR + (\partial^2 P_Z/\partial S\cdot\partial V_T)\cdot(\partial V_T/\partial\theta)d\theta$

$VAL_4 = (\partial^2 P_N/\partial N\partial V_T)(\partial V_T/\partial WR)dWR + (\partial^2 P_N/\partial N\cdot\partial V_T)\cdot(\partial V_T/\partial\theta)d\theta$

$VAL_5 = [(\partial P_Z/\partial V_T)(\partial V_T/\partial WR)\cdot Z - (\partial P_N/\partial V_T)(\partial V_T/\partial WR)]\cdot dWR$

$VAL_9 = [(\partial P_Z/\partial V_T)(\partial V_T/\partial\theta)\cdot Z - (\partial P_N/\partial V_T)(\partial V_T/\partial\theta)]\cdot d$

$VAL_6 = [(24-L)(\partial V_T/\partial WR) - (\partial P_Z/\partial V_T)(\partial V_T/\partial WR)\cdot Z - (\partial P_N/\partial V_T)(\partial V_T/\partial WR)]\cdot dWR$

$VAL_7 = [(24-L)(\partial V_T/\partial WR) - (\partial P_Z/\partial V_T)(\partial V_T/\partial WR)\cdot Z - (\partial P_N/\partial V_T)(\partial V_T/\partial WR)]\cdot d\theta$

$VAL_8 = [X + (\partial P_N/\partial P_X)]\cdot dP_X - Z\cdot dP_Z + dY$

$$dN/dWR = \{\lambda[(\partial P_Z/\partial V_T)(\partial V_T/\partial WR)\cdot D_{25} + VAL_3\cdot D_{45} + (\partial V_T/\partial WR)\cdot D_{35} + VAL_4\cdot D_{55} + VAL_5\cdot D_{65}] - VAL_6\cdot D_{75}\}/D \quad (2.18)$$

$$dS/DWR = \{\lambda[(\partial P_Z/\partial V_T)(\partial V_T/\partial WR)\cdot D_{24} + VAL_3\cdot D_{44} + (\partial V_T/\partial WR)\cdot D_{34} + VAL_4\cdot D_{54} + VAL_5\cdot D_{64}] - VAL_6\cdot D_{74}\}/D \quad (2.19)$$

where D is the determinant of the bordered Hessian matrix and D_{ij} signifies the cofactors of the elements in the bordered Hessian principal diagonal matrix.

Because Willis provides a sound reasoning process for converting the above equations into elasticity form and plausible signs for the resultant elasticities, subsequent analysis concentrates upon the implications for future household demand research that is derived from the spouses presence and an endogenous time value. In general equations (2.17)-(2.19) are composed of own price, cross-price, and a Slutsky income effect, and in specific, the own price effects are identified when i = j in D_{ij}, the Slutsky income effect when i = 7, and the remaining components represent the cross-price effects.

C. Interpretation of Changes

1. Time Value Endogeneity

Equation (2.17) specifies the relationship between the current popular definition of time value--wage rates, and the alternative

offered here, V_T. Keeping the popular assumption that wage rates are exogenous in the presence of the assumption that time value depends upon factors other than just wage rates, such as hours worked and overtime pay, allows determination of the conditions under which the two approaches will diverge.

Foremost among the initial observations of equation (2.17) is the failure of wage rates to show a linear relationship with the value of time. Specifically, the results in equation (2.17) reduce to those presented by Willis only when time value is forced to equal wage rates, by setting $V_T = WR$, and $dV_T/dWR = 1$ throughout the model. As earlier sections have already presented theoretical and empirical arguments against this assumption, the remaining task is to summarize the normative, and most scathing, criticisms of this assumption. In a compendium of reviews on Linder's Harried Leisure Class time value and wage rates are shown to differ by a variety of authors because of individual preferences for work, leisure, and home activity. For example, Phelps cited the utility generating nature of long periods of work, while others indicated an attempt to minimize work loads in order to increase their utility level. All of the opinions suggested that not only does $dV_T/dWR \neq 1$, but that the exact degree to which V_T and WR deviate varies from one individual to another.

In order to maintain continuity with wage rate time monetarization, the hypothesized relationship between V_T and WR is assumed to be positive, or $dV_T/dWR > 0$. However, even when the positive relationship holds, household demand reaction to the two measures can differ

significantly. In the family size equation (equation (2.18)), the relationship between V_T and WR enters into the own price, all the cross-price, and the Slutsky income effect. Therefore, following standard neoclassical theorics belief in a positive income effect, a negative own price effect and negative cross-price effect for normal goods, some possible scenarios can be analyzed. However, first note that the negative sign assumed for cross-price effects in general, and home produced goods in specific, is questioned by Duesenberry's and Gregory's argument that standard-of-living cannot be substituted for children. Rather, quality expenditures are not discretionary because children receive the benefits from their parents' chosen life style. Readers wishing to follow this line of reasoning can easily alter the following analysis to assume complementarity.

If $dV_T/dWR > 1$, then the wage rate time valuation <u>understates</u> time prices effect upon family size and incomes effect on expected family size is <u>overstated</u>. The exact magnitudes of the income effects overstatement and price effects understatement could cancel the potential error. But since no a priori reasons exist to believe that these errors will sum to zero, wage rate time valuation erroneously predicts family size adjustments depending upon whether the price or income effect dominates.

Perhaps the real failing of the assumed positive, linear relationship between wage rates and time value can be illustrated in the familiar setting of a backward bending supply curve. At some point along the labor supply curve the decline in labor force activity as wages rise

implies a reduction in the opportunity cost of time. This paradox--a higher wage rate and reduced time value--cannot be explained since the wage rate model has not established a causal relationship between leisure and work. Instead, the general time valuation model explains the shift from work to leisure by the absence of any restriction on the magnitude and sign of dV_T/dWR. Given the conditions determined by θ, the dV_T/dWR sign can take on a positive value when the opportunity cost of working dominates, and a negative sign when the utility obtained from leisure exceeds work benefits.

Another issue raised by the preceding discussion concerns the rate of change between the alternative time value measures. Time value and wage rates are linearly related only when the nonnegativity implied in neoclassical diminishing marginal utility theory becomes applicable to household demand theory. If not, monetarization of time spent in any activity at a linear rate overstates that activity's actual value to the individual. The linearity condition implies that $d^2V_T/dWR^2 = 1$. In lieu of the normative arguments of Phelps and others plus the findings specified earlier, the expected rate of change in utility generation is expected to diminish as additional time is allocated to any given activity. Depending upon the actual rate at which utility diminishes, wage rate time valuation further overstates changes in the consumption bundle. Although wage rate time valuation is anticipated to differ from the general measure proposed here, the actual magnitude cannot be determined until both techniques are compared empirically.

2. Spouse Effects

To establish the degree to which the spouse affects the female's utility determinants, the cross-price effects between the spouse and female's time (equation (2.17)) and child selection equation (equation (2.18)) can be evaluated. In both equations, the spouse effect enters as a determining factor through VAL_3. Specifically, the element $VAL_3 = (\partial P_Z/\partial S \partial V_T)(\partial V_T/\partial WR)$ indicates that the change in the female's time value stimulated by a wage rate shift affects the husband inspired marginal home produced goods expenditures by the first order partial derivative condition. In the child demand equation, a positive coefficient for VAL_3 weighted by $(\lambda \cdot D_{45})/D$ suggests an increase in family size since the positive sign makes the two complements, and therefore raises the female's utility level depending upon the formal relationship between N and utility. Conversely, a negative signed magnitude makes the husband and children substitutes in utility formation. The actual relationship between husband and children may be positive for the initial decision to bear children because of socially imposed mores which bestow approval upon married mothers and stigmatize fatherless children. However, the shift in time allocated from the spouse to the newborn child could reverse this sign.

A mathematical expression in which the cross-price effect for children determined by VAL_3 produces a family size that does not equal the family size levels predicted from the woman's price and income effects, gives content to observed interaction among married couples to determine individual utility levels. If $VAL_3 \neq 0$, then the husband will

have imposed an equilibrium position upon the wife which is not equivalent to equilibrium when utility independence is assumed. As expected from standard maximization theory, addition of constraints produces an equilibrium position which lowers the optimizing consumption level.

Determining the sign of VAL_3 depends upon the relative strength of Becker's complementarity argument for marriage--spouses are acquired to obtain societies acceptance for child conception--relative to the extent to which children are substitutes for other commodities. Thus, the spouse's effect upon child acquisition depends upon their direct impact upon the wife's attitudes and their indirect effect upon other expenditures, e.g., home produced goods. Although these relative magnitudes have never been empirically determined, the child number equation does not reduce to an equation equivalent to those found by Willis except when VAL_3 approaches 0. The term VAL_3 has never been empirically tested because existing research has always assumed it was zero. But given the prominent position accorded husband's income and attitudes in the existing labor supply and fertility literature suggests that the likely spouse effect upon woman's utility is <u>not</u> zero. To assume that it is zero makes theory and its empirical expression inconsistent.

Again, these mathematical results find important differences between the female's unconstrained and constrained response pattern. This shows that the assumption of utility independence provides an erroneous base for subsequent household demand analysis.

3. Other Effects

One final observation bears upon the current disagreement over

the "true" child income elasticity. Estimated elasticities in the negative and low, positive range have led Becker-Lewis and others to reason that the failure of these empirical results to produce an elastic income demand is caused by a negative or low, positive quantity demand elasticity interacting with the elastic quality demand. Therefore, only by separating quality and quantity can the "true" income elasticity be ascertained. Another interpretation proposed here suggests that one other possible cause of the low elasticities arises from the failure to distinguish between the human capital and the non-human wealth income components in the income constraint.

Applying Barzel-McDonald's equivalent arguments for labor participation to a time value formulation which depends upon factors other than wage rates implies that changes in human capital income levels shifts the budget constraint and the relative prices of goods that are dependent upon the same time value measure. Thus, human capital income represents price as well as income constraint shift. Conversely, non-human capital movements, dY and $dY^S(S)$, do imply a straight change in the budget constraint. The different response patterns to human capital and net asset income can be illustrated in the child selection equation. Net asset income acts only on the total income elasticity level, whereas the human capital position also alters the own and cross-price effects. One possible event could find negative human capital coefficients for dN/dWR and a positive sign for the non-human income figure. Depending upon the irrelative magnitudes, empirical studies using different data

bases could find both positive or negative child income elasticities.

The division between human and non-human capital income, if any, usually occurs early in theoretical studies. Later the two income concepts are aggregated in the final analysis, such as Becker, Becker-Lewis, Willis, and others. In VAL_8, the change in assets--or the straight shift in the budget constraint--is represented by dY, while the human capital income portion is represented for the female and male members by VAL_6 and VAL_7, respectively. These results have remained separated in order to provide a basis for empirically testing each income measure's impact upon family size and labor force participation.

IV. Summary

The model developed here partially advances the current state of household demand theory by relaxing the restrictive utility independence assumption and providing a flexible time value measure. Assigning to individuals attitudes that stem wholly from the satisfaction of selfish factors as the primary reason for household formation, and then ignoring these selfish patterns after household formation occurs is, at best, inconsistent and, in actuality, a failure of current theory to fit economy theory to the family instead of molding the family in the image of economics. The results obtained earlier show that rearranging household demand for purposes of economic analysis is unnecessary when a more detailed specification is undertaken.

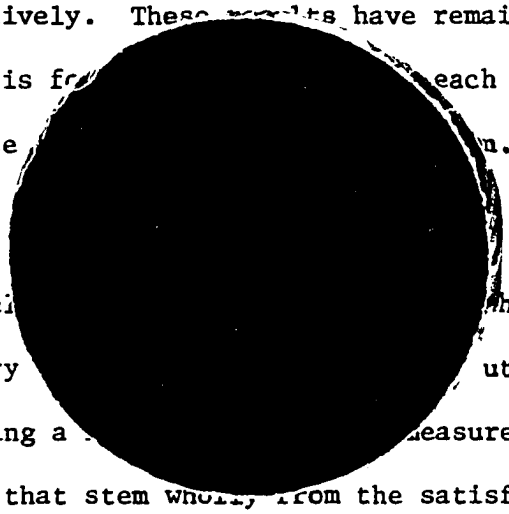
Among the significant deviations from existing research are explicit consideration of alternative reasons for forming multi-member

the "true" child income elasticity. Estimated elasticities in the negative and low, positive range have led Becker-Lewis and others to reason that the failure of these empirical results to produce an elastic income demand is caused by a negative or low, positive quantity demand elasticity interacting with the elastic quality demand. Therefore, only by separating quality and quantity can the "true" income elasticity be ascertained. Another interpretation proposed here suggests that one other possible cause of the low elasticities arises from the failure to distinguish between the human capital and the non-human wealth income components in the income constraint.

Applying Barzel-McDonald's equivalent arguments for labor participation to a time value formulation which depends upon factors other than wage rates implies that changes in human capital income levels shifts the budget constraint and the relative prices of goods that are dependent upon the same time value measure. Thus, human capital income represents price as well as income constraint shift. Conversely, non-human capital movements, dY and $dY^S(S)$, do imply a straight change in the budget constraint. The different response patterns to human capital and net asset income can be illustrated in the child selection equation. Net asset income acts only on the total income elasticity level, whereas the human capital position also alters the own and cross-price effects. One possible event could find negative human capital coefficients for dN/dWR and a positive sign for the non-human income figure. Depending upon the irrelative magnitudes, empirical studies using different data

bases could find both positive or negative child income elasticities.

The division between human and non-human capital income, if any, usually occurs early in theoretical studies. Later the two income concepts are aggregated in the final analysis, such as Becker, Becker-Lewis, Willis, and others. In VAL_8, the change in assets--or the straight shift in the budget constraint--is represented by dY, while the human capital income portion is represented for the female and male members by VAL_6 and VAL_7, respectively. These [illegible] have remained separated in order to provide a basis f[illegible] each income measure's impact upon family size [illegible].



The model devel[illegible] the current state of household demand theory [illegible] utility independence assumption and providing a [illegible]easure. Assigning to individuals attitudes that stem wholly from the satisfaction of selfish factors as the primary reason for household formation, and then ignoring these selfish patterns after household formation occurs is, at best, inconsistent and, in actuality, a failure of current theory to fit economy theory to the family instead of molding the family in the image of economics. The results obtained earlier show that rearranging household demand for purposes of economic analysis is unnecessary when a more detailed specification is undertaken.

Among the significant deviations from existing research are explicit consideration of alternative reasons for forming multi-member

households besides the conception of children. In this model, the spouse is viewed as a utility generating factor apart from their usual specification as a complementary item in the production of children, production of other household items, and an income resource. In short, the work of Becker, Gronau, Freeden, and Keely are assumed to be a special case in the process of household decision-making.

For fertility and labor force activity, the discussion follows existing lines of thought in main, although different conclusions are reached about the optimal allocation of resources as result of endogenizing time value. In particular, the optimal number of children is seen to depend upon marginal changes in time costs and marginal changes in the cost of other goods, not just price and income effects. Similarly, labor force activity conclusions differ from existing studies as a result of these same changes. The following chapters empirically test the importance of these alternative points of view.

CHAPTER III

ESTIMATION OF THE TRADITIONAL MODEL

I. Introduction

Based upon existing criticisms of the "new household demand school" of thought's purely economic analysis of household demand, the five equations--a marital discriminant equation, spouse selection equation, the labor force participation discriminant decision, hours worked equation, and finally a child stock equation--are estimated using non-economic as well as economic determinants to test the validity of these criticisms. Among the major changes from current empirical studies is a direct measure of psychological preferences, and formal consideration of black-white sociological differences in household demand patterns. Specifically, the criticisms by Leibenstein, Griliches, and non-economists of studies using only economic variables to determine fertility, labor force patterns, and marriage, and by Gregory of the failure to include separate factors affecting racial demand are formally evaluated. Because the estimated equations combine several areas of household demand theory which typically have been studied independently, the equations are restricted to a "traditional" specification in order to illustrate the relative importance of psychological and sociological household demand determinants vis-à-vis the traditional economic determinants. Traditional means that the general time valuation procedure

and alternative estimation methods will be delayed until the next chapter. This chapter uses wage rate time valuation and ordinary least squares estimation in order to emphasize the interaction among psychological, sociological, and economc variables in household demand formation.

In Section II the data base is discussed in relation to its impact upon the empirical results. Section III develops the arguments for individual equation specification, and Section IV presents and intercepts the empirical results. Section V summarizes the major conclusions derived from the empirical work.

II. Data Source

The National Longitudinal Survey (NLS) began as a Department of Commerce operation to study the labor force patterns of middle-aged males. Announcement of the study plans produced pressures from such a variety of sources that the sample was extended to include men from the ages of 14 to 24 and two female samples: 14 to 24 and 30 to 44. Designed to be an ongoing project after its initiation in 1967, three complete years (to 1970) are now available for commercial uses with the 1971 and 1972 information schedules for sale in early 1975 by Ohio State University.

The advantage of the longitudinal panel survey approach over cross-sectional data and aggregate time series are severalfold. In both aggregate and microeconomic cross-sectional data, the validity of any model rests upon consistency of the variables in cyclical and secular variations. Existence of disequilibrium in the relevant markets implies future adjustment on the part of the affected variable which may not move in accord with the remaining variables. Should such a disequilibrium

arise, the justification for using cross-sectional data--as an approximation of long-run relationships--becomes untenable. The NLS survey data partly compensates for this potential error by including comprehensive data on labor force, marital, and fertility variables for years preceding 1967 as well as information on subsequent activity. Availability of this longitudinal information minimizes the bias associated with market distortions as long as the analysis of the structural relationships is limited to the short-run.

Unfortunately the NLS survey data possesses potential sources of error that are concurrently solvable and unknown. The solvable error source stems from variations in individual preferences and characteristics among regions. In microeconomic data failure to account for regional differences leads to biassed but consistent estimates when the misspecified variable is uncorrelated with the error term and both biassed and inconsistent parameters when the residual is correlated with the misspecified variable. Although the location of the survey respondents is known to the collector, the Department of Commerce refuses to reveal the state, much less the city, of residence--regretfully of course--on the grounds that the detailed nature of the sample would enable an unscrupulous user to discriminate against the respondent. So, the absence of locational information is acknowledge here as a possible source of error that is curable with existing information.

Another limitation attributable to data uncertainty is the exact nature of the sampling procedure. Official proclamations state that

respondents were randomly selected from a list of U.S. residents used by the Department of Commerce. Since the nature of the list is unobtainable, inferences about the population from the sample results must be made with caution until the samples relationship to the population has been documented in greater detail.

In spite of the weaknesses of the data, the NLS survey information is still superior to alternative sources of data dealing with household decision-making and formation by virtue of its longitudinal nature. As such, its weaknesses are duly noted, but the offsetting benefits should not be forgotten.

III. Equation Specification

The ordinary least squares (OLS) estimates for the five equations and their exact specifications are detailed under separate headings below. In general, existing economic equation specifications have been followed as much as possible except for addition of attitudinal variables and an analysis of covariance variable (0 for white and 1 for black) to measure differences in racial demand patterns.

A. Marriage Discriminant Equation

The marriage discriminant equation determinants are assumed to be the attitude toward children (ATC), attitude toward housework (ATH), attitude toward working (ATW), residence at age 15 (R15), parental marital status at age 15 (P15), woman's education level (ED), woman's wage income (WY), and the analysis of covariance race variable (RD). The exact function and variable definitions are given in equation (3.1)

as:

$$MD = F_1(ATC, ATH, ATW, P15, R15, ED, WY, RD) \qquad (3.1)$$

where MD = 0 when unmarried and 1 when married

ATC = scaled variable from 1 to 5 with 5 representing a strong desire for children

ATH = scaled variable from 1 to 5 with 5 representing a strong preference for housework

ATW = scaled variable from 1 to 5 with 5 representing the strongest preference for working in the labor force

P15 = 0 when residing in rural area at age 15 to 1 when located in an urban environment at age 15

R15 = 0 when parents were still married at age 15 and 1 when not living together at age 15

ED = number of years of school completed

WY = woman's wealth

RD = 0 when woman is white and 1 when the woman is black

and the sample is limited to those women currently married or never married.

Because women with positive preferences for homemaking can increase their marginal productivity through marriage an efficient allocative process should produce a positive coefficient for ATH, ceteris paribus. However, the importance of the ceteris paribus assumption can be illustrated by acknowledging the role of the corresponding work

attitudes and monetary incentives for labor participation. If the woman works, she can participate in home production on a part-time basis, use the remaining time for market activity, and then allocate a portion of her monetary earnings to purchase labor saving mechanical goods or actually hiring other laborers to perform these household activities. That is, this explains the phenomenon of working women hiring maids or the acquisition of time reducing market goods, such as microwave ovens. Thus, women with inclinations toward both home and market production maximize their utility by expending time in both endeavors. Though the net effect of ATH upon marriage should still be positive, the magnitude will vary according to the strength of these relative effects.

As a result of the socially imposed more that bestows approval upon married couples' children and is critical of fatherless children, child attitudes will be positive and have a magnitude that depends upon the importance attached to this social force. Of special interest in household research is the extent to which the "promiscuous" age alters ATC's effect upon the marital decision. One view argues that the net effect of "free love" will be to make this constraint ineffective by breaking down the socially imposed relationship between marriage and child acquisition to the point marriage will no longer be a prerequisite for child birth.

An alternative proposition suggests that the real impact of "free love" will only be increased premarital experimentation, and does not necessarily imply a reduction in the importance of the association

between marriage and fertility. Advocates of the former position cite the increase in the absolute number of unwed mothers for support, while the latter claim more unwed mothers are observed because emphasis on the premarital pregnancy problem has produced detailed data which escaped earlier studies and women in the age group prone to premarital sexual activity have increased.

Given the limitation of the NLS sample used here to women in the 30 to 44 age group, the reported empirical results should represent an upper bound for the magnitude of the parameter estimates--with the difference between the estimated and actual values varying according to the strength of the "free love" effect.

Interpreting the attitude toward work coefficient involves determining whether a woman with a high preference for working will substitute labor force activity for marriage, or will view marriage and labor force activity as complementary activities. Existence of a negative coefficient will support the position taken by the "male chauvinists" that women marry to escape the necessity of having to support themselves. Conversely, an indication of a strong preference for labor force participation and a negative coefficient supports the "woman's libbers" position that women suppress their labor force preferences in order to satisfy the demands of their husband and children.

While the foregoing analysis explains the extreme points of the opposing positions regarding labor force attitudes, dual activity of women as both a laborer and a mother-housekeeper remains to be explained as either a logical chain of events or some incongruous activity.

Positive coefficients for ATW and ATH would support a hypothesis that many women derive satisfaction from participating in both the labor force and having a family. The often assumed hypothesis that women work part-time solely for economic reasons would be contradicted by positive ATW and ATH estimates. Because psychologists and sociologists have pointed out the need for some women to "get out of the house and into meaningful activity," positive coefficients are expected to occur on an a priori basis.

A second use of the attitude coefficients involves comparison of their signs and magnitudes to test for internal consistency among the woman's attitudes. For instance, a woman expressing a strong preference for children should also be expected to have at least a mild preference for housework since the two decisions are concomitant. Similarly, a positive preference for children and work, and a negative desire to participate in housework leads to the situation of a working mother. The mixture of attitudinal variables suggests that a woman may limit her activity to either the home or work force because of the family's economic position, institutional regidities, or family demands even though she receives satisfaction from both household activity and labor force activity. The relative magnitudes of the economic and attitudinal variables in the empirical results will determine their relative explanatory importance.

With regard to the residence at age 15 dummy, Becker, Keely, Frieden, and Gronau observe variations in the decision to marry according

to whether they reside in either a rural or urban setting; specifically the assumed higher proportion of married populace among rural dwellers is derived from a cultural setting where women are encouraged to form their own households to a greater extent than urban dwellers and from market conditions where the range of prospective spouses is limited. Both effects should produce negative coefficients.

The parent's marital status can either reduce the probability that the child will marry if the child reacts adversely (a negative coefficient), or increase the probability if marriage is viewed as a mechanism for removing themselves from this situation (a positive sign). One factor limiting the definitive interpretation of a positive coefficient involves the compatibility of the original parents; for if their parents did not interact in an agreeable manner, then the impact upon the child may be worse than dissolution of the marriage. Unfortunately, data limitations do not allow a ready solution to this problem.

Finally, the socioeconomic variables of female income, education, and race dummy account for the ability to support oneself without the aid of a husband, the ability to obtain and interpret information about the marriage market, and sociological variations in the marriage decision, respectively. More specifically, one of Becker's hypothesized advantages to marriage for low wage earning women is access to individuals with a relatively higher wage income. In essence this view suggests a "why work if you can get someone else to do it for you" attitude. Thus, higher wage income women will have a greater incentive to remain single than lower wage women.

Reactions to marriage caused by changes in education levels remains uncertain because little empirical work has been performed on the subject to date. Both Frieden and Keeley use education as a determinant of the age of marriage and the marriage rate, respectively, and find a positive coefficient in both situations. Education affects marriage in two ways: by altering marginal productivity capabilities and by increasing the ability to acquire and understand market information. The expected positive relationship is founded upon Becker's assertion that higher educated individuals can realize greater gains from specialization than relatively lower educated individuals, and, as such, should respond to these potential gains by entering the marriage market.

Significant differences among the two socioeconomic groups will be illustrated by the sign and magnitude of the RD coefficient. Occurrence of a positive sign means black women have a higher probability of marriage than white women of similar characteristics. A negative sign indicates just the opposite, cateris paribus. Dominance of either position has yet to be ascertained by marriage theorists. On one hand, the black female is supposed to react positively to the institution of marriage as a mechanism for removing her from an overcrowded environment and encouraged by her parents to do so to alleviate parental financial responsibilities. On the other hand, the capability of potential spouses to satisfy these demands dictates a sign reversal. Reconciliation of these two possibilities is the purpose of this analysis of covariance variable.

B. Assortive Mating Equation

Specifying choice of spouse requires an initial determination of the traits a woman might emphasize in deciding upon a mate. Among the likely possibilities determined from a multitude of surveys on what women look for in a husband are the male's income, education, state of health, and various attitudes toward women and their roles in society. Other possible factors women might look at are the amount of time spent working and the positive externality accruing to the wife of husbands in prestigious positions. In the former case the unpleasantness of being married to a work "freak" has been well-documented in the psychological literature. However, in economic terms the wife fails to receive many of the benefits of marriage when the husband allocates his time to activities other than the family. As such, the wife is placed in a situation where the spouse provides material wants, but none of the wife's emotional needs. The prestige factor is exemplified by the status attached to wives of politicians, athletes, intellectuals, etc.

Because a multitude of factors partly determine the "desirability" of a particular male, use of any variable by itself will fail to incorporate all of the potential husband's traits. Instead of arbitrarily choosing a particular variable, such as income, all of the variables discussed above or their reasonable proxy are combined in a factor analytic manner to create a quality index. The specification of the factor analysis procedure is presented in equation (3.2) as:

$$S = F_2(HY, HED, HAT, SOHH, HW, OC) \qquad (3.2)$$

where S = the index of spouse quality resulting from the factor analysis

HY = male's income

HED = male's education

HAT = male's attitude toward women working

SOH = male's state of health

HHW = hours worked on the job daily

OC = occupation code of the male

Variable HAT represents the man's attitude toward the wife's labor force activity. A strong dislike for working women may indicate a general "male chauvinist" view, while a moderate or liberal stance illustrates a more flexible position.

After the quality index, S, has been obtained, the second and larger issue involves explaining the importance of particular female characteristics in the mating process. The variables are divided into attitudinal, family background, and socioeconomic categories as before, and listed in equation (3.3) as:

$$S = F_3(ATW, WY, ED, FOC, FED, SOH, RD) \quad (3.3)$$

where all of the variables are defined as before. FOC = father's occupation code and FED = father's education.

Inclusion of the variables ATW, WY, ED, and RD is justified for reasons similar to their inclusion in equation (3.1). Attitude toward work captures the positive association between women who enjoy working and males with more tolerant attitudes toward their wives working.

Dissimilar attitudes toward working does not always mean that a successful marriage is impossible. Given the ceteris paribus assumption, women who have high preference for remaining in or entering the labor force are unlikely to marry someone with a complete "male chauvinist" attitude or believe that "the woman's place is in the home."

Analysis of the potential positive causality flowing from wife's income to spouse quality can be seen from several directions: 1) higher wage earning women possess an asset--their wage earning potential--that is the 20th century counterpart to the dowry in earlier time periods; 2) the higher wage also enables the female to attain a higher degree of self-sufficiency in the search process for a husband, or in Becker's terminology, the woman has the opportunity to gather more information about the workings of the marriage market; and 3) a higher wage income transforms what may have been an otherwise normally desired woman into an asset producing commodity useful to higher quality men. Each of these three cases suggests a positive connection between spouse quality and the woman's wage income.

As education has been shown to alter preferences for children and augment the ability to assimilate and utilize market information in the fertility literature, it is assumed to do so here. Likewise, the gain in marriage market information that results from marginal increases in education reinforces the positive relationship between marriage and fertility as long as the female can capitalize upon her enlarged capacity to understand the vagaries of the market.

The dummy for racial composition will bear a negative sign if black males can be considered to be lower quality spouses for whatever reason. Although the negative coefficient is plausible given the specification in equation (3.2), it is counterintuitive to acknowledged positive preferences among races and cultures to marry within their well-defined group. This failing represents one weakness of the analysis of covariance approach. Instead, empirical measurement of the strength of racial effects awaits separate estimation in the black-white samples.

The final two variables, FOC and FED, capture P. Jacobsen's suggested parental influences upon their children's preferences for a husband by identifying surrogates for the characteristics of the woman's father, such as "I want a man just like dad" attitude hypothesis. The original hypothesis predicted a positive relationship between father's characteristics and the eventual spouse. But, since this proposition was based upon a congenial father-daughter association, the dual hypothesis that an inverse connection between father's characteristics and the chosen spouse could transpire when the daughter did not get along with her father. Though both variables are incomplete proxies for the female's attitude toward her father, they provide quasi-acceptable variables for testing the impact of the father upon his daughter's mate selection.

C. Labor Force Discriminant Function

Specification of the decision to enter the labor force or remain at home follows traditional labor theory by including racial-cultural

composition variables, income of both husband and wife, education, and transitory income payments. Non-economic determinants include measures of female responsibility in the home, various attitudinal variables regarding work preferences, marital stability and duration, and the respondent's health.

The included variables and equation specification are detailed in equation (3.4) as:

$$LPRD = F_4(C_{0-5}, LPRD_{-1}, HWY, ED, PC, ATW, SOM, SOMA, SOH, RD, WR, HATW) \quad (3.4)$$

where LPRD = 0 - 1 dummy for labor force participation

C_{0-5} = family responsibility defined as the number of children between the ages of 0 - 5

$LPRD_{-1}$ = labor force status in the previous year

HWY = husband's wealth income

PC = 1 if the wife has a professional certificate

SOM = 0 - 1 dummy for stability of marriage

SOMA = duration of marriage

WR = hourly wage rate of woman

HATW = husband's attitude toward the wife's working

and the remaining variables are defined as before.

The two pure deterministic variables are the market wage rate and husband's wealth income: the former variable representing the market's bid for the woman's services, and, as a proxy for time value, represents the cost of alternative uses of time (a substitution effect).

Wealth income explains the necessity of female labor participation in order to obtain a given standard of living. The expected sign for the former variable is positive, while the latter variable can be either positive or negative depending upon whether labor force activity is a superior or inferior good.

Of the remaining variables, ATW, HATW, and RD measure the woman's preferences for work, the husband's reaction toward his wife's labor force participation, and whether a higher proportion of black women participate in labor force activities than white women. Though education continues to have an expected positive relationship with labor force activity, the presence of a professional certificate, PC, signifies the potential low return from human capital investment expenditures in higher education as a result of subsequent decisions to leave the labor force.

Although Cain popularized including family size as a determinant of labor force activity, recent work by Gregory demonstrated that a total family size variable is inadequate for reasons illustrated in Chapter I, section II, part C. The stock measure of family size is deficient because it assumes that the value of mother's time inputs per child are constant regardless of the age and number of children. Gronau's illustrations that because the peak time costs of children occur in the early stages of growth time costs of caring for children vary inversely with age and decline thereafter. Thus, any increase in the number of children between 0 - 5--a proxy for the maximum time input--raises the value of the mother's home production, and, therefore, reduces the probability of labor force participation.

Finally, one of the unanswered questions in labor force studies using aggregate data is the failure to measure individual labor force movements over periods of time. As Ben Porath states, "With a 60% participation rate in one year, the question is 'are the same 60% in the labor force the next year, or have some of the 40% not in the labor force replaced some of the workers in the labor force?' Consequently, considerable movements can take place in individual members of the labor force which is not shown in the aggregate data." By including the dummy variable for women in the labor force in the previous year, $LPRD_{-1}$, a positive coefficient less than 1 indicates the percentage of the current labor force that was also in the labor force a year ago. Parameter estimate approaching the 0.6 to 0.8 values calculated from aggregate data will substantiate Ben Porath's hypothesis that significant movements of the labor force occur each year which are not explained by aggregate data.

D. Hours Worked Equation

The hours worked determinants emphasize the costs and benefits accruing to an individual for working a certain number of hours given their physical capability and need to do so. Among the choice of determinants of time spent at work are the variables detailed in equation (3.5) as:

$$HW = F_5(WR, OTP, DCW, ICW, CC, PERY, ED, SOHH, ATW, HW_{-1}, RD) \qquad (3.5)$$

where HW = usual number of hours worked per day

OTP = scaled variable of overtime pay schedule

DCW = direct cost of working as measured by transportation and time cost of travelling to work per day

ICW = other costs of working per day

CC = daily child care costs

PERY = total wealth of family

and all other variables are defined as before.

The wage rate coefficient in the hours worked function will be positive when the income effect dominates and negative when the substitution effect is preeminent. Though the backward bending labor supply schedule was originally developed for the primary labor force, Wachter's empirically derived conclusion that the inflexion point for the backward bending portion of the labor supply curve occurs at a relatively lower wage than the similar position for the primary labor force makes the issue equally important for secondary labor force analysis. As such, positive and negative coefficients are not only deemed possible, but a negative sign has a higher probability of occurring.

The second wage factor usually cited as a determinant of hours worked is the pay scale for overtime work. For individuals with similar socioeconomic conditions, the one who can avail himself of double time pay is expected to work more hours than the straighttime overtime recipient. Another monetary time worked determinant—originally suggested by Barzel-McDonald and is proxied here by PERY--uses the family's level of wealth to explain differential labor response patterns among

wives with equivalent attitudes and socioeconomic conditions. In essence, Barzel-McDonald argue that women possessing significant family assets or wealth have more flexibility in time spent at work owing to the economic security provided by their asset position. With a relatively secure base for preserving the family's needs, the woman can adjust her hours of work without having to worry about the possible ramifications of job loss. She doesn't have to be a "job taker," but can pick and choose time requirements that correspond to her preferences. The sign of PERY is indeterminant at this juncture because no empirical research has been performed on the effects of family assets upon hours worked for the secondary labor force and because the theory merely acknowledges that the coefficient can bear any sign.

Perhaps the most significant failing of current labor supply empiricism is the absence of cost in the labor decision-making process. Currently, theoretical analysis of secondary labor force supply response functions emphasizes the corresponding benefits of working except to note that each hour of work represents an equivalent loss of leisure. Since participants in the labor force do incur monetary costs, failure to account for these costs in any cost-benefit calculations of labor force activity overstates the returns to working.

On the cost side three measures are specified: 1) the direct cost work as measured by the actual cost of commuting to and from work; 2) the indirect or time cost of travel valued as time spent commuting, and 3) the daily cost of child care for women with children. Cost theory suggests that increases in the cost of working are associated with

a corresponding decrease in hours worked for all three variables. However, the backward bending supply curve's existence suggests that the sign could be reversed if the labor participant is operating on the negatively sloped portion of the labor supply curve. That is, an increase in costs requires an increase in hours worked in order to recoup the expected monetary loss. If a net wage income is the relevant determinant of hours worked, a rise in any of the three costs elicits a negative sign. The individuals apparently maintain net earnings by reducing their work effort, or move to the right on the backward bending portion of their supply curve. When opposite signed coefficient occurs, the individuals can be placed on the positively sloped portion of the labor supply curve.

Of the remaining variables, education is included as a measure of the investment in human capital that alters preferences for work; state of health captures the constraints upon working imposed by physical limitations; attitude toward work represents psychological attitudes toward labor force activity; and hours worked lagged one period captures the stability of the participant's work activity. The expected signs are positive for ED, ATW, and HW_{-1}, and negative for SOH.

E. Family Size Equation

Equation (3.6) defines the fertility as the stock of children ever borne in order to make better use of the information available in the National Longitudinal Survey data. The specification of fertility determinants follow past research plus the inclusion of psychological and new opportunity cost variables as detailed in equation (3.6):

$$FS = F_6(ATK, WR, PERY, ED, EDM, ECC, AOM, \#MK, RD) \qquad (3.6)$$

where FS = the number of children ever borne

#MK = # number of years between marriage and first child

ECC = number of years of education anticipated for children

AOM = age at first marriage

and the remaining variables are defined as before. To prevent possible biassed results caused by incomplete families in the sample data, the data is limited to families where the woman is over 40 years of age or the youngest child is over 4 years old.

The wealth variable, PERY, in included to account for the positive income effect upon fertility. Permanent income is used in place of measured income for the same reasons that permanent rather than measured income is included as an argument in the aggregate consumption function, i.e., a family's fertility decisions will be based more upon its estimate of average income over a period of time rather than on current income. Thus, a family with low-measured but relatively high permanent income is assumed to exhibit a fertility pattern which differs from a family with both low-measured and permanent income.

Inclusion of the wage rate variable represents one opportunity cost of rearing and caring for children. Cain argues that the "single most important price associated with children appears to be the price of the mother's time." The proxy for the value of time is an incomplete proxy for the opportunity cost of children because it ignores the necessary time required to raise children of different ages. In spite of

this deficiency the wage proxy is used in initial computations due to its popularity in the current literature and as a basis for evaluating the general time valuation procedure developed in the following chapter. Nevertheless, the wage rate valuation of time is accurate to the extent that the female's withdrawal from the labor force to bear and raise children involves a loss of income.

Other costs of children are measured in this model by the anticipated number of years of education for all the children in the family. Although some of the burden of the educational expense is borne by the public sector, the family does invest their own time and money into the educational process. Therefore, the effect of raising the anticipated level of education upon family size is negative, ceteris paribus. The inclusion of education is justified on the grounds that education will not only affect the family's utility function concerning additions to the family, but also will affect the family's ability to enforce such decisions insofar as some education is generally required to acquaint oneself with and practice birth control techniques, especially in the absence of government sponsored educational programs. Educational levels of the male and female are separated for two reasons: 1) past research has shown that female education is negatively related to fertility, but the causality between male education and family size has yet to be ascertained, and 2) the existence of family disagreement over the "proper" family size could have a significant impact upon eventual family size.

With respect to the effect of husband's education upon family

size, the a priori reasoning suggests that higher education reduces the total number of children desired. However, the negatively signed coefficient for female education is partially based upon the argument that more education reduces the preferences for children by increasing the woman's awareness of other possible activities foregone in the rearing process. In the man's case, more children may change his overall expenditures of time owing to his smaller time inputs in the child raising process. Instead, the father invests bulk time allotments by taking all of the family to the park, circus, show, or function the family desires. As such, higher levels of education for the male may produce a positive effect upon family size. Although this possibility does exist, empirical settlement of the issue has yet to be obtained.

The woman's psychological attitude toward children determines the utility derived from her production of goods and services for their maintenance. Mothers with high preferences for children should be the ones who bear and rear a larger number of children to the extent that children are utility generating factors.

The age of marriage and the number of years after marriage that the first child was born represent the tendency for couples who marry early to have larger families and couples who delay the arrival of their first child to have smaller families, respectively. In the former case the expected sign is positive, while the delay between marriage and child birth should be negative. The addition of these variables along with other non-economic variables provides a truer picture of the importance of economic variables in fertility determination.

Finally, the race dummy tests the influence of racial factors upon family size. If black families have larger families, the coefficient of the dummy variable will be positive. While this approach is informative about racial differences, separate models for white and black samples are estimated in Chapter IV to determine how much information is lost in the analysis of covariance approach.

IV. Empirical Results and Interpretation

Equation (3.1) and equations (3.3)-(3.6) are estimated by ordinary least squares (OLS) in order to make the estimated results in the traditional model presented here comparable with previous empirical studies. A simultaneous equation estimation procedure was not adopted for two reasons. At a theoretical level, the theory developed in Chapter II, and given empirical content in Section III of the chapter, concerns decisions made by the individual over the course of, roughly, a twenty year time span. The decision to marry and choice of spouse occur in the late teens or early twenties for most individuals; labor force activity and hours worked involve yearly decisions; and the selection of the optimal family size is a decision that is made later in life. In essence, the "life-cycle" nature of the model developed here typifies Wold's arguments against simultaneous equation estimation procedures. At an empirical level, unpublished research by the Wharton macroeconometricians finds that the benefits to deriving consistent estimators has been overstated in the literature relative to the costs of obtaining them. The product of this line of research has been a return to the OLS form of estimation for many of the Wharton model equations.

Following the line of reasoning discussed above, the parameter estimates, their significance level, a coefficient of multiple determination adjusted for degrees of freedom, F - statistic, and observations are presented for each equation. The results of the factor analysis used to construct the spouse quality index is excluded due to its lack of content for economic analysis. However, for the interested reader, the orthogonal rotation by the varimax criterion of the original factor leading matrix produced one factor that explained 91.3% percent of the variation, and each original variable had a high enough communality with the factor to be considered part of that factor.

Contrary to time series analysis in which secular components in the data produce significant R^2's and aggregate cross-sectional data where reduced variability in the determined variable caused by the aggregation process leads to a high goodness-of-fit, the absence of secular elements and more variability combine to produce lower coefficients of multiple determination. As such, published R^2's using detailed microeconomic data typically range in the neighborhood of 0.1 to 0.3 with occasional exceptions being found above 0.3. Based upon the findings of studies using similar data, any specification that yields an R^2 above 0.3 will be considered a good measurement of that variable's determinants.

A. Results

The empirical results for each equation and the level of significance for each parameter are presented below. In general the estimated parameters conform to the theory set forth in Section III, although some

of the signs and significance tests fail to support some of the hypothesis. Further, each equation has an R^2 of 0.3 or above, and the marriage discriminant equation exceeds 0.6 while the hours worked equation reaches above 0.5. The high value of these evaluation parameters along with the significance levels supports an argument for reasonable equation specification.

$$\begin{aligned} MD = {} & \underset{(0.06)}{0.852} \cdot ATH + \underset{(0.02)}{0.527} \cdot ATC + \underset{(0.010)}{0.016} \cdot ATW - \underset{(0.011)}{0.02} \cdot P15 \\ & + \underset{(0.011)}{0.004} \cdot L15 + \underset{(0.000011)}{0.000003} \cdot ED - \underset{(0.055)}{0.228} \cdot RD + \underset{(0.489)}{0.894} \end{aligned}$$

$$R^2 = 0.681 \qquad \text{F-test} = 60.14 \qquad N = 475 \qquad (3.7)$$

$$\begin{aligned} S = {} & \underset{(0.055)}{0.109} \cdot ED + \underset{(0.06)}{0.42} \cdot ATW - \underset{(0.00005)}{0.00002} \cdot WY - \underset{(0.241)}{0.413} \cdot SOH \\ & + \underset{(0.09)}{0.20}\ EDF + \underset{(0.002)}{0.001}\ FOC - \underset{(0.071)}{0.132}\ RD + \underset{(1.303)}{7.727} \end{aligned}$$

$$R^2 = 0.341 \qquad \text{F-test} = 21.40 \qquad N = 341 \qquad (3.8)$$

$$\begin{aligned} LFPRD = {} & - \underset{(0.018)}{0.034} \cdot C_{0-5} - \underset{(0.0000089)}{0.0000132} \cdot HPERY + \underset{(0.00960)}{0.000390} \cdot ED \\ & - \underset{(0.068)}{0.059} \cdot PC + \underset{(0.073)}{0.132} \cdot ATW + \underset{(0.017)}{0.023} \cdot SOM + \underset{(0.032)}{0.037} \cdot SOMA \\ & - \underset{(0.0110)}{0.0081} \cdot SOH + \underset{(0.0018)}{0.0078} \cdot WR - \underset{(0.029)}{0.099} \cdot HATW \\ & + \underset{(0.05)}{0.134} \cdot RD + \underset{(0.05)}{0.503} \cdot LPD_{-1} \end{aligned}$$

$$R^2 = 0.476 \qquad \text{F-test} = 28.09 \qquad N = 499 \qquad (3.9)$$

$$HW = \underset{(0.011)}{0.065} \cdot WR + \underset{(0.0007)}{0.011} \cdot OTP - \underset{(0.01)}{0.01} \cdot DCW + \underset{(0.0213)}{0.0287} \cdot ICW$$

$$- \underset{(0.021)}{0.043} \cdot CC + \underset{(0.000055)}{0.000002} \cdot PERY - \underset{(0.52)}{1.67} \cdot ED$$

$$- \underset{(0.126)}{0.047} \cdot SOH - \underset{(0.131)}{0.323} \cdot HATW + \underset{(0.092)}{0.638} \cdot HW_{-1} + \underset{(6.94)}{12.39}$$

$$R^2 = 0.519 \qquad \text{F-test} = 21.57 \qquad N = 421 \qquad (3.10)$$

$$FS = \underset{(0.159)}{0.402} \cdot ATC - \underset{(0.0006)}{0.0018} \cdot WR + \underset{(0.0000071)}{0.000016} \cdot PERY$$

$$- \underset{(0.007)}{0.0009} \cdot ED - \underset{(0.021)}{0.021} \cdot EDM - \underset{(0.0075)}{0.0798} \cdot ECC$$

$$- \underset{(0.019)}{0.094} \cdot AOM - \underset{(0.021)}{0.093} \cdot \#MK + \underset{(0.190)}{0.353} \cdot RD + \underset{(0.58)}{4.70}$$

$$R^2 = 0.43 \qquad \text{F-test} = 26.69 \qquad N = 353 \qquad (3.11)$$

As indicated, all of the equations yield estimators and a goodness-of-fit that surpass previous models using microeconomic cross-sectional data. A detailed discussion of each equation and its parameters begins in the next section.

B. Interpretation

Each equation discussion follows the order of their presentation in Section III in order to maintain continuity.

1. Marital Equations

The attempt to differentiate between married and unmarried women was the most successful equation as measured by the R^2 value of 0.681 which indicates an unusually high degree of accuracy in the marital

decision. Due to the absence of previous studies in this area, the signs and magnitudes of the parameter estimates cannot be compared against existing values; nevertheless, these results provide useful insights into the socio-psycho-economic variables that lead to household formation.

Among the novel variables to economic analysis of family formation--ATH, ATC, and ATW, the most significant psychological determinant of marriage is the woman's attitude toward children. In equation (3.7), the positive, significant value of 0.527 for ATC supports earlier arguments that the association between child birth and marriage plays a major role in the decision to marry. The empirical interpretation of the parameter estimate is the expected value of the woman being married given that she has a positive preference for children. Thus, E(MD/ATC) = 0.527 means any woman found to have a strong desire for children is expected to have a probability of 0.527 of also being married.

For ATH, the sign and 0.152 value suggests that women who receive benefits from performing the required home production duties have a higher probability of marriage than women who dislike household work. This result supports Becker's contention that marriage is, in part, an attempt by the parties involved to realize the gains to specialization in those activities in which each has an economic advantage and/or preference for doing. However, the absolute value of the parameter, especially in relation to ATC, minimizes the overall ability of ATH to explain marriage. Finally, the ATW value of 0.16 shows that women with preferences for work apparently do not feel compelled to enter the

marriage market, although the positive coefficient apparently indicates a willingness to view marriage and labor force activity as complementary goods.

One of the perplexing issues raised questions whether an individual who enjoys housework, labor force activity, and caring for children simultaneously is being logically consistent. Women apparently do possess a desire to participate in labor force functions and perform household chores concurrently. An alternative explanation can be found by applying a rough cost-benefit analysis to show that engagement in income maintenance and home production at the same time for the single person creates the potential for increasing their level of utility by specializing in those activities in which their comparative advantage exists.

In the case of the dummy variable for parents married or divorced at age 15, P15, the coefficient indicates a 2% decrease in the probability of marriage when the individual's parents were not living together when at age 15. This is empirical support for the commonly held supposition that children from broken homes react to this experience by remaining single. The small value of the estimate, -0.02, suggests that the net effect upon the marriage function is minimal. With regard to the locational dummy, the positive sign means that non-urban dwellers have a higher probability of marriage for two reasons: 1) parental and peer group pressures, and 2) the absence of economic conditions that allow a female to be self-supporting in rural areas.

Finally, two variables, education and race dummy, complete the

specification of the marriage discriminant equation. Education was originally theorized to increase the prospects of marriage by enhancing the individual's preference for life with a member of the opposite six. However, the growth in a woman's preference for marriage is partially offset by an increased awareness that viable alternatives to marriage do exist. These opposing forces are seen as the reason for the insignificant and small value of the educational variable.

The estimated effect of race upon the marriage discriminant function of -0.228 supports the theory that the generally lower economic status of black women forces them to associate with relatively lower status mates, ceteris paribus. Though this finding substantiates further the overstatement of black responses to economic incentives from aggregate data, dummy variables still ignore the positive preference for marriage to members of the same race. The importance of this effect is measured in Chapter IV.

2. Spouse Equation

As expected from the explanation in Section III, the number of years of school completed, attitude toward work, education of father, and father's occupation code possess the expected positive coefficients. Education, as a quality index, causes women with higher educational levels to maximize the return on their investment in human capital by choosing mates with the economic capability to raise their standard of living. At the same time, education raises their expectations about the "perfect" mate. Another factor affecting human capital, health,

makes women with health problems less efficient producers of home products; thus, they can expect a lower quality of spouse relative to the healthy individual. The other factor reducing spouse quality is the -0.228 value for the racial dummy. In spite of a priori arguments that racial-cultural groups interact in a positive manner, the quality measurement of mates explains the negative sign of RD if black mates are characterized by a lower quality index. In light of the documented lower incomes, education, health, and overall economic status, the negative, significant coefficient seems plausible. One implication of this finding for policy purposes is the interrelationship between raising the economic status of black males and subsequent benefits to black females. To the extent that a wife gains from an increase in her husband's economic conditions, future policies raising a black man's status will also benefit black women.

Two variables, EDF and FOC, are included to empirically test the hypothesis that some women mate with men possessing characteristics "like dear old dad." The educational level of the father and his occupation combine to provide a rough proxy for the quality of the father. That is, a female child whose father is college educated and a professional worker is unlikely to choose a high school graduate, blue collar worker for a spouse. From the parameter estimates and their standard errors, education of the father does significantly affect the choice of mate, while father's occupation has almost no influence.

3. Labor Discriminant Equation

In the labor force discriminant function equation, the most

significant variables are the number of children 0-5 years of age, the husband's stock measure of lifetime income, the race dummy variable, and labor force participation lagged one period. A formal discussion of the statistically insignificant variables is foregone in order to illustrate the importance of the dominant variables in the equation. Perhaps the major unsettled issue first raised by Ben Porath questions conclusions based upon aggregate labor force data that 60-80% of the women in the previous year's labor force are also in the next year's labor force. The coefficient of 0.503 for $LPRD_{-1}$ in equation (3.9) suggests that these values overestimate the stability of the secondary labor force in general, and at best represent a lower bound to their actual labor force mobility.

The significance of this result for secondary labor force analysis raises doubts the applicability of primary labor force procedures to study the determinants of women in the labor force. If the secondary labor force retained 70% of its workers from year to year, as the aggregate suggested, the labor force would be displaying enough stability to justify use of a uniform set of procedures. However, with almost half of the women in the labor force turning over every year, the secondary labor force appears to be composed of two distinct types: one group which responds to the same economic forces as the primary labor force activity, and a second group which responds to temporary economic conditions. In short, current secondary labor force research mistakenly assumes that women, especially married women, by virtue of their gender and marital status, can be treated as workers who respond to a different

set of determinants than primary labor force members. These results demonstrate the error in failing to recognize that many women (almost 50%) can be considered part of the primary labor force as a result of their stable participation.

The husband's stock of wealth and the wage rate represent the need to enter the labor force and the opportunity cost of not working, respectively. The strong support for C_{0-5} (-0.034) reflects Cain's finding that family size was not a binding constraint upon labor force activity due to the negative, but insignificant, coefficient between labor force activity. The discrepancy in the findings arises from a difference in determining exactly how family responsibilities restrain labor force activity. Whereas Cain views total family size as the major factor, the arguments set forth in the previous two chapters suggest that children of different ages impose different time costs upon the mother. That is, to the extent that pre-school children require more direct and constant aid in performing their daily routine than older children, the greater opportunity cost of working--separation from their children--for the younger age groups supports the negative, significant coefficient. In defense of Cain's position, he was the first to empirically test the proposition that family demands affect the supply of secondary laborers.

4. Hours Worked Equation

The results of the hours worked equation are informative from the focal point of the equation itself, and to compare with the determinants of the decision to enter the labor force. Though the signs of the

traditional variables--wage rate, education, and income--conform to a priori expectations the most interesting results in equation (3.10) are the indirect cost of work, child care cost, and the husband's attitude toward the wife working. The most significant of these variables, HATW, suggests by virtue of sign and magnitude that women attach a significant weight to their husband's attitudes toward her working in deciding upon how many hours to work. This finding is empirical support for the logic of the theoretical model derived in Section II that application of the Samuelson-Stolper theorems to the "new home economics" incorrectly assumes independence among the individual family member's utility levels. Instead, they are very much interconnected. As expected, the a priori feeling that family utility functions are interdependent warrants future research designed to develop a family utility maximization model in which this interaction is formally explained.

Of the cost variables, child care is largest in magnitude and more significant than the other. A unit increase in the cost of child care elicits a -0.043 unit decline in the number of hours worked per day. Clearly, working women reduce the level of their labor force activity when the net benefits to working are reduced via higher prices in the cost of working. A baby sitter can reduce the net gain from working by raising the cost portion of the profit maximizing behavior function. The positive, moderately significant coefficient for the indirect cost of working variable will seem incongruous until one realizes that the indirect cost of working--defined as the amount of time required to reach the place--can be minimized by working longer hours. For this reason,

the positive coefficient of 0.0287 for ICW apparently represents an attempt to reduce the impact of the opportunity cost of commuting upon their net monetary gains from working by working longer hours.

For comparative purposes, the relative magnitudes and significance levels between the decision to enter work and hours worked illustrate the importance of differentiating between the two decisions. Note that in the LPRD equation, the dominant statistical factors are primarily the variables that restrict the labor supply functions--the number of preschool children (C_{0-5}), the economic need to participate in labor activity (HPERY), and the labor market's valuation of the woman's time (WR). Selection of hours worked depends heavily upon the costs incurred in working. The different response patterns in each equation to the socioeconomic determinants illustrate Tobin's original argument for a significant nonlinearity in the household decision-making process. Chapter IV elaborates upon this problem in greater detail.

5. Fertility Equation

Except for the inclusion of the attitudinal variable, ATC and the proxy for direct commodity cost of children, ECC, the stock of children equation conforms to previous fertility equation specifications. Among the usually included variables, the positive, significant family wealth coefficient contradicts the assertions of Venieris, et al., that children are an inferior commodity. Likewise, the wage rate proxy for the opportunity cost of children and education, as an indicator of alternative tastes for children plus the technical capability to follow

through with family desires, display the postulated negative signs. Finally, women who marry early in life are seen to bear a larger number of children than women who marry later, ceteris paribus.

The impact of psychological factors upon the number of children ever borne bears a positive sign along with a highly significant coefficient. The importance of the inclusion of attitudinal variables manifests itself in the over-statement of the magnitude of economic variables--income and opportunity costs in specific. As the students approaching fertility determination from a sociological perspective have long argued, specification of family size determinants entirely with economic variables requires a ceteris paribus assumption that women have exactly the same preferences for children. Becker proposes the same approach in a roundabout manner by noting that one difference between the observed income effect upon children and the "true" income effect flows from the absence of psychological variables in economic studies of fertility. The empirical results in equation (3.11) support the combined works of Ryder and others in sociology and Becker in economics to the extent that the income parameters reported here are smaller than previous single equation estimates.

To illustrate the importance of excluding attitudes toward children, equation (3.11) is recomputed without ATC, and presented below in equation (3.11a) as:

$$\begin{aligned} FS = {} & \underset{(0.0006)}{-0.0026 \cdot WR} + \underset{(0.000018)}{0.000034 \cdot PERY} - \underset{(0.009)}{0.0095 \cdot ED} + \underset{(0.0016)}{0.014 \cdot EDM} \\ & - \underset{(0.007)}{0.08 \cdot ECC} - \underset{(0.019)}{0.095 \cdot AOM} - \underset{(0.024)}{0.094 \cdot \#MK} + \underset{(0.190)}{0.310 \cdot RD} + \underset{(0.56)}{5.17} \end{aligned}$$

$$R^2 = 0.376 \qquad \text{F-test} = 22.13 \qquad N = 353 \qquad (3.11a)$$

As predicted, both the income effect (PERY) and substitution effect (WR) parameters increase in value relative to their magnitudes in equation (3.11). That is, economic determinants of fertility alone overstate the reaction of parental fertility decisions to economic influences.

A second issue initially raised by Barzel-McDonald questions the use of total family income to represent income. Instead of a total income measure their argument favors separating total income into human capital and net asset income. In specific, income aggregation disguises the hypothesized greater importance of net assets over human capital in the selection of family size. To empirically test the relative magnitudes of the income measures, PERY in equation (3.11) is divided into human capital wealth--HWY, and equivalent measure for the wife--WWY, and family net assets--NA. The reestimated equation is:

$$\begin{aligned} FS = {} & \underset{(0.168)}{0.309}\cdot WAC - \underset{(0.0007)}{0.00133}\cdot WR + \underset{(0.0000062)}{0.0000088}\cdot HWY \\ & - \underset{(0.00000216)}{0.00000385}\cdot WWY + \underset{(0.0394)}{0.0099}\cdot ED - \underset{(0.021)}{0.025}\cdot EDM - \underset{(0.007)}{0.078}\cdot ECC \\ & - \underset{(0.019)}{0.094}\cdot AOM - \underset{(0.019)}{0.093}\cdot \#MK - \underset{(0.00000054)}{0.00000068}\cdot NA + \underset{(0.19)}{0.368}\cdot RD + \underset{(0.59)}{4.82} \end{aligned}$$

$$R^2 = 0.438 \qquad \text{F-test} = 27.31 \qquad N = 353 \qquad (3.11b)$$

The specific argument for the dominance of net assets in family fertility decisions remains unsupported by virtue of its smaller magnitude and significance relative to the human wealth measures.

Of the remaining variables in equation (3.11), the parents' desired level of education for the children can be viewed as one cost of

children. As a proxy for child quality the negative, significant relationship simultaneously supports the position that attempts to raise the quality of children necessitates the reduction in family size, ceteris paribus, and suggests that Becker errs in believing that children are inferior commodities. Rather, the income elasticity of demand is found to be positive when costs are formally measured.

Finally, the race dummy variable shows the expected increase in family size associated with cultural differences. Whether the observed discrepancy among family size is attributable to differential tastes for children between black-white families or to variations in economic factors cannot be completely ascertained until the samples are divided in Chapter IV.

V. Summary and Conclusions

Although the estimations presented in equations (3.7) through (3.11b) add to our knowledge regarding the interaction of various social science determinants in the household decision-making process, the results are constrained because of the need to maintain the comparability of these finds with existing studies. The present results provide information about many issues currently in dispute. In general, the importance of psychological attitudes to equation specifications, the added knowledge that follows from disaggregating the income variable, and the importance of considering costs are demonstrated in both the fertility equation and labor force equation. Because the absence of alternative studies prevents comparisons with the marriage market and spouse equation, the results are evaluated in relation to the theoretical literature.

The main finding disputes the assumption that individual family member utility functions are completely independent by finding a significant interaction between individual decisions and the attitudes of other family members.

Three questions remain to be answered: 1) the error, if any, in wage rate time valuation, 2) the magnitude of black-white demand response differentials, and 3) the usefulness of ordinary least squares estimation. The result of subsequent modifications will be shown to enhance our understanding of the household decision-making process.

CHAPTER IV

ESTIMATION OF THE GENERAL TIME VALUE MODEL

I. Introduction

Criticisms of the traditional model estimations in Chapter III focus upon the failure of wage rates to accurately measure the value of time for nonworkers (an understatement) and for workers alike (an overstatement) and the failure of OLS estimation of nonlinearities inherent in the household decision-making models. Specifically, a nonworking woman's time value can be shown to differ from her labor force wage rate by observing (almost tautologically) that the woman would participate in the labor force if her market time value exceeded her home time value. But the woman, by opting for household production activities, signifies that the wage inducement to labor force activity is insufficient relative to the costs incurred. Therefore, the wage rate proxy <u>understates</u> the nonworking woman's value of time.

Like the assault upon a nonworking woman's time value, Johnson and De Serpa attack the wage rate valuation of time for workers. De Serpa's criticism follows from his inclusion of a substitution effect between time and goods in the household production constraint. That is, incorporation of a substitution effect produces a theory of time that rests upon hours worked and overtime pay schedules as well as the wage rate. For example, two individuals earning exactly the same wage with

one working 40 hours per week and the other 60 hours per week will not have the same time value unless the marginal utility of money is constant. Further, overtime payments between the two individuals will produce deviations in wage payments that the common wage proxy fails to take into consideration. According to both authors, the effect of the wage rate proxy is the overstatement of time value.

The second issue in current empirical studies of the household decision-making process questions the ability of OLS estimation to explain household demand. The OLS estimation procedure is believed to produce biassed results when a dichotomous decision is explained with continuous variables in a single step. An example is the decision to enter the labor force and how many hours to work if labor force participation is accepted.

The first technique suggested as a replacement was the twin linear probability approach (TLP) developed by the social science research center at the University of Michigan. Although an improvement, some problems that remain motivated Tobin to develop an alternative one step extension of probit analysis that yields a nonnegative, maximum likelihood estimate of the coefficients and population variance. Since neither approach has achieved preeminence in the statistics, both are applied to the black-white equations to test their predictive powers.

Section II elaborates upon the value of time measure to be constructed, and discusses in greater detail the strengths and weaknesses of the estimated equations for the separate black-white samples. In Section IV the results are summarized.

II. A General Framework

In part A of this section a general valuation of time equation is developed that incorporates the criticisms of the aggregate wage rate approach into one measure of time value. Part B compares the theoretical properties of the TLP and Tobit techniques.

A. Value of Time

In accordance with the criteria for valuing nonworker's time by the "reservation wage," and worker's time as a combination of hours worked plus overtime pay rates in conjunction with the normal wage rate proxy leads to the dual function specified in equation (4.1):

$$V_t = F_1 \begin{cases} RW & ; \text{ if not in labor force} \\ WR \times \frac{HW}{OT(\Theta)} + \Theta \times WR \times \frac{HW - OT(\Theta)}{OT(\Theta)} & ; \text{ if in labor force} \end{cases} \tag{4.1}$$

where RW = reservation wage in dollars and cents

WR = wage rate in dollars and cents

HW = hours worked per week

OT = hours of work required before overtime pay commences

Θ = the overtime payment rate, for example, $\Theta = 0$ if single time, 0.5 if time and a half overtime, and 1 if double time.

Data on the reservation wage is obtained directly from the NLS survey. The reservation wage represents the individual's perception of their actual time value and is not an imputed value from estimated wage

equations. An objection to survey information of this type correctly argues that the individual might be able to command a wage in excess of their reservation wage by searching all of the potential markets for their services. To evaluate this position search and information costs would have to be quantified. Nevertheless, individuals base their decisions upon their known market values, not unknown market worth. As such, the reservation wage provides observation on the individual's evaluation of the worth of his own time, and this is what the theory of time purports to be concerned with.

The determination of time value for workers can also be taken from NLS data directly. The general value of time measure constructed depends upon the wage rate, hours worked, and overtime pay rate as well as the number of hours of work required before overtime pay is applicable. Because Becker introduces wage rate time valuation within the context of an institutionally determined 40 hour week and no overtime, equation (4.1) will reduce to wage rate time valuation when HW = 40, and $OT(\theta) = 40$, $HW/OT(\theta) = 40/40 = 1$ and $[HW - OT(\theta)]/OT(\theta) = (40 - 40/40) = 0$, or $V_t = WR$. The same result holds for secondary and part-time laborers who may not have the option of working the assumed 40 hours per week.

An example of the greater flexibility built into V_t can be seen from the example two hypothetical workers--one person who works less than 40 hours per week and one who works more than 40 hours per week. Allowing for complete freedom in choice of hours worked, the former represents a "work to live" attitude and the latter a "live to work" approach toward life. Letting $HW_1 = 20$ in the first instance and $HW_2 = 60$

in the latter, assuming equal wages (WR = \$5.00/hr), equal overtime pay scales (O = 0 for straighttime), and the same required number of hours required for overtime pay [OT(O) = 40], the first employee values his working time at V_t^1 = 5.00 (20/40) + 0 x 5.00 (20 - 40/40) = \$2.50; or time is valued at 1/2 the actual wage rate. The latter individual possesses an opportunity cost of V_t^2 = 5.00 (60/40) + 0 = \$7.50. In this instance and in cases where individuals face different values for O, wage rate time valuation fails to provide a close approximation to a person's time cost.

Studies of primary labor force participants may not be completely invalid owing to the institutionally imposed rigidities in the labor market, but the greater variation in time worked by the secondary labor force dictates a more flexible measurement of time value.

B. The Twin Linear Probability and Tobit Approaches

The first solution for handling the dual decision-making process in microeconomic survey data developed by the social science researchers at the University of Michigan uses two OLS equation estimations--one for the dichotomous or 0-1 variable and the second for predicting the continuous variable. For any given decision the initial step is deciding to buy, y = 0, or not to buy, y = 1, and then following up on the decision-making process if y = 1 in the first step. In essence, the second decision only occurs when the initial decision is to buy, or, likewise, the second is conditional upon the first.[36]

---

[36]Since predicting the purchase level of the pertinent dependent variable is the purpose of this analysis, the expected value of Y is derived by finding the intersection between the two equations by noting that $EY = \Sigma Y \cdot F(Y) = F(Y>0) \cdot \Sigma\{Y \cdot [f(Y|Y>0)]\} = \text{Prob}\{Y>0\} \cdot E(Y|Y>0)$.

A current alternative coming into vogue is the extension of probit analysis by James Tobin which develops an index, I, that conforms to the standard zero mean and constant variance assumptions by specifying each dependent observation as a function of the determining variables via the index number I. Using maximum likelihood estimation procedures based upon the likelihood function described in Tobin's original article, the estimated expectation of the dependent variable is determined by $\hat{Y}_t = \hat{I}_t \cdot F(\hat{I}_t/\hat{\sigma}) + \hat{\sigma} \cdot F(I_t/\hat{\sigma})$, which is necessarily nonnegative.

Acceptance of one approach over the other will depend upon the ability to prove that one provides better forecasts at a smaller cost in time and effort. Though the theoretical advantage of Tobit is its assurance that the predicted values will conform to the nonnegative bounds assumed in the model, this potential advantage is partly offset by the increased computer costs in core requirements and the extra

---

By finding the expected value from the first OLS equation, $EY_1 = Y'$, and the expected value in the second OLS equation, $EY_2 = Y''$, then EY is computed by multiplying the two expected values, $EY = Y' \times Y''$.

The major documented weaknesses of the TLP involved in the first equation is the possibility of violating the homoscedasticity assumption since defining Y_1 as a 0-1 variable, the residual of $\epsilon_t = Y_{1t} - X' \cdot \beta$ must be either $-X'_t \cdot \beta$ when $Y_{1t} = 0$ or $1 - X'_t \cdot \beta$ when $Y_{1t} = 1$. In order for ϵ_t to have the expected value of zero, its distribution must be $-X'_t$ when $F(\epsilon_t) = 1 - X' \cdot \beta$ and $1 - X'_t \cdot \beta$ when $\epsilon_t = X'_t \cdot \beta$. Because of the likelihood that these conditions will not be met, a costly generalized least squares approach (GLS) is required. But even if a GLS procedure is applied, EY_1 can still fall outside the defined 0-1 bounds, which is inconsistent with the definition of Y and with its interpretation as a probability measure. Compounding the heteroscedasticity problem in the words of Goldberger is, "the procedure does not directly attempt to fit EY to Y, it takes no explicit account of the estimation of EY by $EY = Y' \cdot Y'' \ldots$" and this statement sums to the need for an alternative estimation procedure.

costs in iterating the solution from the basic likelihood function. Further, the criticism against TLP merely acknowledges the possibility that EY might fall outside the bounds set up by the model. If TLP produces expected values which conform to the required bounds and forecasts as accurately as Tobin's procedure (referred to as Tobit analysis), then the extra expense incurred in the Tobit procedure may not justify its use.

Like any untested procedure, the absence of published empirical comparisons of Tobit with alternative methods prevents a priori assertions about their relative efficiencies. The results reported here will take a step toward reducing the uncertainty surrounding the predictive capabilities of Tobit versus the TLP procedure.

III. Empirical Results

Because the equations and their specifications are discussed at length in Chapter III, the rationale for specific formulations are not repeated. However, one major change replaces the standard wage rate time value measure (WR) with the general time value proxy (V_t). Each equation is estimated and interpreted for both the black-white samples and compared to the results gathered from the traditional models. Though specific details await evaluation of individual equations, the overall results are threefold: one, more detailed insights into black-white household demand formation is obtained by separating the cultures into two samples; second, Tobit analysis consistently outperforms TLP on statistical grounds; and third, wage rate time valuation measurement

errors are demonstrated to be significant for both blacks and whites in all equations.

Individual equation results are presented in Tables 4.1 through 4.6. Each table details the parameter estimates and their significance levels. The white sample calculations are in the odd numbered tables and those for the black sample in the even numbered tables. Besides providing the TLP and Tobit results, OLS results are also included to compare the alternative estimation procedures. Because Tobin has demonstrated the statistical inaccuracies of OLS within a nonlinear demand process, the OLS results are not discussed.

A. Marriage Equations

The signs and magnitudes of the white sample coefficients resemble those in equations (3.7) and (3.8). However, both the signs and magnitudes in the black equations change significantly. This finding suggests that the intercept analysis of covariance approach fails to adequately explain black demand differences. Although the degree of coefficient error is minimal for whites, the extent of error introduced for the minority component of the population sample will be illustrated below.

1. Black-White Equation and Individual Equation Differences

The separate cultural equations provide more detailed information about variation in the dependent variable than the analysis of covariance results in the traditional model. More importantly for policy purposes, black-white responses to the marriage and spouse

TABLE 4.1

WHITE MARRIAGE EQUATIONS

Exogenous Variables	Endogenous Variables			
	Twin Linear Probability		Tobit	OLS
	MD	S	MD•S	MD•S
1. ATH	0.90****	0.07***	0.63****	1.26**
2. ATC	0.632****	0.13**	0.61***	1.20***
3. ATW	-0.134***	-0.071**	-0.114***	-0.228***
4. P15	-0.02**	-0.06**	-0.02*	0.4**
5. L15	0.04**	-0.0003	0.0113	0.022**
6. ED	-0.0003**	0.211***	0.179***	0.34****
7. WY	-0.06**	0.0002**	-0.0063***	-0.0136***
8. SOH	-0.02**	-0.3***	-0.012*	-0.02**
9. EDF	0.213**	0.07*	0.093*	0.177**
10. FOC	0.144***	0.037**	0.089**	0.199****
11. CON	0.90	0.32	0.64	0.54***
R^2	0.694	0.49	0.67	0.53
N	350.	290.	350.	350.
F-test	26.22	21.44		22.16
MSE	0.21	1.02	1.33	1.27

**** Significant at 1%
*** Significant at 5%
** Significant at 10%
* Significant at 15%

TABLE 4.2

BLACK MARRIAGE EQUATIONS

Exogenous Variables	Endogenous Variables			
	Twin Linear Probability		Tobit	OLS
	MD	S	MD•S	MD•S
1. ATH	0.387***	0.005**	0.096***	0.2**
2. ATC	0.213**	0.114**	0.207***	0.419***
3. ATW	0.133***	0.097**	0.110***	0.220*
4. P15	0.07**	-0.13*	0.01**	0.019*
5. L15	0.011***	-0.006*	0.007***	0.016**
6. ED	0.114****	0.144***	0.133***	0.297
7. WY	0.08**	0.0001	0.00632***	0.0126*
8. SOH	-0.06***	-0.54**	-0.132**	-0.264***
9. EDF	0.132**	0.09**	0.127**	0.254**
10. FOC	0.093***	0.006***	0.004***	0.0173*
11. CON	0.776	1.14	0.934	0.186***
R^2	0.712	0.44	0.633	0.49
N	125.	91.	125.	125.
F-test	26.41	18.76		16.74
MSE	0.37	1.97	1.63	1.69

**** Significant at 1%
*** Significant at 5%
** Significant at 10%
* Significant at 15%

TABLE 4.3

WHITE LABOR FORCE EQUATIONS

Exogenous Variables	Endogenous Variables			
	Twin Linear Probability		Tobit	OLS
	LFPD	HW	LFPD·HW	LFPD·HW
1. C_{0-5}	-0.062****	-0.851*	-0.435****	-1.01**
2. HPERY	-0.062**	0.38***	-0.04***	-0.2**
3. ED	-0.0036	-0.216*	-0.021	-0.57***
4. PC	-0.0021	-3.04**	-0.245	-1.9
5. ATW	0.021**	1.006***	0.138***	0.53
6. SOHW	-0.014**	-0.671***	-0.019	-0.09
7. HW_{-1}	0.015****	0.242****	0.062****	0.544****
8. HAW	0.0116	-2.86****	0.187**	1.11*
9. DCW	-0.00067****	-0.04	-0.0026****	-0.004
10. ICW	-0.0028****	-0.056****	-0.337****	-0.271****
11. V_t	-0.0014****	0.098****	-0.0157****	6.12****
12. NA	-0.0025***	-0.028	-0.015****	-0.094****
13. CON	0.031	16.27***	-1.40*	5.67
R^2	0.69	0.587	0.68	0.82
N	187.	85.	187.	187.
F-test	35.73	21.58		71.57
MSE	0.278	6.005	14.23	8.10

**** Significant at 1%
*** Significant at 5%
** Significant at 10%
* Significant at 15%

TABLE 4.4

BLACK LABOR FORCE EQUATIONS

Exogenous Variables	Endogenous Variables			
	Twin Linear Probability		Tobit	OLS
	LFPD	HW	LFPD•HW	LFPD•HW
1. C_{0-5}	0.015**	-0.009*	0.067*	-0.409
2. HPERY	0.0177***	0.11*	0.064***	0.156
3. ED	0.0125*	-0.033	0.058	-0.35*
4. PC	0.162***	-2.135**	0.465	-0.19
5. ATW	0.016*	0.14	0.074	0.42
6. SOHW	-0.0089*	-0.546	-0.041*	-0.24
7. HW_{-1}	0.016****	0.359****	0.077****	0.615****
8. HAW	0.021	0.669***	0.132*	0.66
9. DCW	0.00044***	0.0026**	0.0021****	0.002
10. ICW	0.00343****	-0.0122***	0.681****	-0.841****
11. V_t	-0.00232	0.0569***	-0.0104***	6.71****
12. NA	-0.011*	-0.24***	-0.06****	-0.617****
13. CON	-0.533****	25.41****	-3.129****	-0.24
R^2	0.6382	0.477	0.599	0.898
N	88.	59.	88.	88.
F-test	18.80	15.08		64.34
MSE	0.28	5.02	6.34	5.71

**** Significant at 1%
*** Significant at 5%
** Significant at 10%
* Significant at 15%

TABLE 4.5

WHITE FERTILITY EQUATIONS

Exogenous Variables	Endogenous Variables			
	Twin Linear Probability		Tobit	OLS
	CD	FS	CD·FS	CD·FS
1. V_t	-0.0074***	-0.003**	-0.00016***	-0.101**
2. ED	-0.005***	-0.1367****	0.081	-0.116****
3. EDH	-0.003*	-0.099****	-0.0743****	-0.065***
4. ECC		0.0251	-0.0132**	0.006
5. ATC	0.038***	-0.052***	-0.150**	0.114
6. NA	-0.53***	-2.89*	-0.365**	0.0
7. HWY	0.2**	0.6**	0.174*	-0.00115
8. WWY	-0.06	-6.12****	-3.82***	-0.00593****
9. AOM	-0.013****	0.0054	-0.0563****	-0.124****
10. #MC		-0.0369****	-0.01***	
11. CON	0.715****	1.892****	0.824****	4.58****
R^2	0.7102	0.21	0.644	0.2664
N	275.	250.	275.	275.
F-test	74.10	6.79		11.41
MSE	0.43	1.98	1.47	1.31

**** Significant at 1%
*** Significant at 5%
** Significant at 10%
* Significant at 15%

TABLE 4.6

BLACK FERTILITY EQUATIONS

Exogenous Variables	Endogenous Variables			
	Twin Linear Probability		Tobit	OLS
	CD	FS	CD•FS	CD•FS
1. V_t	0.0001	-0.005***	-0.857****	-0.213*
2. ED	-0.022***	-0.109**	-0.0156**	-0.067
3. EDH	-0.0003	-0.023	-0.0437*	-0.064
4. ECC		-0.0549**	-0.0833**	-0.069
5. ATC	0.095***	1.023***	0.853****	0.8778****
6. NA	-1.9*	-4.3****	-4.31***	-0.028**
7. HWY	-0.24*	6.5***	0.446***	-0.0055
8. WWY	-0.13*	0.27*	-0.93	0.0038
9. AOM	0.00053***	-0.008***	-0.589***	-0.153****
10. #MC		-0.049***	-0.1033	
11. CON	0.517****	3.59***	0.462	5.76****
R^2	0.706	0.312	0.70	0.5013
N	89.	64.	89.	89.
F-test	17.15	12.62		7.59
MSE	0.185	1.31	1.61	1.37

**** Significant at 1%
*** Significant at 5%
** Significant at 10%
* Significant at 15%

selection determinants are significantly different. The attitudinal coefficients--ATH, ATC, and ATW--for white women correspond closely with the traditional model in the first two cases, and have the negative sign expected from the traditional model in the attitude toward work variable. In the latter category, white women with preferences for work substitute labor force activity in place of household maintenance activities. From Table 4.2, the cause of the positive sign in equation (3.7) is the strong positive preference among blacks for working in the labor force and at home concurrently. This difference indicates the information loss caused by the failure to account for the slope differences between cultures. For example, the combined equation specifications in equation (3.7) overstates the magnitude and predicts the wrong sign for the white marital response to ATW, i.e., 0.90 - 0.134 = 0.766 in Table 4.1 versus 0.894 + 0.016 = 0.90 in equation (3.7). The corresponding figures for blacks are 0.894 - 0.228 + 0.016 = 0.682 versus 0.7764 + 0.133 = 0.9009. In both cases the traditional equation inadequately explains the racial decision-making process for policy analysis.

Other significant coefficient deviations between races are education, wage income, and parental marital status at age 15. In each case the white woman reduces her probability of marriage as the respective variables increase while the black female reacts positively. Policies designed to increase women's educational levels reduce household formation among white women and raise it for black women. These alterations in the basic family formation process can have extensive ramifications upon the total secondary labor force and family size decisions to

the extent that marriage allows the participants to specialize in their most efficient activity. Since marriage does influence both decisions, effective policy analysis depends upon understanding the major differences between racial reactions to deterministic variables.

Though the effect of wage income upon marriage varies between races, the primary sociological difference in racial marital decision-making is in parent's marital status. White women with divorced or separated parents have a lower probability of marriage than black women. In the former situation, the woman apparently reacts to the unsettled parental situation by remaining single. At the same time the black female attempts to escape from a similar situation through formation of her own household. The significant coefficients in both samples provides preliminary support for the sociological explanation of household formation.

In the spouse quality selection equation, the only significant sign difference among the racial samples is a reduction in spouse quality when the preference for work increases for white women and an increase in quality for a black woman with a similar attitude. Given the distinctive economic and social patterns between the races, white women with work preferences cannot gain access to the apparent higher status white males who prefer a "stay at home" wife. Higher status black men seem to prefer women with an affinity for labor force participation--perhaps as a means of increasing the family's prestige or maybe as a means to increase their social mobility, but certainly a black woman enhances her potential husband status by remaining in the labor force.

In addition to the black-white responses to marriage determinants, a second advantage to the twin linear probability approach derives from insights into the dual nature of the decision-making process: The first to marry or remain single, and the second is choice of spouse. The value of separating the two steps can be seen by comparing the negative, slightly significant coefficients for education and wage income in the marriage discriminant equation with the opposite signed and significant coefficients for the same variables in the spouse quality equation. As explained previously, higher educated and wage earning white women have a lower probability of marriage, but marry higher quality men if they do marry. Black women, on the other hand, have a higher probability of marriage and spouse quality for each variable.

2. Tobit and TLP Compared

For the TLP black-white equations where both coefficients in the marriage discriminant equation and spouse equations have the same sign, the corresponding Tobit coefficient bears a like sign. For the opposite signed TLP estimates on ED and WY, the positive signed education and negative signed income variables in Tobit signify dominance by spouse selection and marriage discriminant equations, respectively. With regard to coefficient magnitudes and significance levels, the Tobit coefficients lie between the two TLP coefficients. Because comparison of the signs and significance levels between the two estimation procedures fails to produce major differences, the discussion shifts to the relative costs and benefits of each approach. The major questions to be answered are the relative time costs of running the programs, forecasting accuracy,

and knowledge gained from the estimation procedures.

The commonly cited advantage accruing to the Tobit approach is subsequent failure of OLS in the discriminant equation to keep the predicted values or probability of marriage in the 0-1 range. If the OLS coefficients produce an estimated value for MD (MD) that is less than 0, say -1.0, or greater than 1, say 1.5, the estimated value's standard interpretation as a probability of marriage becomes untenable and therefore useless. Tobit analysis satisfied the claims of its founder by yielding expected values within the bounds set up in both samples, i.e., no predicted values were less than the 0 lower bound. In contrast the TLP method produced expected values outside of this range in 5% of the cases for the white sample and 1.3% in the black group. Inconsistency in TLP favors the Tobit estimation procedure. In essence, nonlinear estimation of the nonlinear decision-making process afforded more accurate expected values than the TLP procedure.

Supporting the Tobit method's ability to constrain the expected values within the bounds specified by the marriage equation is the smaller value of its forecasting error. Using the mean square error (MSE) criteria, the residuals from Tobit analysis yielded a MSE of 1.36 and 1.63 for the white and black samples as reported in Tables 4.1 and 4.2 respectively. Equivalent values are reported for the OLS estimates of TLP in the same tables. Due to the nonlinearities in the equations, the appropriate expected values is determined by $\hat{MD}\cdot\hat{S}$ instead of the sum of each equation separately. After making the conversions defined above MSE values for the TLP equations of 2.97 and 4.22 are found for

the respective samples. Once again, transformation of the nonlinear process into two linear decisions fails to match the Tobit procedure for ex post forecasting accuracy.

Offsetting the purely statistical advantages of Tobit analysis are the added time costs in computation and the information lost regarding the relative importance of the determining variables in the decision-making process. For time costs, the roughly one to one and a half minutes required to estimate each Tobit equation relative to the five to ten seconds needed for each TLP equation may prove prohibitive for users with few computer funds or slower computers.

The value of knowing the relative weights attached to the decision to enter the marriage market and spouse selection equations depends upon the extent to which the two decisions are expected to produce divergent results and the importance of these differences for subsequent analytical procedures. Consistency of signs within the black sample coefficients suggests no advantage attributable to the TLP approach. But, the opposite signed education and wage income variables in the white sample exhibits information about the decision-making process which adds to our knowledge about the household decision-making process.

The marriage equation results support Tobins's approach on purely statistical grounds, but at the expense of added time costs and information lost. Deciding upon the proper methodology depends upon computer time availability and the importance of knowing the determining variables differential effects on the discriminant and quantity decisions. A compromise solution for researchers without time constraints is application of both methodologies.

B. Labor Force Equations

Because this study focuses upon time valuation as an important determinant of labor force decision-making, V_t is discussed separately from the rest of the variables in order to emphasize the failings of wage rate time valuation.

1. The Value of Time

Both the white and black sample results in Tables 4.3 and 4.4 confirm Gronau's argument that aggregate wage rate time valuation understates the true value of nonworking women's time and Willis's proposal that wage rates overvalue a worker's time. This result is based upon the negative coefficient for V_t in LFPD and the positive sign in the hours worked equation. These signs differ significantly from the traditional wage rate time valuation results in the preceding chapter. The time value estimates in Tables 4.3 and 4.4 suggest that women with the highest time value are the homemakers. This conclusion is just the reverse of the wage rate model. A general time valuation procedure says that women work, not because the opportunity cost of wages foregone is greater than the imputed value to home production, but because the value of their marginal productivity is less at home than in the labor force.[37]

Although the issue appears at first glance to be semantical in origin, correct value of V_t derives its value from the ability to properly allocate the labor force participants between market producers. Whereas the wage rate time valuation procedure implies that the more

---

[37] This assumes time is measured by the value of their marginal product with all of the necessary competitive conditions implied.

productive worker enters the labor force and the less productive woman remains at home, the general time valuation procedure states that the more productive woman in the home should remain in the home. Clearly, both valuation procedures lead to opposite policies designed to encourage the optimal level of output from women in the economy.[38]

Perhaps the fallacy of the wage rate procedure can be illustrated by comparing the apparent contradiction between the two time value measures in the labor force discriminant equation and the hours worked equation. Consistent with wage rate time valuation theory, hours worked responds positively to changes in V_t (0.098 for white women and 0.059 for black women) although white women have a higher elasticity of hours worked with respect to time value--2.073 to 1.415. Conformity of the V_t measure with traditional specifications suggests that the two approaches are approximately equal in explaining choice of hours worked among women in the labor force. The negative time value response in both discriminant equations suggests that the real failure of traditional wage rate time valuation is its inability to accurately measure the time value of nonworking women.[39]

---

[38]Greater marginal home productivity can stem from the nature of the production process for which some women may be uniquely suited, or because imperfections in the labor market, such as female labor discrimination, arbitrarily reduce market productivity below home productivity.

[39]The unresolved issue at this time concerns the formation of the reservation wage and its exact relationship with wage rates. Willis and Becker would presumably argue that reservation wages are linearly related to wage rates. As such, autonomous shifts in wage rates produces an equivalent shift in the reservation wage. Countering the linearity approach, Gronau would probably cite the increase in marginal productivity associated with specialization in the home as cause for a nonlinear, if any, relationship between wage rates and reservation wages.

Of special interest is the maximum likelihood measurement of V_t's impact upon labor force activity within the nonlinear framework. The negative, significant parameter estimates, -0.0104 and -0.0157, of V_t in the black-white samples respectfully indicates the labor discriminant equations dominance under a nonlinear equation specification. In addition to the sign, a second change between the two estimation procedures involves the smaller differential between the respective coefficients, and a smaller size of the actual parameter estimate. Converting the nonlinear estimates into elasticities produces respective black-white values of -0.10 and -0.28; or while the total response rate of secondary laborers is inelastic, the response rate to hours worked derived above is elastic.

Regardless of the differences in estimation procedures, both approaches support the argument for an alternative time valuation

---

Since the time theory literature is devoid of any attempts to directly tackle this problem, wage rates impact upon reservation wages is empirically determined using a linear and nonlinear specification. Specifically, the estimated equations with attitudinal variables described previously included are:

$$\begin{aligned} RW\ (\text{linear}) &= 0.876 + 0.614 \cdot ATH - 0.113 \cdot ATW + 0.44 \cdot WR \\ &\quad (0.214)\ (0.332) \qquad (0.076) \qquad (0.35) \\ R^2 &= 0.413, \qquad SE = 0.50, \qquad N = 295 \end{aligned} \tag{4.2}$$

$$\begin{aligned} RW\ (\text{nonlinear}) &= 0.086 + 0.734 \cdot ATH - 0.331 \cdot ATW + 0.37 \cdot WR \\ &\quad (0.054)\ (0.413) \qquad (0.157) \qquad (0.27) \\ R^2 &= 0.48, \qquad SE = 0.08, \qquad N = 295 \end{aligned} \tag{4.2a}$$

In both equations attitude toward housework and attitude toward work are more important determinants of reservation wages than wage rates. More importantly, the decrease in utility associated with working (-0.331) offsets part of the pecuniary gains accruing to the worker (0.37). Thus, the net effect of working upon the reservation wage is almost zero, or $0.37 - 0.331 = 0.039 \cong 0.0$.

measure and this paper's assertion that a general time value variable can be constructed.

2. Black-White and Individual Equation Differences

Notable differences among the racial labor force response patterns to preschool children can be observed in the positive labor force reaction from black females, while the corresponding white female leaves the labor force. A similar finding by Gregory explains the difference as the result of "the apparently greater ability of nonwhite mothers to remain in the labor force despite the presence of preschool children in the home and the entry of teenage family members into the labor force to . . . support the larger family size." This result provides microeconomic support for Gregory's and Hill-Stafford's belief that the "most important marginal time cost of black children is the loss of leisure, and not hours worked as in the case of white women." However, this finding together with the observed decline in black hours worked as the number of preschool children increases suggests that the leisure loss declines at a diminishing rate. The opposite response to preschool children by white women shifts the potential leisure loss from child acquisition by reducing the time spent at work. The differential responses observed here confirms Gronau's hypothesis that the significant cost of children is the loss of leisure for black women and the reduction in hours worked for white women.

The reaction among white laborers to increased direct work costs is a reduction in both labor force participation and hours worked. The response to indirect costs--the time cost of commuting--supports the

findings of Gronau, Gregory, and Hill-Stafford that white women preserve leisure time by reducing labor force activity and black women reduce hours worked when possible (-0.00232 in LFPD in Table 4.4), but typically substitute leisure for hours worked (0.0569 in HW in Table 4.4). Combining the labor participation and hours worked reaction to the indirect costs and preschool cost demonstrates the differential response pattern by ethnic groups.

The remaining variables conform to the expected signs and magnitudes, although significance tests upon education for white women and attitude toward work in the black equations prove disappointing. While the lack of statistical significance for education cannot be explained, the attitude toward work for black women is apparently another manifestation of the black woman's willingness to substitute leisure for work. Unlike the marriage equations in Tables 4.1 and 4.2, attitudinal variables do not appear to significantly alter the black woman's labor force pattern relative to the time cost of transportation and child time requirements. However, for white women, attitudinal considerations lend credence to a sociological interpretation of labor force determination.

The significance of net assets in the labor determination equations provides preliminary support for the Barzel-McDonald hypothesis that total family income disguises the relative importance of human and non-human income upon labor activity. Barzel-McDonald believe that net assets' importance exceeds that of human wealth in determining labor force activity. Comparison of the respective coefficient magnitudes for husbands indicates the importance of net assets, but still places

primary emphasis upon human capital wealth. A further demonstration of human wealth's greater role can be illustrated by observing that the white woman's hours worked elasticity for net assets of 0.05% compares to the equivalent measure for husband's human wealth of -0.395%, and the opposite finding, 0.113 to -0.134, for black women. So, although the coefficients fail to support the arguments for equal importance between human and nonhuman wealth, the black elasticity measures provide enough evidence of nonhuman wealth's importance to prevent complete rejection of the Barzel-McDonald proposition.

Besides the variations in time value between equations discussed earlier, another notable deviation between equations and races reflects the woman's labor force response to her spouse's attitudes. The male attitudinal variable is important in two respects: first, as a measure of the extent to which spouse attitudes affect work decisions, and secondly, as an empirical test of the mathematical argument in Chapter II that assumptions of independence between individual family members' utility levels violates the concept of what a family is--the interaction of individual preferences. Given the negative, significant coefficient in the white HW equation and positive, slightly less significant coefficient in the black HW equation, a utility independence assumption in household maximization is not only unwarranted, but completely erroneous.[40]

---

[40]Willis, Becker, and others defend the independence assumption by appealing to the logic that, " . . . the family will tend to respond systematically to changes in the position or shape of the constraints it faces." Note that this quotation bears a remarkable resemblance to Duesenberry's criticism of the quality-quantity discussion that the above authors held in abeyance; for if all family members merely react to the constraints imposed upon the family, it is logically inconsistent

Only by allowing respective family member's utility levels to interact can the decision-making process within the family be accurately described.

A less debated point is the observation that husbands' attitudes apparently do not affect the decision to work, but do alter time spent working. For example, these results indicate that white women apparently reduce their labor force activity if their spouse wants them to. Black women appear to work in spite of their husband's desires. Although a definitive explanation of the difference is unavailable, a tentative sociological justification for the difference emphasizes the greater cohesiveness among white couples that manifests itself in greater responsiveness to spouse preferences. Unfortunately, the absence of attitudinal variables in a range of studies makes this interpretation tentative.

3. Tobit and TLP Compared

The general conclusions derived from the comparison between the two methodologies in marriage also hold here: linearization of the non-linear decision-making process yields more detailed information about the relative impact of the variables, Tobit was more time consuming, and Tobit had a lower mean ex post forecasting error. One principal distinction between the marriage and labor force results was the absence of expected values outside the 0-1 bounds in the LFPD equation. This

---

to argue further that some family members can disregard these constraints in order to alter the quality component of children, especially when the children have some influence in the quality decision-making process. Clearly, to use Griliches' term, the "new household demand" school has to abandon either their independence justification or quality-quantity difference to be logically consistent.

emphasizes the "maybe" warning in econometric literature against the TLP procedure. If TLP forecasts could circumvent this failing as consistently as it did here, the primary objection to its use would be minimized.

C. Fertility Equations

Because fertility studies which restrict their samples to families with children (equation (3.2)) disguise the effect of childless couples upon family size determination, the following equations directly consider the relative impacts of the determining variables upon the initial decision to have children and the subsequent family size selection. Though the results reported below indicate continued variations in black=white response patterns, superiority of the Tobit procedure, and the general time value's flexibility over the wage rate measure, each is discussed in the same order as the labor force results.

1. Value of Time

For comparison with the wage rate time valuation procedure estimated in equation (3.11), wage time valuation indicates a reduction in white family size by -0.0018 units and the corresponding black child time cost is -0.0002. Because equation (3.11) does not include childless couples, direct comparisons of V_t and WR are restricted to the FS results in Tables 4.5 and 4.6. In general, the V_t time measure exceeds the wage rate measure by a factor of two in the black sample and over one and a half in the white sample. This gap supports Gronau's belief that a wage rate proxy understates the true cost of children by

undervaluing non-working women's time value. Once the undervaluation for non-working women and overvaluation of working women is corrected for in V_t, time price in child cost function becomes the primary economic determinant of family size. Further, computation of the respective elasticities at their means produces a relatively inelastic response to the white-black wage rate measure of 0.43 and 0.62, respectively. Similar calculations based upon V_t yield elasticities of 0.89 and 0.93 respectively. That is, the wage rate time valuation procedure not only underestimates the magnitude of time price upon family size, but seriously underestimates family size responsiveness to the price of time. These results confirm the importance of economic time valuation in family size determination even when the noneconomic attitudinal variables are included.

Comparison of time value's coefficient in the child discriminant function with the family size equation shows that time price has its major impact upon the discriminant function for children. The two coefficients taken together, -0.0074 and -0.0030, support Gregory's early position that the marginal time price of additional children is negative and decreases with additional children. So, not only is the marginal time price the proper determinant of family size, but is shown here to decrease as children are added to the family.

While white women respond negatively to time prices in family size selection in both equations, time price does not significantly affect the black woman's decision to bear and raise children. Apparently black women do not monetarize their time value into the child decision-

making process. To the extent that this explanation is valid, it partially explains the larger families found among blacks. Ignoring time price prevents the black culture from forming a number of childless families. Reduction in black fertility could be accomplished through encouraging childless black couples as well as reducing the larger family sizes. Policies designed to affect the discriminant and family size decisions jointly will be more effective in controlling fertility.[41]

2. Black-White and Equation Differences

Surprisingly, one major difference between the racial groups involves the black's negative and white's positive reaction to the only direct child cost variable--ECC. The surprise stems from fertility theories description of white families as being more aware and thus more responsive to child costs, and this awareness of child costs explains much of the differential family sizes among the races. If these relationships survive further empirical testing, direct child costs apparently plays a greater role in the black family size selection than in a corresponding white family.

---

[41]To illustrate this point, suppose a sample of 10 white families and 10 black families produced the following distribution.

Sample	Number of Children					
	0	1	2	3	4	5
White	2	2	2	2	2	
Black	1	1	1	3	2	1

For black women the mean number of children is 25/10=2.5 while white women possess only 2.0 children. Policies designed to reduce fertility among blacks should emphasize the need to increase the number of black women in the 0 and 1 classes, not just the women bearing 4 or more children.

One logical explanation for larger black families can also be found in the larger positive, significant coefficients for the child attitude variable among black women. Besides providing additional support for the value of attitudinal variables in economic research, this finding adds some empirical support to the sociologists' contention that black family sizes are "primarily" determined by a "greater love for children." In both the black child discriminant and family size equations, the attitude toward children variable dominates all other coefficients describing a family's consumption of children. The coefficient value of 1.023 in the family size equation indicates an exact correspondence between a change in attitudes and the addition of a child to the family. Likewise, the 0.095 ATC coefficient in the discriminant equation exceeds the other parameter estimates in magnitude, and further supports the high preference for children among the black population. Perhaps the real significance of the attitudinal variable is as a personal preference explanation for black family sizes. As such, economic policies designed to reduce minority family sizes to a secondary status will be limited.

Observance of the negative attitude toward children in the white family size equation along with the expected positive sign in the child discriminant functions raises doubts about the precise relationship between attitudes and children in family size determination. One possible interpretation explains the difference by appealing to the logic of the child quality-quantity issue raised by Becker and others. The positive ATC coefficient in the CD equation along with the negative effect in the FS equation illustrates a white child demand that declines as

family size selection continues. Apparently white mothers enjoy a positive preference for children which diminishes with the addition of children to the family. That is, the added child's marginal contribution to total child quality is perceived to be negative for white women. Therefore, maximization of child services can only be obtained through production of a smaller number of children.

Both the black and white discussions of ATC belie entirely economic explanations of fertility behavior by emphasizing the noneconomic utility generating nature of children. Given the importance of these preferences in family size formation, policies for birth control policies based completely upon economic tenets will have a low success rate as long as they exclude the mother's attitude toward children. In the case of black mothers, changes in contraceptive knowledge and techniques, income maintenance, and medical programs merely provide the vehicle for realizing total child services. The key element is still the willingness to use them. Further, this explanation illustrates one reason for the failure of extensive fertility programs in less developed countries to alter family child production behavior. This failure will continue so long as parents envision quantity as the most important determinant of child services.

Inclusion of the mother's attitude toward children reduces the importance assigned to education. Education in traditional models purportedly measures the "desire for and ability to plan and carry out child production desires." With desires accounted for with ATC, education reduces to a measure of capability for implementing the desired child

production level. As such the coefficients, -0.109 and -0.1367, for white and black women respectively enhances Gregory's empirical demonstration that one source of the greater black fertility differential stems from "the inability to equate actual and desired family size"--even when the "net effect of education's total impact on both preferences and fertility control" is reduced to the gross effect of fertility control by holding preferences constant.

In general the remaining results conform to the findings in equation (3.11), except to note that converting the respective black-white family size responses of -0.0043 and -0.00289 of net assets into corresponding elasticity form produces the values -5.99% and -4.79%, and supports a Barzel-McDonald asset theory that family size responds relatively more to assets than to human capital income. The importance of maintaining a separate net asset variable relates to its potential for meshing different policies. Since the primary determinant of the white net asset position is home ownership, policies designed to increase home ownership, especially among blacks, engender corresponding benefits in the reduction of family size.

While the general findings reported here downplay economic theories importance in explaining fertility behavior, they also buttress three conventional economic fertility determinants--education, time value, and net assets--as being important factors in the mother's decision to bear and rear children.

3. Tobit and TLP Compared

Unlike the findings in the marriage and labor force equations,

the Tobit forecasts in the fertility equation were unequivocally superior to the twin linear probability predictions for both samples. The respective white-black mean square errors, 1.61 and 1.47, are significantly less than the corresponding error components for TLP, 5.41 and 2.40. Further, TLP failed to keep the predicted endogenous values within the predefined bounds 17 and 9 times in the white-black samples respectively. This failure to constrain the predicted values within the model's bounds simultaneously lends credence to the warnings in the econometric literature against TLP, and explains the poor forecasting performance of the linearization procedure. Rouch calculations of the 17 and 9 incorrect forecasts reduces the magnitude of the MSE to almost the quivalent values for the Tobit results when the incorrect expected values are restricted to either the upper or lower bound.

With respect to coefficient differences between the two estimation procedures, the results conform in sign and magnitude in general, and therefore not pursued here. The most notable deviations from the TLP results are the positive insignificant education coefficient and the negative child care cost coefficient (as it should be) in the white sample. Contrary to the previous equations in which the Tobit parameters appeared to represent the weighted interaction of the two TLP parameters, the education and child cost parameters deviate significantly from the TLP coefficients as the result of sign reversals and lower significance levels. The educational variable change conflicts with accepted theory, while movement in child costs corresponds to the theory set forth in the fertility determination theoretical literature.

The absence of an established body of empirical research makes all conclusions tentative, except to note that the superior methodology inherent within Tobit analysis suggests that its coefficients will be closer to the population parameter.

As before TLP required less computational time to perform the required algorithms, and therefore maintains an advantage over the more expensive Tobit procedure for users with limited computer time. However, the variability in the statistical forecasts and information obtained from the parameter estimates in each methodology suggests an optimal research schema which utilizes both methodologies concurrently. Hopefully, using both techniques simultaneously will provide the added information from TLP and extra statistical forecasting efficiency derived from Tobit analysis.

IV. Summary

The changes made in this chapter have produced several major points. First, the general time valuation method consistently outperforms the traditional wage rate time value measure in both the black and white samples. That is, the wage rate approximation to time value underestimates the time value for nonworking women and overestimates time value in the case of working women to the extent that serious doubts are raised about the continued use of wage rates as an approximation for time value. It must be further noted that this finding does not diminish the theoretical literature--specifically Becker's seminal value of time article because the theoretical literature explicitly considers the weaknesses in wage rate time valuation.

Second, definitive differences between Tobit and TLP failed to materialize. Given an ineffective computer budget constraint, the total results obtained from all equations suggests adoption of both procedures in order to realize the added statistical forecasting advantages inherent in Tobit analysis and the extra information generating capability of TLP regarding the respective elements in the nonlinear household decision-making process. Adoption of both methodologies allows the researcher to test the extent to which each approach fails to, or, for that matter, succeeds in adding to our store of knowledge about household demand.

Finally, the sample separation into black-white components is not considered novel in that Gregory has already illustrated the benefits accruing from such a split. However, the intercept analysis of covariance procedures fails to identify fundamental differences among the racial groups in the decision-making process. The major finding supports the continuation of racial family size responses to quality and quantity factors. In specific, black families appear to maximize total child services by acquiring a larger total number of children--each with a relatively lower quality rate, while white families maximize their yield from child services by substituting child quality for child quantity.

CHAPTER V

REVIEW OF FINDINGS

I. Introduction

Determining a research project's success or failure depends upon the existing state of the arts and the extent to which opposing views prevent any doctrine from becoming established. Based upon this criterion and because household demand studies are relatively new to the economics discipline--with all of the associated uncertainties, the research reported here provides empirical verification for many of the currently disputed theories eminating from the "new household demand" school of thought, such as Becker, Willis, De Tray and others, while concurrently supporting the criticisms of their position flowing from economists--Leibenstein, Griliches, Gregory, and others and the sociologists-demographers--Ryder and others. Specifically, criticisms from the sociological perspective emphasize the "study of the family by destroying the family" (Ryder), failure to consider parental pleasures derived from children in any context other than economic (Griliches), and the absence of sociological determinants upon household demand--especially with their implications for the price and income effects (Leibenstein). Similarly, economic criticisms focus upon the improper specification of the time price for labor force and nonlabor force participants as wages earned (Gronau, Willis, Dé Serpa, and Johnson),

plus the information loss arising from the aggregation of different racial groups into one sample (Gregory) are all found to be important determinants of the decision to marry, labor force status, and the optimal number of children. However, including these criticisms into the basic new household demand schools theoretical model supports most of the conclusions derived from purely economic analysis--the importance of separating quality-quantity factors, low income elasticity of demand for children, and time price's importance as a factor of production. The major unsubstantiated "new household demand" theory was the independence assumption between individual family member's utility functions. Each major finding is discussed in greater detail below.

II. Major Findings

To institute some clarity into the complicated nature of the household demand literature, the critical conclusions of this study are separated into those arising from methodological differences and equation specifications, respectfully.

A. Methodological Findings

1. Estimation Procedures

Although the absence of other studies comparing Tobit and TLP makes the findings reported here tentative, both techniques appear to provide a better understanding of the nonlinearities embodied in the household demand process than OLS estimations. Comparisons in all three equations are found to favor Tobit analysis from a purely statistical perspective for forecasting purposes and TLP as a vehicle for obtaining greater insights into the respective determinant's impact upon the

separate equations. Therefore, these early findings suggest usage of both procedures when possible, TLP when strictly policy considerations are desired, and Tobit for studies primarily interested in forecasting results.

2. Racial Differences

Current household studies aggregation of individual racial groups into one sample has been challenged by a number of authors in various disciplines. Because these studies are subject to the data, empirical, and specification errors illuminated earlier, determining the importance of racial factors is reevaluated again. Earlier studies main finding that the information loss resulting from aggregation is significant enough to justify a disaggregated approach whenever possible is reaffirmed here. Specifically, dominance by the white sample in statistical analysis disguises the nonwhite populations reaction to economic and noneconomic stimuli to the extent that policies based upon aggregated studies may prove to be more harmful than useful to the nonwhite segment of the population. For example, black women's labor force response to additional preschool children was shown to increase the length of their work day, while the corresponding total effect (in equation (3.9)) and white effect (in Table 4.1) suggests a decrease in labor force activity. Thus, policies designed to alter black labor force activity that also changes the families child composition produces opposite reactions between the racial groups.

The second issue in black-white research deals with the "best" means to account for racial differences empirically. One approach common

in the econometric literature applies analysis of covariance techniques within a single set of regressions. The primary alternative splits the main sample into the relevant number of racially determined subgroups. Although restricted to an intercept analysis of covariance procedure, the results reported previously provide evidence of a statistical advantage over the aggregate model. At the same time the racially determined slope response patterns are disguised. Knowledge of these patterns is required before policies designed to reach all groups equally or to concentrate upon a particular race can be effective.

B. Equation Determinants

1. Time Value Measurement

Disenchantment with actual wage rate time valuation has led to the suggested use of the woman's reservation wage for nonlabor force women and a weighted wage rate measure for labor participants. The general time value measure finds that the wage rate time valuation simultaneously understates the homemaker's contribution in the production of home produced goods and overstates the corresponding labor force participants value of time. The net effect is an erroneous allocation of time in favor of labor force activity. To the extent that these findings are supported by further research, the inability to empirically explain many women's foregoing substantive monetary incentives in order to remain in the home except for vague references to attitudes can be explained.

Including the modified time value variable into the fertility and labor force equations indicates an undervaluation of time in the fertility and labor force equation by the traditional wage rate time

measure. The direct effect of time value upon labor force activity experienced a negative sign instead of the normally assumed positive coefficient. Although this anomalous result is explained in greater detail in the preceding chapter, it confirms Gronau's arguments that women work because the value of their net marginal product in the home is less than their net marginal productivity in the labor force. So, when the relative marginal products are reversed, these women have an economic incentive to remain in the home. Hopefully, with Gronau's theoretical base and this empirical work, the myth that nonworking women contribute little to the national social product will be discarded in favor of a more enlightened view.

2. Value of Attitudinal Variables

Incorporating individual family member's attitudes into the traditional economic model both supported and argued against all schools of thought in household demand theory. Particularly important to Ryder's criticism of the utility independence assumption is the female's significant response to her spouse's attitudes in the labor equations and her choice of spouse according to those attitudes in the spouse selection equation. Thus, these results raise serious doubts about the main assumptions underlying the current theoretical base of the new household demand school in particular, and Willis's model in specific. However, extension of the model developed in Chapter II to include the male's response to his wife's attitudes solves this major criticism, and suggests that current conclusions regarding home demands are not wrong absolutely--just based upon a tenuous assumption.

The strong empirical findings for the attitudinal variables confirms the criticisms of Griliches and Leibenstein against current researches failure to permit attitudes to enter the household decision-making process. But in spite of the strong showing of the attitudinal variables, only the magnitudes of the price and income variables are diminished, and not their value for explaining household demand. Although these findings support the continued use of attitudinal variables, they also strengthen the case for the ongoing use of the primary economic determinants of household decision-making developed by the new household demand school of thought.

3. Independence of Individual Utility Functions

Of all the points of view currently in vogue, only the construction of a family utility function failed to receive any empirical support. More importantly, the empirical evidence indicates such a high degree of interaction that mathematical formations based upon family utility independence appears to be questionable at best, and very likely erroneous. The preliminary step toward developing an alternative formulation for household utility maximization originated in Chapter II suggests one avenue for further mathematical research.

III. Suggestions for Further Research

Like most empirical research, more questions are raised than answered. For example, consistently good explanatory variables were education and wage rates (or V_t) in all equations and age of marriage in the fertility equation. For all three variables, a good rationale

can be made for making these variables endogenous. Age at marriage has previously been made a function of education and wage rates by Keely, while a number of labor researchers have made education a prominent determinant of wage rates. Similarly, Eckaus, Campbell-Curtis, and other human capital researchers make education a function of expected wage rates. Obviously, some of the determining variables in the equations developed earlier are actually determined by each other. Although Keeley has done preliminary work upon the determinants of the age at marriage and an initial study is underway at the University of Houston to develop a model which makes education and wage rates endogenous, continued research will be required to understand household demand determinants.

A second area for future research involves continued tests upon the relationship between attitudinal and economic determinants. The significant improvement in traditional economic models plus the corresponding decrease in the economic variables importance should encourage further research along this line.

Finally, a recurring theme in the economic literature emphasizes the diversity of opinion among the participating researchers. In many instances the environment in which the debate takes place exudes an "either you're with me or against me" attitude, or, more specifically, the opposing views are assumed to be mutually exclusive. The support for many of the views found here suggests that the opposing theories have their own unique strengths and weaknesses that demands a synthesis of competing theories in which the best components of each are taken as

complements. Perhaps David Hume summarized this conflict the best by observing that, ". . . there is a truth and falsehood in all propositions . . ., and a truth and falsehood which lies within the compass of human understanding."

APPENDIX A

I. Introduction

Current debate over the early mathematical model's assumption that work carries no utility (or disutility), especially those arguments in favor of including work as a determinant of utility by the contributors to the symposium on Lindner's Harried Leisure Class, prompts extension of the model developed here to include hours worked in the utility function. Two additional changes include a spouse effect in determining value of time in order to explicitly consider this interdependency, and formal analysis of the time resource constraint by preserving its separability. Both changes make the analysis more complex, but offset the disadvantage by illustrating the exact interrelationship between the household demand components in greater detail.

In Section II the basic model with all stated changes is formalized and solved for its first and second order conditions. In Section III the results are interpreted, and Section IV summarizes the results.

II. The Basic Model

Alterations in the utility function and the desired constraints are incorporated into the model detailed below:

$$U = U(X, Z, L, S, N, HW) \tag{A.1}$$

and maximized subject to the following constraints:

$$HW \cdot V_T + HW^S \cdot V_T^S + Y + Y^S(S) = P_X \cdot X + [P_Z - P_Z(V_T, S)] \cdot Z + P_N(V_T, P_Z; N) + L \cdot V_T + L^S(S) \cdot V_T^S(S) \quad (A.2)$$

$$T_O = 24 = HW + L + T_Z + T_N \quad (A.3)$$

where all of the variables are defined as before. Once again, the major changes are inclusion of HW in equation (A.1), an extra constraint--equation (A.3), and adding the spouse's effect upon time valuation. All values refer to the wife except those with the superscript S.

Adding S in the list of V_T determinants impacts the system by directly considering the husband's effect upon his wife's time value, and indirectly by affecting all cross-price effects through the time value measure. Specifically, S only influenced the individual demand functions through one cross-price measure, VAL_3, in Chapter II, and this effect was limited to the spouses competition for the home produced good. Within this framework, the husband exerts a more direct influence upon family size determination, hours worked, etc. by altering the woman's time value. As before, the net effect of the respective cross-price measures plus the income effect will shed some light on the utility independence assumption.

To maximize the utility level subject to the specified constraints, equation (A.4) sets up the Lagrangian function as:

$$L = U(X,Z,L,S,N,HW) - \lambda_1\{HW\cdot V_T(HW,S,WR) + HW^S(S)\cdot V_T^S(S)$$

$$+ Y + Y^S(S) - P_X\cdot X - [P_Z + P_Z(V_T(HW,WR,S),S)]\cdot Z$$

$$- P_N[V_T(HW,WR,S);N] - L\cdot V_T(HW,WR,S) - L^S(S)\cdot V_T^S(S)\}$$

$$- \lambda_2(T_O - HW - L - T_Z - T_N) \qquad (A.4)$$

and then taking the partial derivative of equation (A.4) with respect to X, Z, L, S, N, HW, and setting the results equal to zero gives:

$$\partial L/\partial X = U_X - \lambda_1\cdot P_X = 0 \qquad (A.5)$$

$$\partial L/\partial Z = U_Z - \lambda_1\{P_Z + P_Z[V_T(HW,WR,S),S]\} = 0 \qquad (A.6)$$

$$\partial L/\partial L = U_L - \lambda_1\cdot V_T(HW,WR,S) - \lambda_2 = 0 \qquad (A.7)$$

$$\partial L/\partial S = U_S + \lambda_1\{[HW\cdot(\partial V_T/\partial S) + V_T^S\cdot(\partial HW^S/\partial S) + HW^S(\partial V_T^S/\partial S)$$

$$- [(\partial P_Z/\partial S) - (\partial P_Z/\partial V_T)(\partial V_T/\partial S)]\cdot Z + V_T^S(\partial L^S/\partial S)$$

$$- L^S\cdot(\partial V_T^S/\partial S) - L\cdot(\partial V_T/\partial S)\} = 0 \qquad (A.8)$$

$$\partial L/\partial N = U_N - \lambda_1(\partial P_N/\partial N) = 0 \qquad (A.9)$$

$$\partial L/\partial HW = U_{HW} + \lambda_1[V_T(HW,WR,S) + HW\cdot(\partial V_T/\partial HW)$$

$$- (\partial P_Z/\partial V_T)(\partial V_T/\partial HW)\ Z - (\partial P_N/\partial V_T)(\partial V_T/\partial HW)$$

$$- L(\partial V_T/\partial HW)] - \lambda_2 = 0 \qquad (A.10)$$

$$\partial L/\partial\lambda_1 = HW\cdot V_T(HW,WR,S) + HW^S(S)\cdot V_T^S(S) + Y + Y^S(S) - P_X\cdot X$$
$$- \{P_Z + P_Z[V_T(HW,WR,S),S]\}\cdot Z - P_N[V_T(HW,WR,S),S]$$
$$- L\cdot V_T(HW,WR,S) - L^S(S)\cdot V_T^S(S) = 0 \qquad (A.11)$$

$$\partial L/\partial\lambda_2 = T_O - HW - L - T_Z - T_N = 0 \qquad (A.12)$$

Setting $P_X = 1$ as the numeraire yields equation (A.13):

$$U_{HW}/U_X = -V_T(HW,WR,S) + (\partial V_T/\partial HW)\cdot HW - (\partial P_Z/\partial HW)\cdot Z$$
$$- (\partial P_N/\partial V_T)(\partial V_T/\partial HW) - (\partial V_T/\partial HW)\cdot L + \lambda_2 \qquad (A.13)$$

which states that the marginal rate of substitution between the composite good and hours worked equals the shadow price of time, λ_2, minus the marginal utility of money, λ_1, multiplied by the term in brackets. Instead of reiterating the other marginal substitution conditions, their similarity with equations (2.10)-(2.15) is noted and the analysis proceeds to the second order conditions.

Applying Cramer's rule to the bordered Hessian matrix in Table A.1 yields the following total differentials:

$$dN/dWR = \{\lambda_1[(\partial P_Z/\partial V_T)(\partial V_T/\partial WR)\cdot D_{25} + (\partial V_T/\partial WR)\cdot D_{35}$$
$$- A_8\cdot D_{45} + (\partial^2 P_N/\partial N\partial V_T)(\partial V_T/\partial WR)\cdot D_{55} - A_{11}\cdot D_{65}]$$
$$+ A_{12}\cdot D_{75}\}/D \qquad (A.14)$$

TABLE A.1

TOTAL DIFFERENTIALS FOR MODEL A

$U_{X,X}$	$U_{X,Z}$	$U_{X,L}$	$U_{X,S}$	$U_{X,N}$	$U_{X,HW}$	$-P_X$	0	dX	$\lambda_1 dP_X$
$U_{Z,X}$	$U_{Z,Z}$	$U_{Z,L}$	$U_{Z,S}-\lambda_1[(\partial P_Z/\partial S)+(\partial P_Z/\partial V_T)(\partial V_T/\partial S)]$	$U_{Z,N}$	$U_{Z,HW}-\lambda_1(\partial P_Z/\partial V_T)(\partial V_T/\partial HW)$	A_7	0	dZ	$\lambda_1 dP_Z+\lambda_1(\partial P_Z/\partial V_T)(\partial V_T/\partial W)\cdot dW$
$U_{L,X}$	$U_{L,Z}$	$U_{L,L}$	$U_{L,S}-\lambda_1(\partial V_T/\partial S)$	$U_{L,N}$	$U_{L,HW}-\lambda_1(\partial V_T/\partial HW)$	$V_T(HW,W,S)$	-1	dL	$\lambda_1(\partial V_T/\partial W)\cdot dW$
$U_{S,X}$	$U_{S,Z}-\lambda_1[(\partial P_Z/\partial S)+(\partial P_Z/\partial V_T)\cdot(\partial V_T/\partial S)]$	$U_{S,L}$	$U_{S,S}+\lambda_1\cdot A_1$	$U_{S,N}$	$U_{S,HW}+\lambda_1\cdot A_2$	A_3	0	dS	$-\lambda_1\cdot A_8\cdot dW-\lambda_1\cdot A_9\cdot dV_T^S-\lambda_1\cdot A_{10}\cdot dL^S-\lambda_1\cdot(\partial V_T^S/\partial S)\cdot dHW^S$
$U_{N,X}$	$U_{N,Z}$	$U_{N,L}$	$U_{N,S}$	$U_{N,N}-\lambda_1(\partial^2 P_N/\partial N^2)$	$U_{N,HW}$	$(\partial P_N/\partial N)$	-1	dN	$\lambda_1(\partial^2 P_N/\partial N\partial V_T)\cdot(\partial V_T/\partial W)\cdot dW$
$U_{HW,X}$	$U_{HW,Z}-\lambda_1(\partial P_Z/\partial V_T)(\partial V_T/\partial HW)$	$U_{HW,L}-\lambda_1(\partial V_T/\partial HW)$	$U_{HW,S}+\lambda_1\cdot A_4$	$U_{HW,N}$	$U_{HW,HW}+\lambda_1\cdot A_5$	A_6	-1	dHW	$-\lambda_1\cdot A_{11}\cdot dW$
$-P_X$	A_7	$V_T(HW,W,S)$	A_3	$(\partial P_N/\partial N)$	A_6	0	0	$d\lambda_1$	$A_{12}\cdot dW-dP_N-Z\cdot dP_Z+dY-X\cdot dP_X+dHW^S+dV_T^S$
0	0	-1	0	-1	-1	0	0	$d\lambda_2$	$-dT_Z-dT_N$

TABLE A.1--Continued

Where $A_1 = [HW(\partial^2 V_T/\partial S^2) + (\partial V_T^S/\partial S)\cdot(\partial HW^S/\partial S) + V_T^S(\partial^2 HW^S/\partial S^2) + HW^S(\partial^2 V^S/\partial S^2) + (\partial V_T^S/\partial S)\cdot(\partial HW_T^S/\partial S) - Z(\partial^2 P_Z/\partial S^2) - Z(\partial^2 P_Z/\partial V_T^2)\cdot(\partial^2 V_T/\partial S^2)$
$- V_T^S(\partial^2 L^S/\partial S^2) - 2(\partial^2 V_T/\partial S)\cdot(\partial L/\partial S) - L^S(\partial^2 V_T^S/\partial S^2) - L(\partial^2 V_T/\partial S^2)]$

$A_2 = [(\partial V_T/\partial S) - Z(\partial^2 P_Z/\partial V_T^2)\cdot(\partial^2 V_T/\partial S\cdot\partial HW) - L(\partial^2 V_T/\partial S\cdot\partial HW)]$

$A_3 = HW(\partial V_T/\partial S) + V_T^S(\partial HW^S/\partial S) + HW^S(\partial V_T^S/\partial S) - Z(\partial P_Z/\partial S) - Z(\partial P_Z/\partial V_T)\cdot(\partial V_T/\partial S) - V_T^S(\partial L^S/\partial S) - L^S(\partial V_T^S/\partial S) - L(\partial V_T/\partial S)$

$A_4 = [(\partial V_T/\partial S) - (\partial^2 P_N/\partial V_T^2)\cdot(\partial^2 V_T/\partial HW\cdot\partial S)]$

$A_5 = [(\partial V_T/\partial HW) - Z(\partial^2 P_Z/\partial HW^2) - (\partial^2 P_N/\partial V_T^2)\cdot(\partial^2 V_T/\partial HW^2) - L(\partial^2 V_T/\partial HW^2)]$

$A_6 = [V_T(HW,W,S) + (\partial V_T/\partial HW)\cdot HW - Z(\partial P_Z/\partial HW)Z - (\partial P_N/\partial V_T)\cdot(\partial V_T/\partial HW) - L(\partial V_T/\partial HW)]$

$A_7 = \{P_Z - P_Z[V_T(HW,W,S),S]\}$

$A_8 = HW(\partial V_T/\partial S\cdot\partial W) - Z(\partial^2 P_Z/\partial V_T^2)\cdot(\partial^2 V_T/\partial S\cdot\partial W) - L(\partial^2 V_T/\partial S\cdot\partial W)$

$A_9 = (\partial L^S/\partial S) + (\partial HW^S/\partial S)$

$A_{10} = \partial V_T^S/\partial S$

$A_{11} = (\partial V_T/\partial W) + (\partial V_T/\partial HW\cdot\partial W)\cdot HW - Z(\partial^2 P_Z/\partial V_T^2)\cdot(\partial^2 V_T/\partial HW\cdot\partial W) - (\partial^2 P_N/\partial V_T^2)\cdot(\partial^2 V_T/\partial HW\cdot\partial W) - L(\partial^2 V_T/\partial HW\cdot\partial W)$

$$dHW/dWR = \{\lambda_1[(\partial P_Z/\partial V_T)(\partial V_T/\partial WR)\cdot D_{26} + (\partial V_T/\partial WR)\cdot D_{36} - A_8\cdot D_{46} + (\partial^2 P_N/\partial P_N\partial V_T)(\partial V_T/\partial WR)\cdot D_{56} - A_{11}\cdot D_{66}] + A_{12}\cdot D_{76}\}/D \quad (A.15)$$

$$dS/dWR = \{\lambda_1[(\partial P_Z/\partial V_T)(\partial V\ /\partial WR)\cdot D_{24} + (\partial V_T/\partial WR)\cdot D_{34} - A_8\cdot D_{44} + (\partial^2 P_N/\partial N\partial V_T)(\partial V_T/\partial WR)\cdot D_{54} - A_{11}\cdot D_{64}] + A_{12}\cdot D_{74}\}/D \quad (A.16)$$

where equations (A.14)-(A.16) approximate the total differentials in equations (2.17)-(2.19) in including own and cross-price plus a Slutsky income effect, although the exact composition differs.

Distinct from equations (2.17)-(2.19) and important to us is the observation that the total differential in equation (A.15) does not necessarily imply a reduction in hours worked with an increase in wage income unless the sum of the elements in equation (A.15) are positive. If the value of dHW/dW exceeds zero the worker corresponds to a "depressive" in Phelp's terminology, or one who lives to work instead of the commonly assumed work to live theory. The inherent advantage to this approach follows from its greater generality relative to less flexible techniques usually used to study labor force activity.

Although discussion of every total differential provides unique insights into the operation of household demand and family formation, an alternative approach requiring less space is analysis of changes in the spouses time value and labor force participation upon the labor

force activity of the individual under study. The total differentials with respect to movements in the spouses work habits and time value are specified in equations (A.17) and (A.18), respectfully, as:

$$dHW/dHW^S = -(V_T^S/S)\cdot\lambda_1\cdot D_{47} + D_{67}/D \tag{A.17}$$

$$dHW/dV_T^S = -A_9\cdot\lambda_1\cdot D_{47} + D_{67}/D \tag{A.18}$$

In both instances the change in labor force participation is the sum of the substitution effect and Slutsky income effect. The exact movement in hours worked depends upon the relative sign and magnitude of the two effects. The diversity among the empirical studies suggests that the theoretical approach developed here partially accounts for the conflicting conclusions.

The theoretical conclusions in Appendix A support those of the model developed in Chapter II within a slightly different framework. The advantage of the latter model is its demonstration of the failing in current research to consider utility interdependence and transforms the basic model into a form more suitable for empirical testing.

BIBLIOGRAPHY

Books

Becker, Gary S. "An Economic Analysis of Fertility." In Demographic and Economic Change in Developed Countries. National Bureau Conference Series 11. Princeton: Princeton University Press, 1960.

Bowen, William and T. A. Finegan. The Economics of Labor Force Participation. Princeton, N. J.: Princeton University Press, 1969.

Cain, Glen G. Married Women in the Labor Force: An Economic Analysis. Chicago: Chicago University Press, 1966.

Duesenberry, James. Comment on "An Economic Analysis of Fertility," by Gary Becker. In Demographic and Economic Change in Developed Countries. National Bureau of Economic Research Conference Series 11. Princeton: Princeton University Press, 1960.

Easterlin, Richard A. Population, Labor Force, and Long Swings in Economic Growth: The American Experience. General Series 56. New York: National Bureau of Economic Research, 1968.

_____. "Towards a Socio-Economic Theory of Fertility: A Survey of Recent Research on Economic Factors in American Fertility." In Fertility and Family Planning: A World View. Edited by J. Behrman, Leslie Corsa and Ronald Freeman. Ann Arbor: University of Michigan Press, 1969.

Friedman, M. A Theory of the Consumption Function. Princeton: Princeton University Press, 1957.

Goldberger, Arthur S. Econometric Theory. New York: John Wiley and Sons, 1964.

Gronau, Reuben. "The Measurement of Output in the Non-Market Sector--Evaluation of the Housewife's Time." In Measurement of Economic and Social Performance. Studies in Income and Wealth, no. 38. New York: National Bureau of Economic Research, 1974.

Henderson, James M. and Quandt, Richard E. Microeconomic Theory: A Mathematical Approach. New York: McGraw-Hill Co., 1971.

Jacobsen, Paul, ed. An Anthology of Society. New York: McGraw-Hill, 1970.

Kuznets, Simon. Economic Growth of Nations. Cambridge: McGraw-Hill Press, 1971.

Leibenstein, Harvey. "The Impact of Population Growth on Economic Welfare--Non-traditional Elements." In Rapid Population Growth. Baltimore: Johns Hopkins Press, 1971.

Mincer, Jacob. "Labor Force Participation of Married Women." In Aspects of Labor Economics. Edited by Gregg Lewis. Princeton: Princeton University Press, 1962.

_____. "Market Prices, Opportunity Costs, and Income Effects." In Measurement in Economics: Studies in Mathematical Economics and Econometrics in Memory of Yehuda Grunfeld. Edited by C. Christ. Stanford: Stanford University Press, 1963.

_____. Comment on "The Production of Human Capital Over Time," by Yoram Ben Porath. In Education, Income, and Human Capital. Edited by W. Lee Hansen. New York: National Bureau of Economic Research, 1970.

Okun, Bernard. Trends in Birth Rates in the United States since 1870. Studies in Historical and Political Science, series 77. Baltimore: Johns Hopkins Press, 1958.

_____. Comment on "An Economic Analysis of Fertility," by Gary Becker. In Demographic and Economic Change in Developed Countries. National Bureau Conference Series 11. Princeton: Princeton University Press, 1960.

Reid, Margaret G. Economics of Household Production. New York: Wiley, 1934.

_____. Housing and Income. Chicago: University of Chicago Press, 1962.

Ryder, Norman B. "The Emergence of a Modern Family Pattern: U.S. 1917-1966." In Fertility and Family Planning: A World View. Edited by S. J. Behrman, Leslie Corsa, and Ronald Freedman. Ann Arbor: University of Michigan Press, 1969.

_____, and Westoff, Charles F. Reproduction in the United States, 1965. Princeton: Princeton University Press, 1971.

Schultz, T. Paul. "An Economic Perspective on Population Growth." In Rapid Population Growth. Baltimore: Johns Hopkins Press, 1971.

Theil, Henri. Principles of Econometrics. New York: John Wiley and Sons, 1971.

Articles

Adelman, Irma. "An Econometric Analysis of Population Growth." American Economic Review 53 (June 1963):314-39.

Barth, P. S. "Unemployment and Labor Force Participation." Southern Economic Journal 47 (January 1968):375-82.

Becker, Gary. "A Theory of the Allocation of Time." Economic Journal 75 (September 1965):493-517.

_____. "A Theory of Marriage." Journal of Political Economy 84 (January/February 1974):1-27.

_____. "A Theory of Marriage." Journal of Political Economy 83 (October 1973):1-36.

_____, and Lewis, Gregg. "On the Interaction between the Quality and Quantity of Children." Journal of Political Economy 81 (March/April 1973):279-88.

Ben-Porath, Yoram. "The Production of Human Capital and the Life Cycle of Earnings." Journal of Political Economy 75 (August 1967): 352-65.

_____. "Economic Analysis of Fertility in Israel." Journal of Political Economy 79 (August 1969):390-401.

Blake, Judith. "Are Babies Consumer Durables? A Critique of the Economic Theory of Reproduction Motivation." Population Studies 22 (March 1968):5-25.

Bumpass, Larry. "Age at Marriage as a Variable in Socio-Differentials in Fertility." Demography 6 (February 1969):45-54.

Cain, Glen. "A Comment." Journal of Political Economy 81 (March/April 1973):141-44.

Dernburg, T. and Strand, K. "Hidden Unemployment 1953-1962: A Quantitative Analysis by Age and Sex." American Economic Review 56 (March 1966):71-95.

De Tray, Dennis. "Child Quality and the Demand for Children." Journal of Political Economy 81 (March/April 1973):70-95.

Diewert, W. E. "An Application of the Shepard Duality Theorem: A Generalized Leontief Production Function." Journal of Political Economy 79 (May/June 1971):481-507.

Freedman, Ronald. "Economic Considerations in Family Growth Decisions." Population Studies 20 (November 1966):197-222.

_____, and Slesinger, Doris. "Fertility Differentials for the Indigenous Non-Farm Population of the United States." Population Studies 15 (November 1961):161-73.

Freiden, Alan. "The U.S. Marriage Market." Journal of Political Economy 85 (March/April 1974):1-24.

Friedlander, Stanley, and Silver, M. "A Quantitative Study of the Determinants of Fertility Behavior." Demography 4 (January 1967):30-70.

Fuchs, Victor. "Differences between Hourly Earnings between Men and Women." Monthly Labor Review 94 (May 1971):9-15.

Goldberg, David. "The Fertility of Two-Generation Urbanites." Population Studies 12 (July 1958):214-22.

Gregory, Paul; Campbell, John; and Cheng, Ben. "A Simultaneous Equation Model of Birth Rates in the United States." Review of Economics and Statistics 57 (November 1972):57-64.

Gregory, Paul; Campbell, John; and Cheng, Ben. "A Cost Inclusive Simultaneous Equation Model of Birth Rates." Econometrica 63 (July 1972):29-44.

Griliches, Zvi. "Comment." Journal of Political Economy 82 (March/April 1974):219-21.

Gronau, R. "The Effect of Children on Housewife's Value of Time." Journal of Political Economy 81 (March/April 1973):168-99.

Gronau, Reuben. "The Intra-Family Allocation Time: The Value of the Housewife's Time." American Economic Review 63 (September 1973): 633-51.

Grossman, Michael. "On the Concept of Health Capital and the Demand for Health." Journal of Political Economy 80 (March/April 1972):223-55.

Hill, C., and Stafford, F. "Allocation of Time to Preschool Children and Educational Opportunity." Econometric Abstracts (February 1972), 58.

Houthakker, Hendrik S. "Compensated Changes in Qualities and Quantities Consumed." Review of Economic Studies 19 (1952):155-61.

Lancaster, Kelvin J. "A New Approach to Consumer Theory." Journal of Political Economy 74 (April 1966):132-57.

Landsberger, Michael. "An Integrated Model of Consumption and Market Activity: The Children Effect." American Statistical Association, Social Statistics Section, Proceedings (1971), 137-42.

Leibenstein, Harvey. "An Interpretation of the Economic Theory of Fertility." Journal of Economic Literature 12 (June 1974):457-79.

Lindsay, C. M. "Measuring Human Capital Returns." Journal of Political Economy 79 (November/December 1971):1195-1215.

Mankin, Wyatt. "A New Look at the Muth Model." American Economic Review 77 (September 1972):470-74.

McCall, J. J. "Economics of Information and Job Search." Quarterly Journal of Economics 84 (February 1970):113-26.

Michael, R. and Lazear, P. "On the Shadow Price of Children." Econometric Abstracts (February 1972), 57.

Michael, Robert. "Dimensions of Household Fertility: An Economic Analysis." American Statistical Association, Social Statistics Section, Proceedings (1971), 126-36.

_____. "Education and the Derived Demand for Children." Journal of Political Economy 81 (March/April 1973):128-67.

Nerlove, Marc. "Further Evidence on the Estimation of Dynamic Economic Relations from a Time Series of Cross-Sections." Econometrica 39 (March 1971):359-82.

_____. "Household and Economy: Toward a New Theory of Population and Economic Growth." Journal of Political Economy 82 (March/April 1974):200-218.

Potter, Robert G. "Birth Intervals: Structure and Change." Population Studies 17 (November 1965):152-62.

Reder, M. "Wage Structure and Structural Unemployment." Review of Economic Studies 29 (October 1964):309-21.

Rees, A. "On Equilibrium in Labor Markets." Journal of Political Economy 78 (March 1970):306-10.

Ryder, Norman B. "A Comment." Journal of Political Economy 81 (March/April 1973):68-71.

Samuelson, Paul A. "International Price Equalization Once Again." Economic Journal 59 (June 1949):181-97.

_____. "Social Indifference Curves." Quarterly Journal of Economics 70 (February 1956):1-22.

Schultz, T. Paul. "An Economic Model of Family Planning and Fertility." Journal of Political Economy 77 (March/April 1969):153-80.

Schultz, T. W. "New Economic Approaches to Fertility." Journal of Political Economy 81 (March/April 1973):1-18.

_____. "The High Value of Time: Population Equilibrium." Journal of Political Economy 82 (March/April 1974):2-10.

Silver, Morris. "Births, Marriages, and Business Cycles in the United States." Journal of Political Economy 73 (June 1965):237-55.

Simon, Julian. "The Effect of Income on Fertility." Population Studies 23 (November 1969):327-41.

Stolper, Wolfgang and Samuelson, Paul A. "Protection and Real Wages." Review of Economic Studies 9 (1941):58-73.

Strand, K. and Dernburg, T. "Cyclical Variation in Civilian Labor Force Participation." Review of Economics and Statistics 46 (November 1964):378-91.

Sutton, Gordon F. and Wunderlich, Gooloo S. "Estimating Marital Fertility Rates by Educational Attainment Using a Survey of New Mothers." Demography 4 (1967):135-42.

Tella, A. "Labor Force Sensitivity to Employment by Age and Sex." Industrial Relations 34 (February 1965):69-83.

_____. "The Relation of Labor Force to Employment." Industrial and Labor Relations Review 19 (April 1964):454-59.

Theil, Henri. "Qualities, Prices, and Budget Inquiries." Review of Economic Studies 19 (1952):129-47.

Tobin, J. "Estimation of Relationships for Limited Dependent Variables." Econometrica 26 (January 1958):73-85.

Venieris, Yiannis; Sebold, Fred; and Harper, Richard. "The Impact of Economic, Technological and Demographic Factors on Aggregate Births." Review of Economics and Statistics 55 (November 1973): 640-51.

Vroman, W. "The Labor Reserve: A Reestimate." Industrial Relations (October 1970), 14-21.

Wachter, Michael L. "A Labor Supply Model for Secondary Workers." Review of Economics and Statistics 34 (August 1972):141-51.

Walker, Kathryn E. "Time Spent in Household Work by Homemakers." Family Economic Review 62 (September 1969):5-6.

Weintraub, R. "The Birth Rate and Economic Development, An Empirical Study." Econometrica 40 (October 1962):36-42.

Welch, Ferris. "Measuring the Quality of Schooling." American Economic Review 56 (May 1966):379-92.

Wilkinson, Maurice. "An Econometric Analysis of Fertility in Sweden." Econometrica 41 (July 1973):633-42.

Willis, R. "A New Approach to the Economic Theory of Fertility Behavior." Journal of Political Economy 81 (March/April 1973): 14-69.

Unpublished Papers

Ben-Porath, Yoram. "Economic Analysis of Fertility in Israel: Point Counterpoint." Discussion No. 244, Harvard Institute of Economic Research, Harvard University, June 1972.

_____. "Labor Force Participation Rates and the Supply of Labor." Discussion Paper No. 206, Harvard Institute of Economic Research, Harvard University, September 1971.

Campbell, John. "A Simultaneous Equation Test for an Indirect Relationship between the Components of Population Growth." Paper presented at the 1974 meetings of the Western Economic Association, Las Vegas, June 1974.

_____, and Conger, Darius. "Population Dynamics." Paper presented at the 1974 meetings of the Western Economics Association, Las Vegas, June 1974.

Denton, Frank, and Spencer, Byron. "A Simulation Analysis of the Effects of Population Change on a Neoclassical Economy." Working Paper No. 71-01, McMaster Economic Studies, McMaster University, January 1972.

DeTray, Dennis N. "The Interaction between Parent Investment in Children and Family Size: An Economic Analysis." Santa Monica, California: Rand Corporation, May 1972.

Gregory, Paul. "A Stock Adjustment Model of Fertility: The White and Non-White U.S. Population (1946-1970)." Houston: University of Houston, June 1973. (Mimeographed.)

Gronau, Reuben. "A Study in the Theory of Marriage." Paper presented at the 1971 meetings of the Econometric Society, New Orleans, December 1971.

Grossman, Michael. "The Economics of Joint Production in the Household." Report 7145, Center for Mathematical Studies in Business and Economics, University of Chicago, September 1971.

Hill, C. Russell, and Stafford, Frank P. "The Allocation of Time to Children and Educational Opportunity." Discussion Paper, Institute of Public Policy Studies, University of Michigan, December 1971.

Leibowitz, Arleen S. "Education and the Allocation of Women's Time." New York: National Bureau of Economic Research, 1972. (Mimeographed.)

Mankin, Wyatt, and Campbell, John. "Common Errors in the Theory of Time." Working Paper, Department of Economics, University of Oklahoma, December 1973.

Michael, Robert T., and Lazear, Edward P. "On the Shadow Price of Children." Paper presented at the 1971 meetings of the Econometric Society, December 1971.

Smith, James P. "Life Cycle Patterns." Chicago: University of Chicago, 1972. (Mimeographed.)

Dissertations

DeTray, Dennis N. "The Substitution between Quality and Quantity of Children in the Household." Ph.D. dissertation, University of Chicago, 1972.

Espenshade, T. "The Cost of Children in the Urban United States." Ph.D. dissertation, Princeton University, 1972.

Freiden, Alan. "A Model of Marriage and Fertility." Ph.D. dissertation, University of Chicago, 1972.

Grossman, Michael. "The Demand for Health: A Theoretical and Empirical Investigation." Ph.D. dissertation, Columbia University, 1970.

Keeley, Michael. "A Model of Marital Formation: The Determinants of the Optimal Age of First Marriage." Ph.D. dissertation, University of Chicago, 1973.

Leibowitz, Arleen S. "Women's Allocation of Time to Market and Nonmarket Activities: Differences in Education." Ph.D. dissertation, Columbia University, 1972.

Michael, Robert T. "The Effect of Education on the Efficiency in Consumption." Ph.D. dissertation, Columbia University, 1969.

Ofek, H. "Allocation of Time in a Family Context." Ph.D. dissertation, Columbia University, 1972.

Smith, James P. "The Life Cycle Allocation of Time in a Family Context." Ph.D. dissertation, University of Chicago, 1972.

Willis, Robert J. "The Economic Determinants of Fertility Behavior." Ph.D. dissertation, University of Washington, 1971.

Public Documents

Cohen, Malcolm S.; Rea, Samuel A.; and Lerman, Robert J. "A Micro Model of Labor Supply." Bureau of Labor Statistics Staff Report Paper no. 4, U.S. Depaetment of Labor Statistics, Washington D.C., 1970.