HOUSEHOLD INCOME POOLING AND THE DEMAND FOR FOOD:

DOES FAMILY FINANCIAL STRUCTURE MATTER?

A Dissertation

by

ERNESTO PERUSQUIA CORRES

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2006

Major Subject: Agricultural Economics

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Approved by:

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ABSTRACT

Household Income Pooling and the Demand for Food:

Does Family Financial Structure Matter? (August 2006)

Ernesto Perusquia Corres, B.A., The University of Texas at San Antonio;

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Research on food consumption and expenditures usually employs the use of unitary models that do not account for type of family financial structure. This research presents two collective models of household behavior, conditional and unconditional models, which were used in the analysis of the household data that came from the "Parental Time, Role Strain and Children's Fat Intake and Obesity Related Outcomes". This research utilized the Generalized Method of Moments in the estimation of the system of expenditures on food at and away from home to test the validity of the unitary model by testing one of the implications of this model, the income pooling hypothesis, as well as family financial structure. It was found that the omission of family financial structure and not the income pooling hypothesis would lead to the incorrect assertion that the unitary model is the correct model for the analysis of intrahousehold allocation. The collective models proposed in this research were found to be preferred to those of the unitary models. These two models, conditional and unconditional, not only allow for the effect of earned and unearned incomes of fathers and mothers to be different, but also incorporate family financial structure into the analysis of expenditures on food

at and away from home. This research shows that the parameters of the unitary models are reduced form parameters that do not represent the effect that the variable of interest has on the household expenditures category of interest. This research finds that these reduced form parameters show the total effect which is composed of three parts. First, the change in the expenditure category of interest that comes about from a change in the variable of interest when we hold family financial structure constant. Second, the change in the expenditure category of interest that comes about from a change in the family financial structure. Third, the change in family financial structure that comes about from a change in the variable of interest.

DEDICATION

To my beloved wife Elaine, the love of my life and the source of my inspiration

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My PhD journey was long and hard. It started in late 1998 just before my daughter Paige was born. I decided to embark on the journey that, over the last seven years, has taken me to the completion of my PhD studies at Texas A&M University. After meeting the faculty and staff at Texas A&M University, the decision to attend this university was very easy. As a married student with small children, my family and I faced a different set of circumstances. We were very pleased to be welcomed into a great community in which all of us prospered. I am extremely thankful that I was embraced by Professors George Davis, Rodolfo Nayga, W. Alex McIntosh and H. Alan Love, members of my graduate advisory committee. I cannot thank them enough for their friendship, guidance, as well as for their continuous contributions to my learning during these seven years. I want to express my deepest appreciation and eternal gratitude to Professor George Davis who was the most important contributor to the development of my dissertation. I am especially grateful to Dr. Nayga for his important contributions to my research. I am also indebted to Dr. McIntosh for his contributions to my research, in the areas of power within the household and family financial structure. I would also like to thank Professor Cruz Torres for sharing words of wisdom and providing continuous encouragement. Special thanks to Vicki Heard for her patience and help in answering countless questions and providing help in the graduate office.

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CHAPTER I

INTRODUCTION: INTRA-HOUSEHOLD ALLOCATION OF RESOURCES

A. Introduction

In chapter V of his book *Foundations of Economic Analysis,* Samuelson (1986) states that the single criterion that differentiates modern economic theory (i.e. neoclassical economic theory) from classical economic theory is the introduction of the subjective theory of value (utility). Neoclassical microeconomic theory is founded on the assumption that an individual's preferences and tastes can be represented by his/her personal rational utility that determines his/her behavior. The common assumption is that an individual's preferences are represented by a fixed utility function. The consumer's problem then becomes the maximization of his/her utility, *U*, which is defined over *n* market goods, x_i where *i*=1,…,*n,* available for his/her consumption subject to a budget constraint which defines the set of available alternative choices. The budget constraint states that total expenditures on market goods, $\sum_i p_i x_i$, must be no greater than total money income, *I,* p_i is the price of market good *i,* x_i This maximization problem is given by:

$$\begin{aligned} &\underset{x_i}{Max}\, U\left(x_1,...,x_n\right) \\ &s.t.\quad \sum_i p_i x_i \le I \end{aligned} \tag{1.1}$$

This dissertation follows the style and format of the *American Economic Review*.

The result of this maximization problem is a set of market good demands which are functions of market goods prices and total money income. The market good demands are given by:

(1.2) $$x_i = h(p_1, ..., p_n, I)$$

This set-up also leads to the following restrictions: homogeneity, adding-up, symmetry, and negative semi-definiteness of the Slutsky matrix on demand functions, which can be empirically tested with observable consumptions and labor supply. Conversely, demand functions that are found to satisfy these theoretical restrictions can be shown to be integral to a rational preference ordering.

In the majority of economic literature, *consumers* and *households* are treated as if they are the same, and single individual households are lumped together with households that have multiple members. The neoclassical approach assumes implicitly that a household, even if it has different individuals, behaves as a single decision-making unit. Furthermore, household labor supply and consumption are considered to be the observable result of the maximization of a fixed utility function subject to the household budget constraints. Because the household is treated as a single unit, this framework is often referred to in economic literature as the *unitary model*.

The validity of the unitary model is questioned on three perspectives: methodological, empirical and welfare analysis. From the methodological perspective, it is argued that subjective preferences are inseparable from what is referred to as *methodological individualism*, which asserts that social theories should correspond with

individual behavior[1]. Therefore, *methodological individualism* calls for an approach that explicitly takes into account the notion that a household is a group of individuals, with different preferences and tastes, among whom an intra-household decision process takes place. The distinction between individual and household preferences is necessary if household preferences and individual preferences do not coincide. The sociological literature in the area of money management in households pioneered by Pahl (1983) shows that since the early part of the twentieth century household and individual preferences in industrialized nations have diverged.

Vermeulen's (2002) characterization of the unitary model as an *empirical straight-jacket* for observable household labor supply and consumption behavior rests on two empirical restrictions. The first empirical restriction of the unitary model is referred to as the *income pooling hypothesis*, which implies that the source of exogenous (nonlabor) income is not important in determining the allocation of labor supply and consumption. Therefore, only total household nonlabor income matters. The income pooling hypothesis has been rejected by a number of empirical studies such as Thomas (1990) and Lundberg, Pollak and Wales (1997). The second empirical restriction of the unitary model is that the marginal compensated wage changes of two individuals in a household have the same effect on each other's labor supply. This restriction of the unitary model is rejected by, among others, Browning and Chiappori (1998).

From the welfare analysis perspective, the unitary model faces some difficulties when it comes to the normative welfare analysis of household behavior. Unitary

[1] Blaug, M. (1980), *The Methodology of Economics. Or how Economists Explain.* Cambridge: Cambridge University Press.

models must impose very strong and restrictive assumptions in order to determine the intrahousehold allocation of labor supply, consumption and welfare. The majority of welfare economics only studies the distribution of welfare among households. One of the implications is that the welfare of individuals within the household is not important. The unwarranted acceptance of the unitary model may conceal inequality in the distribution of welfare within the household and lead to the underestimation of poverty, health status, and access to resources for individuals within the household, i.e., women and children. Therefore, knowledge of the intrahousehold decision process may be necessary when trying to evaluate programs that target the welfare of women and children.

The purpose of this literature review is not only to explore the changes that have taken place in the study of household behavior since the introduction of the unitary model, but also to incorporate the sociological literature on family financial structure in the analysis of household behavior. We pay special attention to the treatment of intrahousehold allocation of resources and time.

The first section of the literature review is dedicated to the study of the unitary model with time and household production. We begin by examining Becker (1965) who introduces household production and time into the unitary model. We then turn our attention to extensions to the basic unitary model which do not examine intrahousehold allocation of resources. We divide these extensions into two parts.

First, we examine the possible limitations of the household production model (HPM). Pollak and Wachter (1975) conclude that joint production, which is inherently

important in household technology, breaks the link between the HPM and the neoclassical theory in which it is based. They argue that the break between both theories happens because the demands for household commodities become functions of commodity prices, which are themselves functions of goods prices and household technology. Therefore, the household production model of Becker (1965) requires two strong assumptions about household technology, constant returns to scale and nonjoint production, in order for the demand for household commodities to be functions of only commodity prices.

Second, we will look at examples of the HPM paying special attention to the role of time. This research is found in the recreational demand literature. Within the recreational demand literature, we examine four different aspects of the valuation of time within the household production model. We first examine the concept of *timing of time* which was introduced by Smith, Desvousges and McGivney (1983). The concept of *timing of time* states that all of time in the time horizon can not be treated the same due to the time constraints imposed by one's type of work. We then examine the effect that work flexibility has in the valuation of recreational time which was introduced by Bockstael, Strand and Hanneman (1987). We then study in McConnell (1992) the dual role that time spent onsite has as a source of utility and a cost of engaging in a recreational activity. Finally, we examine the effect that endogenous marginal value of leisure time has in terms of both money and time as proposed by Larson and Shaikh (2001). We then turn our attention to the study of the unitary models that account for the intrahousehold allocation of resources (Gronau, 1973 and Gronau, 1977).

In section two of the literature review, by using game theoretic models we examine nonunitary models of household behavior that explicitly take into account the possibility of several decision makers in a household. The first part of section two is dedicated to the study of cooperative bargaining models of household behavior based on the Nash-bargaining solution concept (McElroy and Horney, 1981; McElroy, 1990 and McElroy and Horney, 1990). The second part of section two is dedicated to the study of collective models of household behavior based on Pareto efficiency (Chiappori, 1988a; Browning et al., 1994; Chiappori, 1997 and Browning and Chiappori, 1998). The third and final part of section two is dedicated to the study of noncooperative bargaining models of household behavior which may provide noncooperative suboptimal outcome (Lundberg and Pollak, 1993).

In section three of the literature review, we examine the empirical results of the analysis of time in unitary models using household production methodology. One model by Kooreman and Kapteyn (1987) not only examines total household consumption but also examines the individual household member's allocation of time between work and household production.

The two remaining models not only analyze household production and consumption of different household commodities but also study the allocation of time by individual household members among household production activities, leisure and work (Yamada, Yamada and Kang, 1999 and Lecocq, 2001).

In section four of the literature review, we examine two important tests of the unitary model that empirically determine the validity of the income pooling hypothesis.

The first test of the income pooling hypothesis not only examines whether the unearned income of fathers and mothers is spent differently, but also examines the effect that income in the hands of the mother and father has on family health and welfare as measured by the nutritional outcomes on children (Thomas, 1990). The second test of the income pooling hypothesis makes use of a natural experiment that occurred in the United Kingdom that led to an exogenous increase in the unearned income of mothers (Lundberg, Pollak and Wales, 1997).

In the fifth and last section of the literature review, we will examine the role that the family financial structure literature can play in the study of collective models of household behavior. The literature of family financial structure can provide us with sociological information that may shed light on the decision-making process within the household.

B. Unitary Models

1. *Unitary Models with No Intrahousehold Allocation*

The unitary model was extended by Becker (1965) with the introduction of his household production model that added household production and a time constraint to the unitary model. Unlike its predecessors, the household production model (HPM) derives its utility from the maximization of the consumption of household commodities, which are produced by combining market goods and time, subject not only to a budget constraint but also a time constraint.

In Becker's (1965) model, time is divided into two categories: working and non-working time. The cost of non-working time is subdivided into direct and indirect. The direct costs are defined as the sum of the market prices of non-working activities while the indirect costs are defined as the opportunity cost of time used on non-working activities. Becker's HPM uses what he terms the *full income approach* which incorporates time into budget constraint by converting time into goods through money income. Becker's HPM not only allows us to examine the effect that earned income, unearned income and market prices have on consumption behavior but also allows us to examine the effect that the changes in work productivity, the allocation of time to working and non-working activities, has on the set of household commodities produced. Becker's 1965 HPM is given by equations by:

$$\begin{aligned} &\underset{z_i}{Max}\ U = U(z_1,...,z_n) \\ &s.t.\quad \sum_i p_i x_i = N + T_w w \\ &\qquad \sum_i T_i = T_c = T_o - T_w \\ &\qquad T_i = t_i z_i\,,\ x_i = b_i z_i \end{aligned} \tag{1.3}$$

In this model, N denotes unearned income, T_w denotes the total time that the household spends working, w denotes the wage rate of the household, T_i denotes the time used in the production of household commodity i, T_c denotes the time spent consuming or leisure time, z_i denotes household commodity i, x_i denotes market good i and p_i is the price of x_i. Household commodity i is produced by combining market

goods and time[2]. The price of the household commodity *i* is can be obtained by substituting the last three constraints into the first constraint. The resulting household commodity price is given by $\pi_i = b_i p_i + t_i w$. The household commodity price has two parts: the sum of the price of the market good per unit of household commodity $\left(b_i p_i\right)$ and the cost of time per unit of commodity produced $\left(t_i w\right)$. The sum of unearned and earned income, $N + T_w w$, when T_w is equal to the total available time of the household, T_0, gives us the maximum attainable income. We can see that the maximum attainable income can be spent on market goods, $b_i p_i z_i$, or as forgone income from consuming instead of working, $t_i w z_i$. The resulting household commodity and market goods demands are given by:

(1.4) $$z_i = z_i\left(\pi_1,...,\pi_n, N, w, T_c, T_o, T_w\right) = z_i\left(p_1,...,p_n, N, w, T_c, T_o, T_w\right)$$

(1.5) $$x_i = f_i\left(\pi_1,...,\pi_n, N, w, T_c, T_o, T_w\right) = f_i\left(p_1,...,p_n, N, w, T_c, T_o, T_w\right)$$

It is important to make the observation that the demands for household commodities and market goods can be written as functions of household commodity prices and unearned income or as functions of market goods prices, wages which in this case give us the value of time, and unearned income because commodity prices are defined as functions of market prices and wages.

Becker's (1965) model rests on three strong assumptions. First, it assumes that the household exhibits constant returns to scale (CRTS) in the production of household

[2] This production function (1.3) is a fixed coefficient production technology. The last two equations of (1.3) represent the fixed coefficient production technology which is in terms of t_i and b_i which represent the

commodities[3]. Second, it assumes that there is no joint production when producing household commodities[4]. The first two assumptions are consequence of the fixed coefficient technology that is employed by Becker (1965). Third, the household hourly wage, *w*, is assumed to be constant across time and independent of the household commodities produced. From the first order conditions, we observe that the marginal utility of the i[th] household commodity is equal to the marginal utility of income times the full price of the i[th] household commodity, $U_{Z_i} = \lambda \pi_i$. However, if the household wage rate is not constant, *w*, then the maximum attainable income will overstate the money income if the marginal wage rate is less than the average wage rate. Thus, the allocation of money spent on non-working activities will be determined only by the effect of income and not by the effect of utility.

The validity of CRTS in the production of household commodities and non-joint production of household commodities made by Becker (1965) have come into question. Pollak and Wachter (1975) show that the violation of either of these assumptions renders the use of commodity prices useless since demand for household commodities would not only become a function of commodity prices but would also depend on the household technology, market goods prices and preferences. This means that commodity prices can no longer be interpreted as shadow or implicit prices because we

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input time and the amount of market goods per unit of Z_i respectively.

[3] We can see that the production function given by the last two constraints of (1.3) is linearly homogeneous, which implies that doubling the inputs will result on doubling the outputs.

[4] Becker (1965) not only assumes that $\frac{\partial z_i}{\partial x_i} \geq 0$ and $\frac{\partial z_i}{\partial T_i} \geq 0$ but also assumes that if a market good or time period was used in the production of several commodities that we can separate these joint costs and uniquely and fully allocate them between the household commodities being produced. We can see that this is a result of the production function in (1.3) proposed by Becker (1965).

cannot untangle the effects of preferences and technology. In the absence of constant returns to scale and/or non-joint production, Pollak and Wachter (1975) argue that we must therefore re-write Becker's (1965) model in the following manner:

$$\begin{aligned} &\underset{x_i, T_c}{Max}\, U(x_i, T_c) \\ &s.t. \sum\nolimits_i p_i x_i = N + T_w w \\ &T_o = T_w + T_c \end{aligned} \tag{1.6}$$

Here we can see that the utility function is written as a function of market goods and time spent consuming. Pollak and Wachter (1975) formulate the utility function in this manner because they argue that due to the violations of CRTS and non-joint production, commodity prices are not central to the HPM and that commodity demands can be modeled as functions of market goods price, wages, unearned income and the household technology. We find that another reason for this formulation of the utility function is that, as argued by Pollak and Wachter (1975), time can in itself be a source of utility or disutility. In other words, time spent consuming yields utility. The solutions to the maximization problem (1.6) are the demands for market goods and time, respectively, which are functions of prices, wages and unearned income.

$$x_i = h_i(p_1, ..., p_n, w, N, T_0, T_w) \tag{1.7}$$

$$T_c = h_{T_c}(p_1, ..., p_n, w, N, T_0, T_w) \tag{1.8}$$

$$I(p, w, Z) = \sum\nolimits_i \pi_i z_i \tag{1.9}$$

Therefore, the implicit household income is defined by Pollak and Wachter (1975) as (1.9) where the implicit commodity prices are given by $\pi_i = \left(\frac{\partial C(p,w,Z)}{\partial Z_i} \right)$ which implies that the commodity prices are dependent on the bundle that is consumed[5].

Pollak and Wachter (1975) conclude that if there are non-constant returns to scale and/or joint production we are unable to untangle the effects that market goods, the household technology and preferences have on household commodity prices. Pollak and Wachter (1975) believe that we are left with two alternatives. First, we can apply the HPM to those activities that do not involve joint production or non-constant returns to scale. This alternative limits the use of the HPM since joint production is not the exception but the norm because the time used in the production of household commodities can in itself be a source of utility or disutility. In this case, we would estimate household commodity demand with equation (1.4). Second, we can argue that commodity prices are not essential to the HPM and that commodity demands can be modeled as functions of market goods prices, wage rate, unearned income and household technology. The resulting model is a reduced form model that retains the household production model's emphasis on household commodity demands while dispensing with the use of commodity prices. The reduce form model consists of equation (1.7) and equation (1.8).

[5] The cost function is given by the following equation: $C(p,w,Z) = N + T_w \tilde{W}$ where Z denotes the household commodity.

2. *Extensions to Unitary Models with No Intrahousehold Allocation*

The area of recreational demand has made extensive use of the household production model. It provides numerous examples of the implementation of the HPM. This literature extensively discussed problems that have arisen from the use of HPM's. Within recreational demand literature, the travel cost models are an important area of study. The purpose of these models is valuation of non-market commodities such as outdoor recreation. The HPM has been used by this literature to assign value to time spent on different recreational activities. The travel cost models are demand-based models that study the use of recreational sites and attempt to estimate the access value to a site or sites or to evaluate the elimination of sites.

The valuation of travel time in a recreational setting provides us with an illustration of the use of the HPM. Smith, Desvousges and McGivney (1983) argue that the valuation of travel time by recreational demand models as a proportion of the wage rate is not only theoretically inconsistent but also practically unreasonable. It is their belief that different times should be treated differently. In other words, they believe that the *timing of time* is important. The time in the time horizon may not be used equally due to the work schedule of an individual and/or other time commitments. Hence, the *timing of time* provides us with a problem that must be addressed by the recreational literature.

Smith, Desvousges and McGivney (1983) propose a modified HPM that maximizes a household utility function, *U,* which is a function of two types of service flows: a recreational service flow, z_R, and a composite non-recreational service flow, z_0. These service flows are subject to two time constraints for recreational activities and work

activities, a budget constraint, and a household production technology constraint for f_R and f_o. The two budget constraints reflect the importance of the *timing of time*. Smith, Desvousges and McGivney (1983) model is given by:

$$
\begin{aligned}
&\underset{z_R, z_0}{Max}\ U(z_R, z_0) \\
&s.t.\quad p_R x_R + p_N x_N + c(d_1 z_{RN1} + d_2 z_{RN2}) \le T_W w + N \\
&\qquad z_R \le f_R(x_R, z_{RN1}, z_{RN2}, z_{RT1}, z_{RT2}) \\
&\qquad z_N \le f_N(x_N, T_N) \\
&\qquad T_0 = T_W + T_N + T_R \\
&\qquad T_R = z_{RN1}(z_{RT1} + (T_0 - T_R)) + z_{RN2}(z_{RT2} + T_R)
\end{aligned}
\tag{1.10}
$$

In this model, x_R (x_N)[6] denotes recreational (non-recreational) market goods with a corresponding price of p_R (p_N), z_{RNi} denotes the number of trips to the ith recreational site where *i*=1,2, T_N (T_R) denotes the time spent in the production and consumption of non-recreational (recreational) activities, z_{RTi} denotes the time spent on-site of the ith recreational activity, d_i denotes the round trip distance to the ith recreational site and *c* denotes the vehicle related travel cost per mile traveled. Unlike Becker (1965) who represents leisure and consumption time of all commodities in a single time category, Smith, Desvousges and McGivney (1983) created two distinct leisure and consumption time uses: one for recreational activities and a second for nonrecreational activities. It is important to note that in this model the amount of on-site time is assumed to be the same for all individuals. Smith, Desvousges and McGivney's (1983) find that there are three components of the cost of a visit to a site: the vehicle related travel cost, the cost of

[6] The household chooses the amount of x_R and x_N bought and used in the production of recreational and non-recreational service flows.

travel time, and onsite cost of a trip. The Smith, Desvousges and McGivney (1983) estimated demand function for trips to a recreational site *j* by individual *n* is given by:

$$(1.11) \qquad Z_{RNi} = f\left((cd_i), \left(\frac{\varphi_2}{\varphi_1} w\left(T_o - T_R\right) \right), \left(\frac{\varphi_2}{\varphi_1} wZ_{RTi} \right), \left(wT_w + N\right), D \right)$$

Equation (1.11) indicates that the demand for recreational service flows, in this case visits to a particular recreational site, is a function of five variables[7]. The first variable, cd_i, is the vehicle related travel cost of a trip to a site by an individual[8]. The second variable, $\left(\frac{\varphi_2}{\varphi_1} w\left(T_o - T_R\right) \right)$, represents the cost of travel time and because the model restricts all trips to the same amount of time on site, the onsite time cost of one more trip is given by the third variable, $\left(\frac{\varphi_2}{\varphi_1} wZ_{RTi} \right)$. The fourth variable is the total household income, $\left(wT_w + N\right)$. The fifth and last variable, *D*, represents socio-demographic characteristics of the individual. They find that the most significant determinants of the demand for a recreational site are travel cost and individual taste for water recreation.

Recreational demand literature prior to 1987 did not properly address the valuation of non-working time, since not all non-working time can be valuated with the use of the

[7] The term φ_1 is the lagrangian multiplier of the total time constraint and φ_2 is the lagrangian multiplier of the recreational time constraint. Since φ_1 and φ_2 are lagrangian multipliers they are functions of all of the parameters to the optimization problem including wages. The opportunity cost of time is therefore a nonlinear function of wages and is the same for both time on site and travel time per trip.

[8] Recall that *c* is the vehicle related travel cost per mile and d_i is the round trip distance to a recreational site.

wage rate but should be valuated with the use of the individuals opportunity cost of time. Bockstael, Strand and Hanneman (1987) examine the effect of the recreationalist's labor market situation, that is, whether the work schedule of household members is fixed or allows for some flexibility in the work schedule. In the case of a work schedule that has some flexibility, we can trade work time for leisure time at the margin therefore total time available becomes the limiting factor. In the case of a fixed work schedule, we can not trade work time for leisure time at the margin, therefore discretionary time becomes the limiting factor. When an individual has a flexible work schedule, the wage rate reflects the tradeoff between work and leisure since they can be traded at the margin. When an individual has a fixed work schedule, the wage rate no longer reflects the tradeoff between work and leisure, and the opportunity cost is no longer an observable parameter.

Bockstael, Strand and Hanneman (1987) attempt to address this problem with the use of two budget or time constraints: one for time spent working at a job with a flexible work schedule and one for time spent working at a job with some flex time. Their model is given by:

$$\begin{aligned} &\underset{z_R, z_N}{Max}\ U(z_R, z_N) \\ &s.t.\quad p_R z_R + p_N z_N \le T_{WF} w_F + T_{WD} w_D + N \\ &\qquad T_0 = T_{WF} + T_{WD} + T_R z_R + T_N z_N \end{aligned} \tag{1.12}$$

In this model, w_F is the wage rate at a job with a fixed work schedule, w_D is the wage rate at a job with some flex time in his/her work schedule, T_{WF} is the time spent working at a job with a fixed work schedule and T_{WD} is the time spent working at a job with some flex time.

(1.13) $$z_R = h^I(p_R + w_D T_{WD}, p_0 + w_D T_N, T_{WF} w_F + N(T_0 - T_{WF}))$$

(1.14) $$z_R = h^c(p_R, T_R, p_N, T_N, T_{WF} w_F + N, T_0 - T_{WF})$$

The demands for recreational commodities considering flexible and fixed work schedule are given by (1.13) and (1.14) respectively.

As Bockstael, Strand and Hanneman (1987) point out, maximizing a utility function subject to two linear budget constraints or time constraints, creates an implementation problem associated with HPM the existence of two duals. The first dual involves the minimization of cost subject to utility and time constraints. The second dual involves the minimization of time costs subject to utility and time constraints. Each dual is associated with an expenditure function and a compensated demand. Both duals yield an expenditure function that depends on prices, utility and time cost, $\left(e(p,U,TC)\right)$[9]. We know from Bockstael and Strand (1985) that compensation can be measured in terms of time or money or any combination of the two. In the two constraint cases, it is not plausible to integrate back to expenditure function or to obtain exact welfare measures. In order to obtain these exact welfare measures, Bockstael, Strand and Hanneman (1987) propose that we start with the preference structure and explore the demand functions that can be derived from alternative utility functions[10]. A

[9] TC denotes time cost.

[10] The empirical demand function used by Bockstael, Strand and Hanneman (1987) contained a quality variable to help determine among the various choices available. This was an adaptation of a quantity-quality model.

consequence of this setup is that the utility function considered must be a function of at least three goods because it will be maximized subject to two constraints. Therefore, it is no longer possible to use the single Hicksian bundle concept. The researchers find that individuals with fixed work schedules have a value of time that is greater than their wage rate. While these individuals are willing to trade work for leisure they are constrained by the all or nothing decision they face since they can not engage in recreational activities during their work hours. For these individuals, there is no trade-off between work and leisure. The most significant empirical finding of Bockstael, Strand and Hanneman (1987) is that the compensating variation measure of money and time derived from the expenditure function leads to opposite conclusions about what type of individual suffers more from the elimination of a recreational site.

Prior to 1992 there was no serious attempt in the recreational demand literature to deal with the fact that time spent on-site at a recreational activity can involve an opportunity cost of time and also be a source of utility. This dual role of leisure (on-site) time had been apparent in economic literature since Pollak and Watchter (1975). Before 1992, recreational demand theory dealt with this problem by assuming that on-site time is fixed. This problem is addressed by McConnell (1992) who relaxes the assumption that on-site time is fixed and investigates the consequences of allowing on-site time, z_{RT}, to be a choice variable. In McConnell's (1992) model, on-site time not only enters the utility function but it also enters the budget constraint. McConnell's (1992) model is given by:

(1.15)
$$\underset{z_{RN},z_{RT},z_N}{Max}\ U(z_{RN},z_{RT},z_N)$$
$$s.t.\quad z_{RN}(p_{RN}+p_{RT}z_{RT})+p_N z_N \le I$$

McConnell (1992) finds that in the single site case when on-site time is endogenous we cannot investigate the demand for a site, which in this HPM would be the household commodity, through the direct utility function approach. McConnell (1992) states that Roy's identity must be used, in this case, to derive the demand for trips to a recreational site, z_{RN}. Hence, the demand for trips to a recreational site is given by:

(1.16)
$$z_{RN}(p_{RN},p_{RT},p_N,I)=\frac{\partial V(p_{RN},p_{RT},p_N,I)/\ \partial p_{RN}}{\partial V(p_{RN},p_{RT},p_N,I)/\ \partial I}$$

However, McConnell (1992) states that due to the nonlinearity of the budget constraint the optimal value of onsite time can not be derived from the direct utility approach or with the use of Roy's identity. Rather, the demands must be derived using duality theory by:

(1.17)
$$z_{RT}(p_{RN},p_{RT},p_N,I)=\frac{\partial V(p_{RN},p_{RT},p_N,I)/\ \partial p_{RT}}{\partial V(p_{RN},p_{RT},p_N,I)/\ \partial p_{RN}}$$

However, McConnell (1992) states that this demand functions cannot be interpreted as a welfare measure. McConnell (1992) concludes that when onsite time is endogenous there are two Marshallian demand functions (1.16) and (1.17) which represent the demand for trips to a recreational site and the time spent on onsite at a recreational site, respectively. McConnell argues that (1.17) needs to be estimated only to attain greater efficiency and not for welfare analysis of trips to a recreational site.

Larson and Shaikh (2001) show that commonly used two-constraint models such as Smith, Desvousges and McGivney (1983) are theoretically inconsistent because they

omit the time budget variable in the empirical model. The time budget variable is formed by prices of travel and money income. The omission of the time budget variable invalidates the use of full prices in the HPM. The inconsistency comes from the fact that there are two constraint requirements that need to be met by two constraint models in order to be consistent with economic theory that are not met when the time budget variable is omitted. The two requirements are: $\frac{V_{tj}}{V_{pj}} = \frac{V_T}{V_M}$ and $\frac{V_{tj}}{V_{pj}} = \frac{V_{ti}}{V_{pi}}$.

The rationale used for omitting the time budget variable is that it has no effect on the demand for market goods. In contrast to both Smith, Desvousges and McGivney (1983) and Larson and Shaikh (2001) present a two-constraint version of the model that implies a different time and commodity complementary relationship, and thus a different structure of the implicit prices for the recreational services. Larson and Shaikh (2001) unlike its predecessors concludes that time budgets must be included in the analysis of two-constraint recreational models since they provide the theoretical justification for the use of full prices. The dual constraint model of Larson and Shaikh's (2001) is given by:

$$\begin{aligned} &\underset{x}{Max}\ U(x,s) \\ &s.t.\quad p \bullet x \le I \\ &\qquad p_t \bullet x \le T_0 \end{aligned} \tag{1.18}$$

In this model, x denotes the vector of market goods, p denotes the vector of market goods, I denotes the money budget, p_t denotes the price (cost) of time, T_0 denotes the time budgets, and s denotes a vector of shift parameters. The estimated incomplete demand for recreational services x_j is recovered using two forms of Roy's Identity:

$$x_j\left(p,p_t,s,I,T_0\right)=\frac{-V_{pj}}{V_I}=\frac{-V_{tj}}{V_{T_0}}=f\left(p,p_t,s,I,T_0\right) \tag{1.19}$$

As we can see from (1.19), the resulting conditional demand is a function of p,p_t,s,I and T_0.

In Larson and Shaikh (2001), the two constraints are separately maintained, with time and income budgets pre-determined from a non-modeled first stage allocation. In the first stage of the two step budgeting process used by Larson and Shaikh (2001), labor supply is chosen by maximizing utility subject to work time and leisure time. In the second step, time is allocated to different leisure activities given a level of discretionary spending and time. The result of this two-step budgeting process is two restrictions which must be met in order to be consistent with the theory. The first restriction relates the observable Marshallian demand slopes in time and money and unobservable marginal value of leisure[11] and the second restriction gives us Slutsky-Hicks equations in money and time[12]. The two constraints imply there are two Slutsky symmetry conditions: one each for the equality of cross money-price and cross time-price effects. These conditions suggest a specific structure on how choices respond to the relative scarcity of money and time. The implicit price of recreational services is not only a function of market price of purchased inputs, but also an endogenously

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[11] $\frac{\partial x_i}{\partial t_j}+x_j\frac{\partial x_i}{\partial T}=\rho(z)\left[\frac{\partial x_j}{\partial p_i}+x_j\frac{\partial x_j}{\partial M}\right]$ where $\rho(z)$ is the money value of time.

[12] The Slutsky-Hicks equation in time is $\frac{\partial x_i}{\partial t_j}+x_j\frac{\partial x_i}{\partial T}=\frac{\partial x_j}{\partial t_i}+x_i\frac{\partial x_j}{\partial T}$ and the Slutsky-Hicks equation in money is Slutsky-Hicks equation in time is $\frac{\partial x_i}{\partial p_j}+x_j\frac{\partial x_i}{\partial M}=\frac{\partial x_j}{\partial p_i}+x_i\frac{\partial x_j}{\partial M}$.

determined marginal cost of time which is given by the ration of the Lagrange multipliers.

(1.20) $$x_i = h_i\left(p + W_D p_t, s\right) g\left(I + W_D T_0, s\right)$$

(1.21) $$x_i = h_i\left(p_1 + \rho(z) p_{t1}, ..., p_n + \rho(z) p_{tn}, s\right) g\left(I + \rho(z) T_0, s\right)$$

In equations (1.20) and (1.21), the variable W_D is defined as the change in the demand for market goods that comes about from a change in the price of market goods, which is given by $\frac{\partial x_i}{\partial p_i}$, and the variable $\rho(z)$ denotes the money value of time. Larson and Shaikh (2001) chose (1.20) and (1.21) because both of these demand equations met interior solutions that satisfy the two constraint requirements in the case of exogenous and endogenous marginal value of time, respectively. In both systems of demand equations, the cross partial price slopes are symmetric $\left(\frac{\partial h_j}{\partial p_i} = \frac{\partial h_i}{\partial p_j}\right)$. The demand functions in equation (1.20) and (1.21) have individual full price effects given by $\left[h_i\left(p + W_D p_t, s\right)\right]$ and $\left[h_i\left(p_1 + \rho(z) p_{t1}, ..., p_n + \rho(z) p_{tn}, s\right)\right]$ and a common full budget effect $\left[g\left(I + W_D T_0, s\right)\right]$ and $\left[g\left(I + \rho(z) T_0, s\right)\right]$, respectively.

While Larson and Shaikh (2001) find that demand systems derived from two constraint models that employ full prices and incomes are not consistent with these two restrictions, they find that models that use full prices and full budgets are consistent with their two restrictions, regardless of whether the value of time is endogenous or exogenous. Larson and Shaikh (2001) relax the link between commodity prices and wages and the opportunity cost of time however potentially relevant constraints are not

considered. This model assumes that each unit of good consumed is temporally exchangeable with the other units. Recreational activities are dependent on both the amount and the timing of available time. Time cannot be stored, although it can be transferred between periods by changing commitments. Free time is often available only in discrete bundles of time due to fixed work schedules and other time constraints. Therefore, the feasible choice of time is constraint in a given time period.

These recreational demand studies have explored how the household production model valuates time. Smith, Desvousges and McGivney's (1983) research introduces the importance of *timing of time* which states that time in the time horizon may not be used equally due to time constraints. The research of Bockstael, Strand and Hanneman (1987) shows the effect that different types of work schedules have on the value of time. McConnell's (1992) research allows for on-site time to have a dual role as a cost and also as a source of utility. Larson and Shaikh's (2001) research shows us the restrictions in money and time from a unitary model with both time and budget constraints with an endogenous marginal value of leisure.

3. *Extensions to Unitary Models with the Introduction of Intrahousehold Allocation*

In the economic literature discussed up to this point, there is no analysis of the intrahousehold allocation of resources. Becker's (1965) model is modified by Gronau (1973) in order to better deal with both household production, the allocation of time and intrahousehold allocation of resources. The first important research that dealt with

intrahousehold allocation of resources within the household production model was conducted by Gronau (1973) and Gronau (1977).

Gronau (1973) believes, as Becker (1965) does, that the division of time should be between working and non-working time (leisure), but he also believes in a further division of work time between work in the market and household production. Gronau (1973) believes that Becker's (1965) division of time overlooks the wife's household production. Gronau's (1973) model accounts for the spouses' division of time by employing individual time constraints that allocate time among the three uses of time: leisure, work in the labor market and household production. In Gronau's (1973) model, we have time constraints for each of the spouses. This marks a significant departure from Becker's (1965) model which employs a household time constraint that allocates time only between working and non-working time. Another significant difference between Gronau (1973) and Becker (1965) is the relative magnitude of wages. Gronau (1973) and Becker (1965) assume that wages are constant across time but, unlike Becker (1965), Gronau does not assume wages of spouses to be the same. Gronau's (1973) model has different wages for each spouse and assumes that husbands' wages are greater than wives' wages $(w_1 > w_2)$[13].

Gronau's (1973) household production model allocates household members' time according to their comparative advantage in the production of household commodities and market goods. Gronau (1973) defines comparative advantage in terms of the relative wages of each spouse and the spouses' efficiency in the production of

[13] Here w_1 is the wage of the husband while w_2 is the wage of the wife.

household commodities. Gronau's (1973) model is discussed under the assumption that only two household commodities are produced by the household. Gronau's (1973) model is given by:

$$\begin{aligned} &\underset{X,Z,T_{c1},T_{c2}}{Max}\ U(Z,X,T_{c1},T_{c2}) \\ &s.t.\quad p_M x_M + p_H x_H \le T_{w1}w_1 + T_{w2}w_2 + N \\ &\qquad T_{0i} = T_{wi} + T_{ii} + T_{ci} \\ &\qquad z_{ji} = f_{ji}(x_H, T_{ji})\ where\ j,i = 1,2\ j \neq i \end{aligned} \tag{1.22}$$

In this model, x_M denotes market goods, x_H denotes market foods used in the production of household commodities, z_{ji} denotes the j[th] household commodity produced by individual i, Z denotes the vector of all j household commodities where the j[th] household commodity is defined as $z_j = \sum_{i=1,2} z_{ji}$, T_{wi} denotes the time spent working by individual i, T_{ji} denotes the time used to produce commodity j by individual i, T_{ci} denotes leisure time or time spent consuming of individual i, T_{0i} denotes the total time available to individual i, w_i denotes the wage rate of individual i where $i = 1,2$, p_M denotes the price of market goods and p_H denotes the price of market goods used as inputs in the production of household commodities. The total amount of goods of market goods, X [14], is the sum of market goods consumed at home and market goods used in the production of household commodities.

The demand for the j^{th} household commodities is given by:[15]

$$z_j = f_j\left(p_M, p_H, w_1, w_2, N\right) \tag{1.23}$$

[14] We have $X = x_M + x_H$.

[15] The household commodity depends on the value of market goods used in the production of household commodities and the value of time used in the production of household commodities.

Gronau (1973), like Becker (1965), finds that the marginal cost of producing a commodity, $\left(\pi_i = \gamma_i p_x + \delta_i w_i^*\right)$, has two parts: the cost of market inputs, $\gamma_i p_x$, and the value of time, $\delta_i w_i^*$[16]. Gronau's (1973) model shows that the labor market participation decision can be explained by comparing the value of the household member's time in the absence of market opportunities and the potential wage rate. Therefore, Gronau (1973) concludes that one of three following statements must be true of wives that participate in the labor market. First, these wives value of time exceeds their wage rate and increases with family income. Therefore, housewives lack of participation in the labor market indicate that in the absence of labor market opportunities their value of time would have fallen short of their attainable wage rate. Under Gronau's (1973) second assumption that the value of time and wage rate are independent and identically distributed, if we also assumed that all women in a given age-education group anticipate the same wage rate, their participation in the labor market is explained in terms of differences the value (price) of time[17]. Therefore, Gronau finds that women who participate in the labor market are those that have the lowest price of time, i.e. are the least productive in the household. Therefore, the women who do not participate in the labor market have average wage rate that are lower than the average cost of their time[18]. Third, if instead of assuming that women in the same group anticipate the same wage, we assume that differences in labor force participation can be attributed to

[16] The marginal product of market inputs (time) used in the production of household commodities is given by γ_i^{-1} $\left(\delta_i^{-1}\right)$.

[17] We find this in page 643 of Gronau (1973).

[18] We find this in page 645 of Gronau (1973).

differences in wage offers. We can then conclude that women who participate in the labor market are the most prepared, i.e., those that have received the largest wage offers. As a consequence, the women that do not participate in the labor market have mean cost of time that fall short of the average wage rate in the market. Gronau (1973) also finds that the household member with the lowest cost of production will produce all of the household commodities. Gronau's (1973) research assumes that there is specialization in household production and states that comparative advantage is determined by the relative wage rates of husbands and wives and their efficiency in the production of household commodities. Husbands' wage rates as a rule exceed those of their wives, according to Gronau. He, therefore, concludes that household production is mostly carried out by wives because they are relatively better equipped for this type of work.

There is one serious problem with Gronau's (1973) empirical estimation. He assumes that the wage rate and the value (cost) of time are independent and identically distributed. This assumption is not logical. The value of time is assumed to be a function of the wage rate which depends on age and education. Therefore, it must be the case that household income is not affected by age and education in order for this assumption to hold, but this is not the case because education does affects income.

In order for us to be able to aggregate time used in household production and leisure, it is necessary that the two time uses must be a composite input in the production of household commodities. Gronau's (1977) research deals with this problem. From the composite commodity theorem, we know that in order for two time

uses to be composite inputs, the two uses of time must move in a parallel manner so that they can be treated as a single commodity. This implies that $\frac{T_{ii}}{T_{ci}} = \theta$ where θ is a constant of proportionality and that the two time uses are affected in the same manner by all variables. However, empirical studies have shown that time spent on household production and leisure activities are affected differently by changes in socioeconomic variables. Gronau (1977) states that in order to understand why time spent on household production and leisure are affected differently by socioeconomic variables, we must study the differences between time spent consuming and producing. He believes that while household production and market work are perfect substitutes there is no perfect substitute for leisure.

Unlike Gronau (1973), who uses a household production model for all of the members of a household, Gronau (1977) proposes a household production model for a single individual which maximizes the quantity consumed of the household commodity subject to an individual budget constraint, time constraint and household production technology in order to explore the conditions under which we can aggregate time used in household production and leisure. Gronau's (1977) model is given by:

$$
\begin{aligned}
&\underset{z_j, x_{Mi}, x_{Hi}, T_{ji}}{Max} \; U(z_1, ..., z_n) \\
&s.t. \quad x_{mi} = T_{wi} w_i + N \\
&\qquad x_{Hi} = f(T_{ji}) \\
&\qquad x_{Ti} = x_{Hi} + x_{Mi} \\
&\qquad T_{0i} = T_{wi} + T_{ci} + T_{ii} \\
&\qquad z_{ji} = f(x_{Ti}, T_{ci})
\end{aligned}
\tag{1.24}
$$

In this model, w_i denotes the wage for individual i, N denotes unearned income, T_{Wi} denotes time spent working by individual i, T_{ci} denotes leisure or consumption time of individual i, T_{ji} denotes time used in the production of household commodity j by individual i, x_{Mi} denotes the expenditures on the ith market good, x_{Hi} denotes household goods of individual i, and x_{Ti} denotes total goods of individual i. Total goods, x_{Ti}, can be bought in the market or produced at home. This implies that market goods and household goods are perfect substitutes. Gronau (1977) measures the value of home goods and services, x_{Hi}, in terms of their market equivalents, x_{Mi}. The demand for household goods is given by:

(1.25) $$z = f\left(w_i, N\right)$$

Gronau's (1977) study of how household production is affected by income leads to a number of innovations in the household production literature. One of Gronau (1977) empirical finding is that an increase in unearned income leads to a decrease in the household production of the non-labor market household members but has no effect on the household production of household members that participate in the labor market. The income effect is found to work primarily through its effect on leisure. Labor supply is more elastic the greater the sensitivity of the household production to the wage rate. Gronau (1977) finds that in the short run there is a negative effect between the wage rate and household production. In the long run, the wage rate is found to have a positive effect on education. Marriage is found to lead to specialization within household production. This finding is rooted in the assumption that individual household members do not sell household commodities in the market. Gronau also

finds that there is a tradeoff between goods and time. Gronau (1977) states that a husband's wage rate is higher than his wife's due to greater market involvement and discrimination. He also argues that on the job training makes women's household production more efficient. Within the family, Gronau (1977) argues that there is an incentive for wives to trade goods for time. The extent of wives' willingness to trade home goods for market goods depends on the marginal cost of producing home goods. Specialization is found to increase the welfare of the household by increasing the wives' household production and the fathers' labor force participation. Gronau (1977) concludes that when both household members participate in the labor market and there are no goods that are solely supplied through household production, then there are no gains from marriage since the household members face the same prices.

C. Nonunitary Models

In the early 1980's, we see a move away from unitary models and toward nonunitary models with the introduction of bargaining models of household behavior. While unitary models are very limited when dealing with intrahousehold allocation of resources, due to the assumptions of the model that treat all individuals in a household as a single individual, extensions to the unitary models such as those of Gronau (1973), provide a good beginning to try to deal with this problem. Nonunitary models of household behavior provide a more fertile ground for the study of intrahousehold

allocation because they model individual members of a household separately instead of modeling a household as a single unit.

Economic models that study the intrahousehold decision process attempt to understand the internal structures that motivate and guide patterns of resource allocation among household members. While households are dynamic units with respect to their composition and size, the majority of research in the area of intrahousehold allocation avoids these complexities by assuming a static and narrower framework. The study of intrahousehold allocation commonly assigns decision making over the allocation of all household resources to the same household unit, while the appropriate unit of analysis may depend on the resource being allocated.

1. *Cooperative Bargaining Models of Household Behavior*

Cooperative bargaining theory combines in the framework of household model elements of cooperative game theory and more specifically of axiomatic bargaining theory. The household members are the agents that attempt to come to an agreement on how the gains from cooperation within the household should be divided. Depending on the bargaining power of individual household members, we arrive at specific intrahousehold allocation equilibrium. This equilibrium can take on different forms depending on the solution concept that is used. We can arrive at a Nash-bargaining solution as in the case of McElroy and Horney (1981) and McElroy (1990), a Pareto efficient outcome as in the case of Chiappori (1988a), Browning et al. (1994), Chiappori (1997) and Browning and Chiappori (1998) or a noncooperative solution as in

the case of Lundberg and Pollak (1993). We will discuss each of these models in this section.

The cooperative models of household behavior based on the Nash solution concept were introduced by McElroy and Horney (1981). McElroy and Horney (1981) also show that the unitary model results are nested within their Nash generalized model. McElroy and Horney (1981) develop a nested test that determines whether the Nash demand system collapses to a common preference demand system.

McElroy and Horney (1981) model the household decision process as a Nash bargaining process, which maximizes the utility gain product subject to the household budget constraint[19]. Their model is given by:

$$(1.26)\qquad \begin{aligned} &\underset{x_p, x_m, x_f, T_{cf}, T_{cm}}{Max} \prod_{i=m,f} \left[U_i\left(x_p, x_m, x_f, T_{cf}, T_{cm}\right) - V_o^i\left(p_p, p_{mm}, p_{mf}\right) \right] \\ &s.t. \quad p_p x_p + \sum_{j=m,f} \left(p_{mj} x_{mj} + p_{cj} x_{cj} \right) = (p_{cm} + p_{cf}) T_0 + N_f + N_m \end{aligned}$$

In this model, x_m $\left(x_f\right)$ denotes the market goods consumed by the male (female) household member, x_p denotes public goods consumed by both household members, T_{cm} $\left(T_{cf}\right)$ denotes the leisure or consumption time of the male (female), p_p denotes the price of public goods consumed by both household members, p_{mm} $\left(p_{mf}\right)$ denotes the price of the market goods consumed by the male (female) household member, p_{cm} $\left(p_{cf}\right)$ denotes the price or cost of leisure time consumed by the male (female) household member, T_0 denotes the total time available to the household, N_m $\left(N_f\right)$ denotes the

[19] The gains from marriage are given by: $U_k - V_0^k$.

unearned income of the male (female) household member and V_0^m $\left(V_0^f\right)$ denotes the maximum attainable utility (indirect utility) for the mother (father) outside of marriage.

(1.27) $$x_j = h_j(p_p, p_{mm}, p_{mf}, p_{cm}, p_{cf}, N_m, N_f)$$

(1.28) $$\lambda = h_\lambda(p_p, p_{mm}, p_{mf}, p_{cm}, p_{cf}, N_m, N_f)$$

McElroy and Horney (1981) find that the demand for each good which is a function of prices and non-wage incomes is given by (1.27). The optimal value for the multiplier is given by (1.28).

McElroy and Horney (1981) derive a Nash generalization of Slutsky's equation for their bargaining model[20] as well as the Nash generalization of substitution symmetry[21]. When the price effects and the unearned income effects of both mother and father on the indirect utilities of unmarried individuals are equal to zero, the authors find that uncompensated, compensated and income price effects, as well as the Nash generalization of both the Slutsky equation and substitution symmetry collapse to those of their unitary model counterparts when both threat points are independent of prices and unearned incomes. Also, when unearned income effects of both mother and father on the indirect utilities of unmarried individuals are equal to zero, the Nash generalization of Engel aggregation reduces to the neoclassical Engel aggregation. The authors also find that Nash and neoclassical Cournot aggregations are identical. When

[20] In this model, the effects of prices and unearned incomes on the male and female household member threat points, which are defined as the maximum attainable utility outside of the household, are captured by the matrix V_p and V_I respectively.

these Nash restriction do not collapse to their neoclassical counter parts this implies that the Nash demand model does not collapses to the unitary model.

McElroy and Horney's (1981) research is criticized by Chiappori (1988b) on two grounds: pre-marital utilities (i.e. V_0^f and V_0^m) are unknown and the Nash-bargaining assumption made by the authors is neither restrictive nor convenient. First, Chaippori (1988b) argues that the Nash-bargaining hypothesis employed by McElroy and Horney (1981) is only restrictive when each of the individual's pre-marital utility functions is known. Therefore, Chiappori (1988b) argues that since we do not know a priori about the agents non-marital preferences, we can not say anything about the agents demand functions. Chiappori (1988b) argues that McElroy and Horney's (1981) definition of the Nash substitution symmetry equation which is denoted by *G* is not invertible. He then shows that by substituting the Nash generalization of Cournot aggregation and Engle aggregation into equation G^{-1} the wrongly specified matrix becomes zero. Therefore, he argues that no matter what matrix of prices, $\hat{p}$,post-multiplies the right hand side of the inverse of *G* the product will be always equal to zero. Chiappori (1988b) also shows that the Slutsky matrix is not invertible confirming the fact that G^{-1} is not correctly specified. Second, Chiappori (1988b) criticizes McElroy and Horney's (1981) Nash-bargaining hypothesis on the grounds that it is not convenient or restrictive since they assume that pre and post marital preferences are independent. When preferences are unknown, Chiappori (1988b) argues that Nash-bargaining does not imply anything more than Pareto efficiency of household decisions process therefore concluding that

the collective setting (Pareto hypothesis) would yield a more convenient approach than Nash-bargaining.

McElroy and Horney (1990) and McElroy (1990) reply to Chiappori's (1988b) criticisms of their 1981 model. McElroy and Horney (1990) discard Chaippori's (1988b) criticism of their model while conceding that the empirical applications were not clear. McElroy and Horney (1990) state that Chiappori's (1988b) criticisms of their 1981 work is based on the Nash generalization of substitution symmetry. The Nash generalization of substitution symmetry not only generalizes the observable neoclassical substitution matrix but also allows for the separate effects of the male and female household members income effects to be observed.

McElroy and Horney (1990) state that Nash generalization of substitution symmetry requires that we have knowledge of the threat points or at least knowledge about their sensitivity to changes in prices and unearned incomes. McElroy and Horney (1990) state that there is no reason to assume that there is knowledge about the threat point when the direct utilities are unknown. However, they believe that Chiappori (1988b) overlooked the fact that the threat points can be estimated with the use of econometric techniques that account for selectivity into and out of marriage. McElroy and Horney (1990) also state that it is true that the data requirements for the explicit estimation of the Nash-bargaining model go beyond prices, family income, aggregate consumption and labor supplies of each spouse. This does not, however, mean that there is no empirical content in the Nash generalization of substitution symmetry. The empirical content of McElroy and Horney's (1981) model is discussed in McElroy (1990).

McElroy's (1990) research shows how the augmented unitary model can be nested within the Nash bargained model and how in turn we can nest this model within a broader unrestricted model. McElroy (1990) also discusses the data that is necessary for the estimation and outlines the estimation process that needs to be used to test this nested hypothesis.

McElroy's (1990) research studies whether the opportunity cost of family membership matters for the intrahousehold allocation of income and therefore the demands. The determinants of the opportunity cost of family membership are treated as parametric variables called extra environmental parameters (EEP's). The EEP's serve as pure shifter's of the threat points. In the indirect utilities of McElroy (1990) unlike those of McElroy and Horney (1981), the EEP's shift the maximum values of the utility that an individual can obtained outside of marriage. In other words, the EEP's shift the threat points in the Nash bargained model but do not affect prices and nonwage incomes faced by married individuals and are, therefore, parametric to the bargaining outcome. The use of EEP's is a clear departure from McElroy and Horney (1981). McElroy (1990) states that the Nash model can jointly analyze household formation and the allocation decision process.

McElroy's (1990) model differs from to McElroy and Horney (1981) model (1.26) in that it incorporates EEP's, $(\alpha_i's)$ into the maximization problem. McElroy's (1990) maximization problem is given by:

$$\underset{x_p,x_m,x_f,T_{cm},T_{cf}}{Max} \prod\left[U_i\left(x_p,x_m,x_f,T_{cm},T_{cf}\right)-V_0^i\left(p_p,p_{mm},p_{cm};\alpha_i\right)\right] \quad (1.29)$$
$$s.t. \quad p_p x_p+\sum\nolimits_{j=m,f}\left(p_{mj}x_j+p_{cj}x_{cj}\right)=\left(p_{cm}+p_{cf}\right)T_0+N_f+N_m$$

The solution to the maximization problem yields a system of demands similar to those in McElroy and Horney (1981) but with the addition of extra environmental parameters:

(1.30) $$x_j = h_j\left(p_p, p_{mm}, p_{cm}, p_{mf}, p_{cf}, N_f, V_m, \alpha_j\right)$$

The Nash demand systems are functions of prices of public goods, market goods consumed by each household member, the price of leisure for each household member, unearned incomes of each of the household members, and EEP's that affect both household members. The EEP's help in the identification of the Nash model and also provide rich and fertile new grounds that aid in the exploration of household behavior.

The EEP's discussed by McElroy (1990) encompass a large number of parameters that include parameters that describe marriage markets, parameters that characterize the legal structure within which marriage and divorce occur, and parameters that characterize government or private transfers that are conditioned on marital or family status.

McElroy (1990) states that the opportunity cost of being married in the unitary model is zero which, therefore, implies that only pooled income matters. This means that there are two restrictions implied by unitary models. The first restriction is that the EEP's of father and mother have no effect. The second restriction is that the unearned incomes of the father and mother are spent in the same manner and hence only total unearned income matters.

The matrix of partial derivatives of EEP's with respect to the consumption goods available is denoted by: x_α. McElroy (1990) finds that the larger the effect that EEP's of

an individual have on their threat point the larger the effect that the EEP's will have on the demand for the consumption good for that individual. McElroy shows that the Nash aggregation condition can be extracted from matrix x_α. The Nash aggregation condition limits changes in demand due to changes in EEP's to movements along the budget constraint.

McElroy derives the fundamental matrix equation of Nash bargaining by collecting the partial derivatives of the F.O.C's with respect to α, p, and I. With the aid of full income and the fundamental matrix equation of Nash bargaining, McElroy shows that we can derive the general characteristics of a complete system of Nash bargained demand functions regardless of the type of utility function used.

McElroy augments the fundamental matrix equation of the theory of consumer demand in terms of partial derivatives by allowing both time endowments associated with labor supply and the zero derivatives of the neoclassical F.O.C's with respect to the EEP's.

McElroy shows that the Nash demand system exhibits well defined Nash uncompensated and Nash compensated income effects, as well as separate income effects for each household member. McElroy argues that these three effects are related to the Nash generalization of the Slutsky matrix and its properties of symmetry and negative semidefinite.

McElroy states that V_p, V_I and V_α record how the threat point shifts from changes in prices, income and EEP's, respectively. If *m*'s and *f*'s incomes affect demands in the same manner then we get the unitary model's substitution matrix and therefore only

total unearned income is important. McElroy shows that matrix G captures the component of the Nash generalization of the substitution matrix that comes about from the income and price changes on the threat points, V_p and V_I, respectively. McElroy shows that if $V_p = V_I = 0$ not only is the Nash generalization of the substitution matrix is symmetric and negative semi-definite but the unitary model's substitution matrix will also be symmetric and negative semi-definite.

McElroy derives the Nash generalization of Cournot aggregation from the differentiation of the budget constraint with respect to prices and incomes respectively. McElroy shows that if we constrain the Nash fundamental equation by setting, $V_p = V_I = V_\alpha = 0$, we get the augmented unitary fundamental equation which leads us to the conclusion that the Nash demand system is a generalization of the unitary demand system.

McElroy (1990) concludes that the empirical content of the Nash bargaining model can be derived from the budget constraint and the fundamental matrix equation of Nash bargaining. The empirical content, she argues, can be summarized by four conditions. First, the Nash generalization of the Slutsky matrix must be symmetric. Second, the Nash generalization of the Slutsky matrix must be negative semidefinite. Third, there must be separate income effects for the father and mother. The fourth condition states that changes in the EEP's affect the demand for household consumption goods according to x_α defined previously.

Chiappori (1991) questions the validity of McElroy and Horney's (1990) and McElroy's (1990) claim that the independent estimation of the threat points leads to

testable restrictions that can be placed on household behavior by pointing two. First, Chiappori (1991) states that the basic model stipulates that we should estimate not only the indirect utility function for each individual but also that we should estimate the direct utility function for each individual. While McElroy (1990) states that we can estimate the indirect utility functions from a distinct sample of divorced individuals, McElroy (1990) makes no mention of how we should estimate the direct utilities of each spouse. Second, the Nash bargaining solution Chaippori (1991) states is not invariant to a non-decreasing transformation of preferences, threat points or both. Therefore, McElroy's (1990) procedure would require a cardinal representation of preferences to be estimated from independent data. He says that this is impossible given that an independent estimation cannot provide more than an ordinal representation of indirect utilities.

2. *Collective Models of Household Behavior*

In addition to the problems outlined by Chiappori (1991) about the Nash bargaining models of McElroy and Horney (1981) and McElroy (1990), there is an even more important criticism of the Nash bargaining models of household behavior. If the empirical implications of the Nash bargaining model are rejected, then it is impossible to determine whether the bargaining setting in general is rejected, the Nash solution concept chosen is rejected, or both are rejected. The collective models of household behavior that are based on Pareto efficiency such as Chiappori (1988a, 1997), Browning et al. (1994), and Browning and Chiappori (1998) provide an alternative to Nash

bargaining models. These models do not place a prior restriction, by assuming a particular solution concept such as Nash, on which point on the Pareto frontier will be chosen by the household. Collective models of household behavior are based on the weaker restriction of Pareto efficiency but still allow us to derive some testable implications of the model and help us identify an important part of the intrahousehold decision process and individual preferences. We will hereafter refer to this as the collective model of household behavior.

The collective models of household behavior based on Pareto efficiency were introduced in the economic literature by Chiappori (1988). Chiappori (1988) believes that previous collective models that used equilibrium concepts such as the Nash or Kalai-Smodorinsky were unable to test the collective setting separately from the equilibrium concept chosen. Therefore, Chiappori (1988) believes the rejection of the collective model could not be attributed to the collective setting, the equilibrium concept chosen or both. He also believes that the lack of sociological data about the decision process renders the decision process a *black box.*

Chiappori (1988) employs *Pareto efficiency,* which is a less restrictive solution concept. In other words, he assumes that the outcome of the decision process is *Pareto efficient*. He develops an income sharing rule that is a mapping which is a reduced form model that summarizes the decision process of the household as shown below. In essence, the income sharing rule takes into account the spouses' wages, w_w and w_f, and total household unearned income, N, and determines the allocation of unearned household income among the spouses, N_f and N_w. Chiappori (1988) defines an

income sharing rule as a mapping $G:\left(\mathbb{R}^{+}\right)^{2}\times\mathbb{R}\rightarrow\mathbb{R}^{2}$. The income sharing rule mapping is represented by:

(1.31) $$\left(w_w, w_f, N\right)\rightarrow G\left(w_w, w_f, N\right)=\left(N_f, N_w\right)$$

For a given income sharing rule, Chiappori (1988) states that a unique pair of labor supply functions can be derived. However, he states that there is no way to observe the household income sharing rule. Chiappori (1988) goes on to states that for any pair of labor supply functions or conversely demands for leisure it is possible to find two utility functions U_w *and* U_f and a sharing rule such that the labor supply functions or demands for leisure are the solutions to a utility maximization problem.

The bargaining power within a household depends not only on the level of unearned income but also on the wages of each individual household member. Chiappori's (1988) collective model explores two different preference structures: altruistic and egoistic preferences. In the altruistic case, household member *i* cares in a non-paternalistic manner about his/her spouse's utility. The altruistic model is given by:

(1.32) $$\begin{aligned} &\underset{z_{cm},z_{cf},T_{cm},T_{cf}}{Max}\; U_m(z_{cm},T_{cm})+k(w_m,w_f,N)U_f(z_{cf},T_{cf}) \\ &s.t.\quad z_{cm}+z_{cf}\leq w_m(T_{0m}-T_{cm})+w_f(T_{0f}-T_{cf})+N \end{aligned}$$

In this model, *k* represents a strictly positive function of male and female wages respectively, w_m and w_f, and unearned income *N*. We also have that z_{ci} represents the private consumption of individual i, T_{ci} represents leisure of individual i, and T_{0i} represents total time available for individual i. In this model, private consumption is

not observable. However, we can observe labor supply and leisure demand. The demand functions for private consumption and leisure time demanded are given below by (1.33) and (1.34) respectively. These demand equations will be the same for the altruistic and egoistic cases.

(1.33) $$z_{ci} = f\left(w_i, w_j, N\right) = f\left(T_{ci}, w_i\right)$$ [22]

(1.34) $$T_{ci} = f(w_i, w_j, N)$$

Collective rationality is satisfied by a parametric specification in the case of the altruistic model if three conditions are satisfied. First, the marginal utilities of each spouse private consumption is proportional distributed according to the sharing rule[23]. Second, the wage rate of the i[th] household member is equal to the ration of his/her marginal utility of private consumption to his/her marginal utility of leisure[24]. Third, the ratio of marginal utilities of leisure of the spouses is equal to the ratio of their wages times the sharing rule[25].

The definition of *collective rationality with altruistic agents*, Chiappori (1988) states, is more than a transposition of the usual revealed preferences conditions[26]. The observed bundle is the *best* in a collective, Pareto optimality sense; hence, for each *j*, there must

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[22] z_{ci} can be expressed as a function of T_{ci} and w_i because the maxim in the altruistic case possesses a separability property because it is a linear combination of two functions.

[23] Therefore, we have $U^i_{z_{ci}} = kU^j_{z_{cj}}$.

[24] In other words, we have $U^i_{L_i} = w_i U^i_{z_i}$.

[25] This is equal to $\left(\frac{U^1_{L_1}}{U^2_{L_2}}\right) = \left(\frac{w_1}{w_2}\right)k$.

[26] The bundle observed is the best among all the bundles which are financially available when wages are given by w^j_m and w^j_f, and unearned income is given by N_j.

exist a θ_j such that $U_i + U_j\theta_j$ is maximized. Second, only total private consumption is observable and represented in the constraint. Therefore, it is efficient for the data to be collectively rational for some $\left(z_{cm}^j, z_{cf}^j\right)$ satisfies this constraint. Chiappori (1988) finds that the demand for private consumption can be represented as a function of leisure time demanded and the wage rate and can be characterized up to an additive constant.

In the case of egoistic preferences, the utility of an individual household member is a function of his/her private consumption and leisure and is subject to his/her individual budget constraint. The egoistic model is given by:

$$\begin{aligned} &\underset{z_{cj}, T_{cj}}{Max}\, U(z_{cj}, T_{cj}) \\ &s.t. \quad z_{cj} = N_j(w_m, w_f, N) + w_j(T_{0j} - T_{cj}) \end{aligned} \tag{1.35}$$

From the first order conditions of the egoistic model, we get one condition, $\frac{U_{L_i}^i}{U_{z_i}^i} = w_i$, that must be satisfied by a parametric specification in order to satisfy collective rationality of egoistic agents (CREA). In other words, the marginal rate of substitution of leisure for private consumption for individual i must be equal to the wage rate of individual i.

Similar to the case of altruistic preferences, *collective rationality with egotistic agents* is more than a transposition of the usual revealed preferences conditions. The observed bundle is the *best* in a collective, Pareto optimality sense; hence, for each *j*, there must exist a θ_j such that $U_i + U_j\theta_j$ is maximized. Second, only total private consumption is observable and represented in the constraint. Therefore, it is efficient for the data to be collectively rational for some $\left(z_{cm}^j, z_{cf}^j\right)$ satisfies this constraint. Chiappori (1988) finds

that the demand for private consumption can be represented as a function of leisure time demanded and the wage rate. In the case of egoistic agents, the demand for private consumption cannot be characterized up to an additive constant.

If the revealed preference conditions like their altruistic counterparts are met, then we will get the best available bundle among the ones which are financially available. Chiappori (1988) concludes that in the case of altruistic preferences only revealed preferences or non-parametric techniques can be used to differentiate between the collective model and the neoclassical model.

In Chiappori (1988a), we are unable to identify the sharing rule in the case of altruistic preferences. Browning et al. (1994) for the first time are able to identify Chiappori's income sharing rule with altruistic preferences with the use of assignable and exclusive goods. Public goods are defined by Browning et al. (1994) as those goods that are consumed by all household members. Private goods are defined as those goods that are purchased and consumed by one individual household member while exclusive goods are defined as those that are only consumed by one individual. Therefore, non-public goods are defined as those goods that are exclusive and/or private. The income sharing rule is defined as the outcome of the decision process that explains the division of expenditures on non-public goods between spouses. It is important to note that this income sharing rule in Browning et al. (1994) is different than the one proposed by Chiappori (1988a). In this formulation, we have that the income sharing rule is a function of individual money incomes of the mother and the father, I_m and I_f, EEP's faced by the mother and father, α_m and α_f, private

consumption of the father and mother are , x_m and x_f , E_i denotes the total expenditures of individual i , and E denotes total household expenditures where $E = E_m + E_f$.

(1.36) $$\rho(I_m, I_f, \alpha_m, \alpha_f, E_m, E_f)$$

The income sharing rule gives us the share of individual $i's$ total expenditures as a function of exogenous variables that affect the decision process but do not affect preferences, the budget constraint or the consumption set. The income sharing rule of Browning et al. (1994) is denoted by (1.36).

The identification of the income sharing rule in the case of altruistic preferences has four requirements. First, there must be some non-public good such that $E = E_m + E_f$. Second, there must be at least one exclusive or non-public good for each household member. Third, each individual household member's subutility function must be separable with respect to non-public goods consumption such that for $x_j = \alpha_j(x_m, E_m) + \beta_j(x_f, E_f)$ and either $\alpha_j(x_m, E_m) = 0$ or $\beta_j(x_f, E_f) = 0$. The subutility functions for individual *m* and *f* are given by V_m and V_f , respectively. The model proposed by Browning et al. (1994) is given by:

(1.37) $$\begin{aligned} &\underset{x_m, x_f}{Max}\ U_j = \left[V_m\left(x_m, x_p\right), V_f\left(x_f, x_p\right)\right] \\ &s.t. \quad p_{mm}x_m + p_{mf}x_f + p_p x_p \le E \end{aligned}$$

Browning et al. (1994) defines in page 1074 the expenditures of mother and father with the use of the sharing rule as:

(1.38) $$E_m = \rho(I_m, I_f, \alpha_m, \alpha_f, E_m, E_f)E$$

$$E_f = \left[1 - \rho(I_m, I_f, \alpha_m, \alpha_f, E_m, E_f)\right]E \tag{1.39}$$

The solution to Browning et al. (1994) model, which is shown in page 1078, yields the household demand for private good j which is given by (1.40), and the demands for private good j for the mother and father which are given by equations (1.41) and (1.42)[27].

$$x_j = \lambda_j\left(x_m, E\rho(I_m, I_f, \alpha_m, \alpha_f, E_m, E_f)\right) + \beta_j\left(x_f, E\left[1 - \rho(I_m, I_f, \alpha_m, \alpha_f, E_m, E_f)\right]\right) \tag{1.40}$$

$$x_{mj} = \lambda_j\left(x_m, E\rho(I_m, I_f, \alpha_m, \alpha_f, E_m, E_f)\right) \tag{1.41}$$

$$x_{fj} = \beta_j\left(x_f, E\left[1 - \rho(I_m, I_f, \alpha_m, \alpha_f, E_m, E_f)\right]\right) \tag{1.42}$$

The economic literature in the area of collective models of household behavior then turns its attention to the incorporation of household production and addressing the different types of market structures. Chiappori (1997) undertakes these two tasks. Chiappori (1997) not only incorporates household production into the collective setting but he also examines two different types of market structures: complete and incomplete markets. Chiappori (1997) devises a two-step maximization problem that accounts for different types of preference structures, altruistic and egoistic, and different types of household commodity markets, complete and incomplete markets.

The first stage is the same for both preference structures and markets. In the first stage, the household maximizes household production subject to the cost of their household production. The first stage maximization problem is given by:

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[27] This is the case for private goods when either $\lambda_j(\bullet)$ or $\beta_j(\bullet)$ equal to zero. If good *j* is not a private good, we only observe the response of q_j to changes in $(I_m, I_f, \alpha_m, \alpha_f, E_m, E_f)$.

(1.43) $$\underset{T_{im},T_{if}}{Max}\ p_z \bullet h(T_{im},T_{if}) - w_m T_{im} - w_f T_{if}$$

The solution to the first stage yields the amount of time used by household member *m* and *f*, T_{im} and T_{if}, in the production of each household commodity, $z_{ci} = h(T_{im},T_{if})$.

(1.44) $$T_{im} = f(w_i, w_j, N_i, N_j)$$

(1.45) $$T_{if} = f(w_i, w_j, N_i, N_j)$$

These allocations of time by *m* and *f* are given by (1.44) and (1.45), respectively.

In the second stage for the complete market case, the household commodity, z_{ci}, can be bought or sold in the market at a price of *p*. The quantity bought or sold is denoted by z_B. There are two plausible preference structures altruistic or egoistic. The second stage maximization problem for the complete market case with altruistic preferences is given by:

(1.46) $$\underset{x_i,z_{ci},T_{ci}}{Max}\ W^i\left[U_m\left(x_m,z_{cm},T_{cm}\right),U_f\left(x_f,z_{cf},T_{cf}\right)\right]$$
$$s.t.\quad \sum\nolimits_{i=m,f}\left(p_{mi}x_i\right) \le \sum\nolimits_{i=m,f}\left(w_i T_{wi} + V_i\right)$$

The second stage maximization problem for the complete market case with egoistic preferences is given by:

(1.47) $$\underset{x_i,z_{ci},T_{ci}}{Max}\ U_i\left(x_i,z_{ci},T_{ci}\right)$$
$$s.t.\quad \sum\nolimits_{i=m,f}\left(p_{mi}x_i\right) \le \sum\nolimits_{i=m,f}\left(w_i T_{wi} + V_i\right)$$

Chiappori's (1997) income sharing rule summarizes the household decision process when household production is incorporated into the collective setting and is given by: $S = s_f + s_m = w_m T_{wm} + w_f T_{wf} + p_z \bullet Z$.

Chiappori (1997) finds three results in the case of the complete market case. First, he finds that the sharing rule can be identified up to an additive constant. Second, the Marshallian demands for leisure can be recovered. Third, he finds that testable restrictions on market and labor supply functions can be generated. In this model, L_i denotes the demand for leisure time for individual i[28], λ_i denotes the Marshallian demand derived from U^i[29]. The Marshallian demands for leisure must have the following form in the case of egotistic preferences.

(1.48) $$L_i(w_i, w_j, N_i, N_j) = \lambda_i(w_i, s_i)$$

Similarly, Chiappori (1997) finds that in the incomplete market case there are four results. First, the sharing rule can be identified up to an additive constant of $\left(w_m, w_f\right)$. Second, the endogeneity of domestic price *p*, has a cost in terms of identification because *p* is not only a function of w_m, w_f, N_m and N_f but also a function of preferences and the decision process. Third, the parametric estimation of the income sharing rule can be misleading since it is a reduce form representation that can be derived from multiple models. Fourth, the welfare implications derived from the parametric model may be incorrect. The Marshallian demands for leisure must have the following form in the case of egotistic preferences[30].

(1.49) $$L_i(w_i, w_j, N_i, N_j) = \lambda_i\left(w_i, p\left(w_m, w_f\right)s_i\right)$$

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[28] L_i is described in Chiappori (1997) page 192 and defined in terms of w_i and s_i in page 197.

[29] This definition is found in Chiappori (1997) page 203.

[30] This definition is found in Chiappori (1997) page 207.

The economic literature on collective models of household behavior then turns its attention to the derivation of testable implications for the collective models. Browning and Chiappori (1998) derive testable implications of the Nash-bargaining and collective models of household behavior that can be viewed as generalizations of Slutsky symmetry and negative semi-definiteness in the unitary models.

Their maximization problem is given by:

$$(1.50)\quad \begin{aligned} &\underset{x_m, x_f, x_p}{Max} \ \mu\left(E, p_p, p_{mf}, p_{mm}\right) U_m\left(x_m, x_f, x_p\right) + \left(1 - \mu\left(E, p_p, p_{mf}, p_{mm}\right)\right) U_f\left(x_m, x_f, x_p\right) \\ &s.t. \quad p_{mm} x_m + p_{mf} x_f + p_p x_p = E \end{aligned}$$

The maximization problem yields not only the demands for private consumption, $x_i = f\left(p_{mm}, p_{mf}, p_p, E, \mu(.)\right)$, but also the income sharing rule, $\mu\left(E, p_p, p_{mf}, p_{mm}\right)$, which represents the distribution function that summarizes the decision process and determines the location of the demand in the Pareto frontier. The income sharing rule can be thought of as welfare weights that are attached to both household members. An interpretation of these welfare weights is that they represent the bargaining power of the household members in the intrahousehold allocation process. Under this setting, changes in wages, nonlabor incomes or prices, may then shift bargaining power from one spouse to the other. When we have $\mu\left(E, p_p, p_{mf}, p_{mm}\right) = 1$ this implies that individual *m* always gets his or her way and $\mu\left(E, p_p, p_{mf}, p_{mm}\right) = 0$ implies that individual *f* always gets his or her way. The variables p_p, p_{mf}, p_{mm} and E enter thorough the income sharing rule and the budget constraint. Variables such as extra

environmental parameters and family financial structure enter the decision process but not the preferences.

The resulting collective model counterpart to the Marshallian demand functions for private consumption is a function of $\mu(\bullet)$:

(1.51) $$x_i = f\left(p_{mm}, p_{mf}, p_p, E, \mu(.)\right)$$

From duality theory, Browning and Chiappori (1998) derive the following expenditure function, $e\left(p_{mm}, p_{mf}, p_p, E, \mu(.)\right)$. For collective rationality, it must be the case that $x_T(p_{mm}, p_{mf}, p_p, E)$ is such that there exists a $x_m(p_{mm}, p_{mf}, p_p, E)$, $x_f(p_{mm}, p_{mf}, p_p, E)$ and $x_p(p_{mm}, p_{mf}, p_p, E)$ that is the solution to the maximization problem such that $x_T = x_f + x_m + x_p$.

The Marshallian demand is given by:

(1.52) $$\xi\left(p_{mm}, p_{mf}, p_p, E\right) = f\left(p_{mm}, p_{mf}, p_p, E, \mu(.)\right)$$

The pseudo Slutsky matrix is $S = \xi_p + \xi_x \xi'$. The unitary model implies that S is symmetric and negative semi-definite. The collective model implies that $s = \Sigma + UV'$ where Σ is a symmetric semi-definite matrix, $u_i = \partial f_i / \partial \mu$ and $v_i = \partial \mu / \partial p + \left(\partial \mu / \partial X\right) \bullet \xi_j$. Browning and Chiappori (1998) developed a testing procedure named SR1. The first step is to define an anti-symmetric matrix, M, such that $M = S - S'$. The test is based on the rank of M. There are three possible outcomes for households with one and two individuals. In the one and two household cases, if the rank(M)=0 then the unitary models is the correct model. In the two household case, if the rank(M)>2 then the collective model is rejected. While in the one person household case, we reject the

collective model when the rank(M)>1. In the two person household case, if the rank(M)=2 then the collective model is the correct model. While in the one person household case, the collective model is the correct model when the rank(M)=1. The addition of distributional factors that enter μ means that in addition to testing SR1 we must also test whether distributional factors are collinear, $\xi_{y_i} = \xi_{y_1}\theta_i$.

3. Noncooperative Bargaining Models

Noncooperative bargaining models provide an alternative formulation to Collective and Nash bargaining models. Unlike cooperative collective models, the solution to noncooperative bargaining models need not be Pareto efficient intrahousehold allocations. Noncooperative bargaining models use a noncooperative Cournot-Nash equilibrium within marriage that is suboptimal.

Lundberg and Pollak (1993) introduce a noncooperative model called the *separate spheres* which has a threat point that reflects a noncooperative suboptimal outcome within marriage that reflects traditional gender roles. This model may result in different equilibrium distributions in existing marriages from child allowances made to the spouses.

Lundberg and Pollak (1993) discuss two *separate spheres* models. The first model has a Cournot threat point. In this specification, the spouses play a simultaneous move game. This model starts with a Cournot equilibrium that arises from the voluntary

provision of public goods by the spouses in accordance with societally prescribed gender roles[31].

The utility functions of the parents are Von Newman-Morgensten. In this model, I_i denotes the total income of household member i which is equal to the sum of his earned income, $w_i T_{wi}$, and unearned income, N_i, x_i denotes the private good consumed by individual i with price p_i, x_{pi} $\left(x_{pj}\right)$ denotes the public goods consumed by the household that are part of $i's$ $\left(j's\right)$ sphere with price p_p. This simultaneous move game is given by:

$$\underset{x_i, x_{pi}}{Max}\, U^i(x_i, x_{pi}, x_{pj}) \quad s.t.\ p_i x_i + p_{pi} x_{pi} = I_i \tag{1.53}$$

In the case of a noncooperative equilibrium, the level of the public good is determined by the spouses. The resulting demand (reaction) function for the private good consumed by the i^{th} household member and the public good that he provides are given by (1.54) and (1.55), respectively where p_{pi} is the price of the public good provided by individual $i = m, f$.

$$x_i = h\left(p_i, I_i, x_{pj}\right) \tag{1.54}$$

$$x_{pi} = h\left(p_{pi}, I_i, x_{pj}\right) \tag{1.55}$$

When we have a noncooperative marriage, each spouse simultaneously decides the provision of x_{pi} and x_{pj} and are assumed to reject societal sanctioned allocation of the

[31] Corner solutions and non-neutrality in the provision of public goods are a possibility but can be mitigated when we allow for cash transfers or binding premarital contracts between spouses.

responsibilities. The levels of x_{pi} and x_{pj} that are chosen are independent of preferences and productivity differences between spouses.

In Lundberg and Pollak's (1993) model, the noncooperative equilibrium has been shown to depend on the individual resources of each spouse. The control of the resources, child allowance payments, is important in determining the allocation of resources within the household. The distribution within two-parent families can be affected by policy changes that have no effect on the relative well-being of divorced men and women.

In the second type of *separate spheres* model, Lundberg and Pollak (1993) incorporate transfers from the father to the mother. The husband plays the role of the Stackelberg leader and moves first. He maximizes his utility subject to his budget constraint that accounts for his transfer to his wife and her reaction function. The wife, as the follower, moves second as to maximize her utility subject to her budget constraint. The wife is assumed to specialize in the provision of the public good, x_p child services, while the husband specializes in the provision of money income, I_m. There is a transfer from husband to wife, *s*, and it can be augmented by an amount, *t*. Therefore, he maximizes his utility by choosing his private goods and the transfer he gives to his wife.

This maximization process takes two periods. In the first period, the marriage contract takes place. At this point, the parties do not know the actual values of incomes, I_m and I_f, but they know the distribution from which the incomes of spouses will be drawn. It is also assumed that costless enforceable and binding prenuptial contracts can be made by prospective spouses. The prenuptial contracts stipulate that a

minimum transfer, *t*, will be paid from the husband to the wife in the second period[32]. The transfer, *t*, can be voluntarily augmented by the husband in the second period by a positive amount, *s*, or it can be substituted by cooperative bargaining outcome after his and his wife's income are realized in order to increase his consumption of her public good, x_m. The Cournot equilibrium is determined by the intersection of the public goods demand functions.

Lundberg and Pollak (1993) conclude that in the separate spheres model with positive transfers the effect of the alternative child allowance scheme is identical regardless of which parent gets the child allowance payment. However, if there is no positive transfer made to the mother the threat point is affected by which parent receives the payment.

D. Applications

1. The Analysis of Time with Unitary Models

The majority of researchers in the area of intrahousehold allocation of resources and economics of the family agree that the incorporation of time into the analysis of intrahousehold allocation with the use of time surveys would allow us not only to measure the value of unpaid but productive activities, but also leisure and non-leisure non-productive activities. However, there is no clear consensus on which non-market work should be measured and how the activities should be evaluated. Joyce and Stewart (1999) believe that we should use the third person criterion, which states that an

[32] It is important to note that this amount is not contingent on future earnings.

activity is productive and should be measured if it can be done by someone else and still reach the desired result. They also believe that we can use one of two approaches to assign value to different activities. The first approach is the output approach, which states that we must first identify the output and assign a price to that output. The second approach is the input approach, which states that we must estimate the amount of time spent on the activity and then we must multiply by the wage rate. There are some problems with both of these approaches. What price should be assigned to the output from the output approach? Some argue that we must value it according to the market price. In the case of the input approach, it is not clear which wage rate should be used. Should we use the individuals wage rate, a specialists wage rate or a generalist wage rate[33]? There is a serious problem with using the time spent on an activity as an appropriate indicator of the output from an activity. From McConnell (1992), we know that time spent on a non-working productive activity may not only be a cost but also enhance the activity and yield utility.

There have also been other concerns with the implementation of the use of the HPM. There is an argument of whether the variables being investigated are utilities rather than commodities. The proponents of this argument believe that these misapplications *confounded* preferences and technology by interpreting specific utility functions as production functions. This argument was first proposed by Pollak and Wachter (1975). There is little attention paid to the problem of identification of household commodities and activities because while goods are limited by the definitions used in market transactions, activities and commodities are constructed by

[33] If we think of building a deck a specialist would be a carpenter and a generalist would be a handy man.

researchers (Pollak 1999). Multitasking is also believed to pose a problem in the collection and analysis of time use data. A solution to the multitasking problem proposed by Pollak (1999) involves the use of two new definitions for simultaneous activities. Simultaneous activities such as driving a car and listening to the radio are defined as *parallel activities*. While simultaneous activities that involve the responsibility for the care of another in a situation in which time constraints are stochastic are defined as *on-call activities.*

Even though there are a number of concerns with the use of the household production model, many uses of the household production model have attempted to examine the allocation of time to different household production activities. The following review provides some empirical implications of the household production model in the economic literature.

Kooreman and Kapteyn (1987), like Pollak and Wachter (1975), believe that due to non-constant returns to scale and joint production it is not possible to disentangle the effects preferences and technology have on observed behavior. They also argue that, due to the lack of data on household commodities, previous literature has disaggregated non-working time into time spent on house work and pure leisure. This division of time does not allow for the large number of allocations of time that take place in the household to produce household commodities. In addition, they also believe that the categorization of household commodities into aggregate goods and total consumption is too limited. The authors state that the exclusion of households with non-working members from the previous literature leads to a bias that has not

properly been addressed. The authors propose a model of allocation of time within the household with data that allows us to distinguish between nine different categories of time: household activities, childcare, obtaining goods and services, personal needs and care, organizational activities, hobbies and sports, entertainment and social activities, radio television and reading and total leisure. The model is given by:

$$
\begin{aligned}
&\underset{T_{mi},T_{fi}}{Max}\ U(T_{mi},...,T_{mk};T_{fi},...,T_{fk};x_T) \\
&s.t.\quad p\bullet x_T \le (T_{0m}-\textstyle\sum_i T_{mi})w_m+(T_{0f}-\sum_i T_{fi})w_f+N \\
&\textstyle\sum_i T_{mi} \le T_{0m} \\
&\textstyle\sum_i T_{fi} \le T_{0f} \\
&T_{mi} \ge 0 \\
&T_{fi} \ge 0 \\
&x_T \ge 0
\end{aligned}
\qquad (1.56)
$$

In this model, T_{mi} and T_{fi} denote the time spent by the male and female spouses on the *i*th activity respectively, x_T denotes total consumption, *p* denotes the price of total consumption, w_m and w_f denote the wage rate of males and females respectively, T_{0m} and T_{0f} denotes total number of hours per time period available to household member *m* and *f* and *V* represents unearned family income. Optimization results in the allocation of time by each household member on the eight available activities if the last five constraints are not binding. The resulting demands for time allocated to the different activities are given by[34]:

$$T_{ji} = h(p, x_T, w_i, w_j, N, T_{0m}, T_{0f}) \qquad (1.57)$$

[34] When only one spouse works, the share equations can be derived with the use of the shadow price wage concept (i.e., one constraint is binding).

Kooreman and Kapteyn (1987) use a Heckman like procedure to correct for selection bias that arises from the exclusion of households with non-working spouses.

Kooreman and Kapteyn (1987) find that their results are consistent with three of Gronau's (1977) findings. First, they find that in two-earner households the amount of household work is a function of the partners wage rate. Second, they find that an increase on household income does not change the wage rate. Third, they find that in the case of the female partner an increase in the real wage of the male partner would lead to a decrease in the partners' profitability of household work. However, Kooreman and Kapteyn (1987) disagree with Gronau's (1977) findings with regard to male partners. They believe that the correct test of Gronau (1977) should be to ascertain whether weak separability between consumption and leisure activities exists.

Researchers agree that there are differences in time allocation between different countries, time and ages. Yamada, Yamada and Kang (1999) try to explain how time allocation patterns are affected by Japanese culture and the economic reality of the household members. First, they compare patterns of time allocation between two different age groups, 25-39 and 65 and over. Second, they compare time allocation patterns between the employed and unemployed. Third, they compare time allocation patterns between male and female Japanese households.

Yamada, Yamada and Kang (1999) use a HPM much like Becker (1965) but there are three differences. First, the household production technology is not only a function of market goods, male and female time used in the production of the household commodities, but also a function of exogenous stock of health capital, H_o. Second, the

stock of health capital only enhances non-market productivity. Third, the wages of male and female partners are allowed to be different, that is, $W_f \neq W_m$. The maximization problem is given by:

$$\begin{aligned} &\underset{Z_i}{Max}\, U\left(Z_1,...,Z_n\right) \\ &s.t.\quad \sum\left(P_i X_i + W_f T_i^f + W_m T_i^m\right) \leq W_f T_i^f + W_m T_i^m + N \\ &\quad Z_i = F_i\left(X_i, T_i^m, T_i^f : H_0\right) \end{aligned} \tag{1.58}$$

In this model, X_i denotes market good *i*, T_i^f and T_i^m denote male and female time used in the production of household commodity, Z_i, and *V* denotes unearned income. The resulting demand functions for market goods and non-market time are given by (1.59) and (1.60). As with Pollak and Wachter (1975), this model uses demand functions as functions of market good prices and wages but then includes functions of health stock, H_0.[35]

$$X_i = X_i\left(P_1,...,P_n, W_m, W_f : H_o\right) \tag{1.59}$$

$$T_i^j = T_i^j\left(P_1,...,P_n, W_m, W_f : H_o\right) \tag{1.60}$$

The authors assume that there are constant returns to scale and non-joint production associated with the production of household commodities. This assumption is made to follow Pollak and Wachter's (1975) argument for the usefulness of household commodity shadow prices. This assumption renders the shadow prices exogenous. The authors find like Gronau (1973) that the wage of the male partner is

[35] Here we have *i*=1,…,n and *j*=m,f.

greater than that of the female partner, $W_m > W_f$. Therefore, men are found to allocate less time to household production than women.

Unlike previous time allocation studies, Yamada, Yamada and Kang (1999) find both an increase in the number of market and non-market working hours for male and female Japanese between the ages of 25 and 39 for the period from 1976 to 1986. They find that the labor supply elasticity of females is much greater than of males. They attribute the large difference to the fact that Japanese women have more alternative allocations of time than men in Japanese society because married Japanese women generally specialize in household production and, therefore, are less likely to enter the labor market than their husbands. They also find a low elasticity of male labor supply which they attribute to the role of men in Japanese culture as full-time workers.

Yamada, Yamada and Kang (1999) find that the gender gap in non-market activities remains constant in the period from 1976 to 1986 for the young and the elderly, and the employed and unemployed, which they believe can be explained by Japanese culture, which emphasizes gender specific social roles. They find positive relations between the cost of raising children and size of family and between household income and childcare provided by the parents.

Yamada, Yamada and Kang (1999) explore the relationship between the market wage rate and time used for healthcare, which is defined as the time spent sleeping and in medical care. Unlike past studies of elderly males in the United States, the researchers not only find a negative relationship between the wage rate and time spent on healthcare but also find that the effect of sleeping for young males and females is

positive, which is believed to be the case because the indirect effect of sleeping time on market and non-market productivity is large enough to offset the substitution effect of rising wages for young males and females. Yamada, Yamada and Kang (1999) also find that the life time cycle of time allocation to health care appears to be U-shaped.

Due to the lack of a direct measure of household commodities, the trend in the household production literature has been to study the allocation of time and goods between household activities as proposed by Pollak and Wachter (1975). Previous to Lecocq (2001) no one had studied the restrictions implied by a model such as that of Pollak and Wachter (1975). In other words, previous to Lecocq (2001) no one had tested: (1) the weak separability of time and resources used in the production of every household commodity, and (2) whether the production of some household commodities are consistent with the HPM while at the same time the production of other household commodities are not. Lecocq (2001) and Smith, Devougues and McGivney (1983) believe that the timing of time is important and explore its effect by studying weekday time versus weekend time.

Lecocq (2001) obtains the derived utility function by introducing household production technology into the budget constraint. The derived utility function is given in terms of market goods, time and environmental variables. The estimation of the demand for household commodities rests on the identification of goods and time used to produce a given household commodity. This implies that weak separability of goods and time used in the production of a given household commodity is possible. Lecocq's

2001 model concentrates on ascertaining whether the production of meals is consistent with the HPM.

When weak separability in the production of meals is supported by the available data, the resulting model is given by:

$$\begin{aligned} &\underset{x_i, T_{im}, T_{if}}{Max}\ U\left[U_{FH}(x_{FH}, T_{FHm}, T_{FHf}, x_{FAH}, T_{cm}, T_{cf}), x_{OH}, T_{OHm}, T_{OHf}, x_{FAH}, T_{cm}, T_{cf}, d\right] \\ &s.t.\quad p_{FH}x_{FH} + p_{OH}x_{OH} + p_{FAH}x_{FAH} \le w_m T_{wm} + w_f T_{wf} + N \\ &\qquad T_{om} = T_{cm} + T_{FHm} + T_{OHm} + T_{wm} \\ &\qquad T_{of} = T_{cf} + T_{FHf} + T_{OHf} + T_{wf} \end{aligned} \tag{1.61}$$

In Lecocq's (2001) model, $z_{FH} = f(x_{FH}, T_{FHm}, T_{FHf})$ denotes meals prepared and $z_{OH} = f(x_{OH}, T_{OHm}, T_{OHf})$ denotes other household commodities. In this case, Lecocq (2001) substitutes the household production functions for these two household commodities into the objective function. We also have x_{FAH} , x_{FA} and x_{OH} which denote food consumed away from home, food consumed at home and other household commodities, respectively, and *d* denotes demographic variables. The first constraint is the full income constraint. The last two constraints show how the total time for the mother and father are allocated.

The resulting demands for meals prepared and other household commodities are given by:

$$x_i = h\left(p_i, w_m, w_f, N, x_{FAH}, T_{cf}, T_{cm}\right) \; i = FA, OH \tag{1.62}$$

When weak separability in the production of meals is not supported by the available data, we can not substitute the household production function into the utility function and get the derived utility function. The resulting model is given by:

$$(1.63)\quad \underset{x_i, T_{im}, T_{if}}{Max}\ U\left[x_{FH}, x_{FAH}, x_{OH}, T_{cm}, T_{cf}, T_{FHm}, T_{FHf}, T_{0Hm}, T_{0Hf}, d\right]$$
$$s.t.\quad p_{FH}x_{FH} + p_{OH}x_{OH} + p_{FAH}x_{FAH} + w_j \sum_{j=m,f}\left(T_{cj} + T_{FHj} + T_{0Hj}\right) \le \sum_{j=m,f} w_j T_{0j} + N$$

The resulting demands for meals prepared and other household commodities are given by:

$$(1.64)\quad x_i = h\left(p_i, w_m, w_f, N, x_{FAH}, T_{cf}, T_{cm}, x_j, T_{0Hm}, T_{0Hf}\right)\ i = FA, OH\ and\ i \neq j$$

The test of weak separability consist of testing that the coefficients of, x_j, T_{0Hm} and T_{0Hf} are jointly equal to zero.

There are three important results from Lecocq (2001). First, household commodities that are weakly separable in goods may not be weakly separable in time. This is the case for meals prepared and other household commodities produced during weekends. This is believed to be the case because individual household members are not strongly time constrained on weekends. This argument is similar to Smith, Devougues and McGivney's (1983) *timing of time argument.* The HPM is supported by weak separability of meals prepared on weekends, however, weak separability is rejected in the case of male and female time inputs devoted to other household commodities.

E. Tests of Unitary Models

The unitary model has been used widely in the studies of welfare of household members and of the impact of government programs on the welfare of women and children. However, the validity of unitary models has come into question. The test of unitary models is based on the test of the income pooling hypothesis, which is an

implication of the unitary models on the demand functions. The income pooling hypothesis states that income from different household members is spent in the same manner. When this hypothesis is true, one policy implication is that no welfare gains are made by switching an assistance program that provides resources to the husband to an assistance program that provides the resources to the mother. We will now examine the most important tests of the unitary models.

Two significant tests of *unitary models* are found in the literature in Thomas (1990), and Lundberg, Pollak and Wales (1997). Thomas (1990) tests the validity of *unitary models* by testing the income pooling hypothesis. The restriction placed by the income pooling hypothesis is that the income from each spouse should have the same effect on demand functions and should be spent in the same manner. Thus, demand functions should be based only on total household income and not on income from each spouse. Thomas (1990) examines the *unitary model* and the *Nash bargaining model* of McElroy and Horney (1981).

The *unitary model* analyzed by Thomas is given by:

$$\begin{aligned} &\underset{X,Z}{Max}\ W\left[U_1(X,Z),...,U_n(X,Z)\right] \\ &s.t.\ P \bullet X = \sum_{i=1}^{n} w_i T + Y_i \end{aligned} \tag{1.65}$$

In this model, the variable $U_i(X,Z)$ represents the i^{th} individuals utility which is a function of the vector of commodity demands, X, and a vector of non-market goods, Z. The variable *p* denotes a vector of prices of all of the commodity demands and also includes, w_i. As in previous models, we have that w_i is the price of time for the ith household member, T is individual *i's* total available time and N_i is the unearned

income of the i^{th} individual. In most of the economic literature, we only observe household consumption of good i, $X_i = \sum_{i=1}^{n} x_i$, rather than the individual consumption for that good, x_i.

When the unitary model is the correct model, Thomas (1990) states that the demand functions are given by:

$$X_i^* = \sum_{i=1}^{n} x_i = g\left(p, \sum_{i=1}^{n} N_i, T\right) \tag{1.66}$$

However, when the unitary model is not the correct model then the demand functions are given by:

$$X_i^* = \sum_{i=1}^{n} x_i = g\left(p, N_1, ..., N_n, T\right) \tag{1.67}$$

The Nash bargaining model of McElroy and Horney (1981) which was analyzed by Thomas is given by:

$$\begin{aligned} &\underset{X,Z}{Max}\ \Pi_{i=m,f}\left[U_i(X,Z) - V_0^i(p, N_i, A_i, T)\right] \\ &s.t.\ P \times X = \sum_{i=1}^{n}\left(w_i T + N_i\right) \end{aligned} \tag{1.68}$$

There are two new variables in this model: V_0^i denotes the maximum attainable utility outside of marriage, and A_m denotes characteristics of the environment individual i would face if he/she exited the household.

When the Nash bargaining model is the correct specification, the demand functions are given by:

$$X_i^* = \sum_{i=1}^{n} x_i = g\left(p, N_1, ..., N_n, T, A_i\right) \tag{1.69}$$

Therefore, the test of the unitary model is whether the coefficients of all household individual incomes are the same. If these coefficients are different we reject the income pooling hypothesis and, therefore, the unitary model.

Thomas (1990) tests the effect of unearned income in the hands of the mother and father on the health and welfare of women and children as measured by nutrient intake, children's health (height by age and weight by height), child survival rate, women's fertility and clothing expenditures. His research shows that unearned income in the hands of the mother has a greater effect on children's and women's welfare. His research also shows evidence of gender bias in the provision of resources by parents. Mothers (fathers) are found to devote more resources to improve the nutritional status of their daughters (sons).

Thomas (1990) disagrees with Chiappori's (1988) assertion that the use of a bargaining concept such as Nash is too restrictive. Chiappori (1988) states that if preferences are not purely egoistical only the use of revealed preferences or non-parametric techniques will allow for the distinction of the collective model from the unitary model. Thomas (1990) believes that this argument is too strong, because even if income pooling fails a change in non-wage income under the control of different household members will have the same effect on demands when the dictatorial model is correct. Thomas states that if parents have different preferences, even if household allocations are Pareto efficient, the demand equations will not only depend on prices but also on individual components of unearned income. Therefore, Thomas (1990) concludes that rejection of the income pooling hypothesis is not a constructive test. He

points out that, theoretically, the correct measure of income needed to test the income pooling hypothesis is the present discounted value of lifetime nonlabor income. He explains that this is necessary to insure that the measure of nonlabor income is independent of prices, wages and preferences. When the income measure used is not independent of prices, wages and preferences, it would be measured with error. His research fails to reject the hypothesis that unearned income is measured with error. Thomas's use of anthropometric variables is important because it bridges the nutritional literature and the intra-household allocation literature in economics. However, the variables used for the comparison leave a lot to be desired. He compares average height by age of U.S. and Brazilian children which were mostly from rural areas. He also compares Brazilian boys and girls without accounting for differences in sexual maturity of children of different genders.

Lundberg, Pollak and Wales (1997) test the unitary model by testing the income pooling hypothesis. Unlike previous tests of the income pooling hypothesis using differences in earned or unearned income of husbands and wives which are likely to be correlated with differences in prices, wage rates and preferences and, therefore, are not truly exogenous, Lundberg, Pollak and Wales' test is based on a natural experiment in the form of a policy change in the United Kingdom that transferred a substantial child allowance to wives from husbands in the late 1970's. The authors reject the income pooling hypothesis and state that this rejection provides significant new evidence against the unitary models. The authors found that there were increases in relative expenditures on children's and women's clothing relative to men's clothing that

followed the policy change in the U.K. Therefore, the authors conclude that the welfare of children increases when mothers are given control or are targeted as the beneficiaries of child allowance programs instead of fathers. The empirical model is only loosely connected to the underlying economic theory. The most significant problem with their model is that the change in policy could have led to a change in relative prices of children's to men's and women's to men's clothing, which in term led to the change in the consumption pattern.

F. A Possible Theoretical and Empirical Extension

Chiappori (1988a) states that *in the absence of sociological data about the decision process within the household, the latter has to be considered as a "black box"*. The literature of family financial structure provides us with sociological information that may shed light on the decision process within the household. In the following section we will explore this literature.

1. Family Financial Structure

The sociological literature concerning power within the family and inequality within the household was pioneered by Blood and Wolfe (1960). Blood and Wolfe's (1960) research attempts to explain how the balance of power within the household is determined. They define power as the potential ability of one partner to influence the others behavior. Authority is defined as power held by one spouse because both

spouses feel it is right. They state that there are two competing theories of what determines the balance of power. The first theory states that the balance of power is determined mostly by the culture under which the household members live. The second theory states that the balance of power is determined mostly by the economic resources provided by each spouse to the household. Blood and Wolfe (1960) find that the source of power is determined by the comparative resources that each spouse brings to the marriage. Blood and Wolfe (1960) argue that the balance of power leans toward the spouse who brings the greatest financial contribution of resources to the marriage since this individual is strategically positioned to influence the distribution of resources.

Recent sociological literature has focused on studying the relationships among financial organization, administration of finances and financial decision-making within the family. The economic literature has developed models that study the impact of incomes from different spouses on the purchase of different commodities. One major implication is that assistance projects targeting different household members can result in different outcomes in the standard of living of women and children. However, economic theory has not fully considered the ways in which different family financial structures not only account for who earns the income but under what structure financial decisions are made within the household. The following chronological literature review explores the most significant studies in the area of family financial structure.

The sociological literature on family financial structure starts with Pahl (1989) who believes that the treatment of the household by economists as if it was a single

individual, *unitary models*, led to the creation of a *black box* between earnings and spending. Pahl (1989) examines how household income is managed within the marriage, the sources of income and control over household income and studies the implications of these areas on the patterns of spending. She believes that the use of the unitary models has led to three important effects. First, she believes that it has blurred the distinction between controlling, managing, spending and consuming. Second, she contends that these models fail to make distinctions between different kinds of expenditures. It is her contention that income used for different expenditures may come from different sources: own income, partner's income or common resources. She also believes that *spending* can have different claims on the sources of income depending upon the item being bought. Therefore, the distinction between personal and household spending is important. Third, she wants to examine the effect that *unitary models* have had on the study of how household members share resources.

Pahl's (1989) analysis consists of sorting couples by joint or separate accounts and then by who controls the pooled income. The results are four categories of household financial organization: wife controlled pooling, husband controlled pooling, husband controlled non-joint account and wife-controlled non-joint account. Her analysis shows that the amount of money spent on housekeeping is not only related to the level of household income but also to the amount contributed by each partner and his/her control over the resource. She also finds that resources in the hands of the mother lead to greater expenditures on food than in the hands of the father. The proportion of resources spent on housekeeping was found to be greater if the wife controlled the

finances. She also finds that women hold less money back in absolute and relative terms in times of need. Therefore, she concludes that in order to raise the living standards of women and children, economic aid should be directed to women.

Wife-controlled finances are found to be more common in low-income working class households. Wife controlled finance are found to go hand-in-hand with wife management. Husband controlled finances were found to be associated with higher income, an allowances system for housekeeping and husband control of large expenditures. Pahl finds that pooled income under wife control is associated with middle income levels and two-income households, while husband controlled pooling is more typical of higher income levels.

She also finds that expenditure patterns are different according to gender. Wives were found to be more likely to pay for food at home, clothing for themselves and children, presents and school expenses. These expenditures can be categorized as expenditures from running the household and, therefore, belong to the wife's sphere of responsibilities. Husbands were found to be more likely to pay for their clothing, car, household repairs and decorations, food away from home and alcohol. These expenditures can be seen as belonging to the husband's sphere of responsibilities. Therefore, Pahl's (1989) findings seem to supports Lundberg, Pollak and Wales *separate spheres model*. She also finds that joint expenditures include consumer durables, donations and Christmas expenditures. This result seems to indicate that, for large expenditures, the household may be pooling income while at the same time we may

observe separate spheres of expenditures for husbands and wives. Pahl's (1989) analysis lacks a rigorous formal theoretical model and a robust empirical model.

Burgoyne (1990) examines the perception of money within the household paying particular attention to control and ownership of income. She studies control of income not only as a function of the source of income, as did Pahl (1989), but also as a function of the life cycle. She observes that the majority of the changes in the way families organize their finances take place in response to changes in the level and source of the income, with the spouse with the greater financial contribution having a larger role in decision making and control of the household income. She found that the life cycle was an important determining factor and explanatory variable in the shift of power. She argues that, for example, the beginning of a family involves the exit of the mother from the labor market, a decrease of her contribution to household income and a resulting loss of power. She also found that the *rights of ownership* associated with earning the income remains and leads to overall control, while the financial structure of pooling household income may lead to the erroneous conclusion that resources are equally shared.

Burgoyne (1990) and Edwards (1981) believe that management is more of a matter of fact, and control is more of a matter of perception. Burgoyne believes that perception determines an individual's subjective reality, which then determines the individual's economic behavior. Burgoyne (1990), like Wilson (1987), believes that the existence of a shared bank account does not necessarily signify that sharing exists but may conceal inequality. She argues that when income is pooled issues of control, such as the right to

access the money and decisions to spend, can be observed to lead to a traditional distribution of power within the family but is perceived as equality. It is also her belief that increased contribution by the wife to household income may not to lead to a more equitable distribution of power, but may, in fact, lead to a greater asymmetry in her financial status if her contribution only serves to augment the housekeeping and allows her partner to keep more of his own money.

Burgoyne (1990) finds that the psychological sense of ownership of income is not removed by pooling income. She argues that while pooling resources within marriage might remove the overt label of ownership, the earner of income is found to retain a powerful influence upon the psyche of both spouses and is reflected in the way both spouses treat the joint account. Therefore, perceived ownership of resources legitimizes a pattern of control, while disadvantaging a spouse whose contribution is in the production of household commodities. She also finds that the life cycle affects and changes the financial organization of households over time. It is her belief that life cycle can be used to track and explain major shifts in balance of economic power within a household.

Burgoyne's (1990) analysis is based on a non-representative sample. Her research could be improved by using a larger sample that is random and representative of the desired population. A new classification that incorporates details of the sources and levels of income would be useful in accounting for the way money ownership is viewed.

Vogler and Pahl (1994) explore the relationships among control of financial resources, allocation system and general power within the household by examining the relationship between money, power and inequality within marriage while paying special attention to gender inequality and welfare implications to women and children. Volger and Pahl's (1994) research differs from Pahl's (1989) in that their analysis of household financial organization examines inequalities in financial decision-making and access to money rather than expenditure patterns. Vogler and Pahl (1994) utilize Pahl's (1989) typology of household financial allocation systems. There are four management systems in Pahl's (1990) typology that represent separate spheres of responsibility for household income: female whole wage, male whole wage, housekeeping allowance and the independent management system. The remaining management system is the pooling system which represents joint sphere of responsibility. Vogler and Pahl's (1994) findings validate Pahl's (1989) typology but also find that the pooling system is very heterogeneous in terms of management practices. Therefore, their findings indicate that the general pooling category contains three distinct forms of pooling: the male pool, the female pool and joint pool. Therefore, Vogler and Pahl (1994) propose the use of seven types of management systems instead of Pahl's (1989) five.

Vogler and Pahl (1994) contend that inequalities in power over financial decision-making may facilitate inequalities in access to money as a resource, which results in differences in living standards between spouses in household. Therefore, they believe that the distinction between strategic control over household finances and financial

management as an executive function must acknowledge that the person exercising strategic control may be different from the person responsible for the implementation of daily decisions.

Vogler and Pahl (1994), unlike Pahl (1989) and Burgoyne (1990), construct a summary index of power with in the household[36]. They characterize households in which husbands (wives) exercise control in both spheres as strong male (female) power and those in which both partners exercise equal control in both spheres as strong equality. In the case of households in which wives (husbands) exercised control in one sphere and where joint decisions were made in the other sphere, they characterized them as weaker female (male) power. Their findings indicate that wife and joint management were subject to joint control, whereas male control is exercised through male management. Therefore, Volger and Pahl (1994) conclude that financial allocation systems are found to be associated with inequalities in power over decision-making. The inequalities are smaller in households that use joint or female managed systems and greater in households using male managed systems.

Vogler and Pahl (1994) believe that individuals in the same household can experience two different types of inequalities in access to money as a resource. First, they may experience different levels of financial deprivation. Second, they may experience inequalities in access to personal spending money. Their research concludes that wives are much more likely than husbands to experience cuts in spending on means and clothing. This, they argue, is the case because the categories of expenditures

[36] The index is created by combing the subjects' answers to financial control questions and combining them with couples' answers to general decision making questions.

reflect gendered responsibilities and because wives tend to protect their husbands from the effect of reductions. This belief closely resembles the separate spheres model of Lundberg and Pollak (1993).

Vogler and Pahl (1994) conclude that inequalities between spouses in personal spending and financial deprivation tend to move together. The two female managed systems and housekeeping allowance system were found to have the greatest inequalities between spouses both in terms of financial deprivations and personal spending money. They find that the joint and managed pools are associated with greater equality in both financial deprivation and in access to money. The smallest differences are observed in jointly managed pools.

It is not clear how Volger and Pahl (1994) compute the independent indicator of financial management. How are their perceptions combined into a five-point scale and more importantly how does this yield their results? A multivariate analysis that considers not only sociological variables but also economic variables might lend more clarity to the analysis of intra-household allocation and control of resources as well as inequality within marriage.

2. Empirical Economic Literature That Supports Family Financial Structure

Phipps and Burton (1998) provide evidence that male and female incomes do not always have the same effect on household expenditures. The novelty of their approach is that they test whether income is pooled for different expenditure categories. They find that income pooling holds for expenditures in some categories but not in others.

They conclude that households pool their incomes for big-ticket items but not for personal goods or in gendered spheres. This result is not only consistent with Vogler and Pahl's (1994) findings but also lends support to the separate spheres model of Lundberg and Pollak (1993) which is an intrahousehold bargaining model.

CHAPTER II

THEORETICAL AND EMPIRICAL MODELS

A. Introduction

Research on food consumption and expenditures usually employs the use of the unitary model (e.g. Becker, 1965), which implies the use of the income pooling hypothesis. As we have previously discussed, there is overwhelming evidence against the income pooling hypothesis in economic literature (e.g. Lundberg, Pollak and Wales, 1997; Thomas, 1990) and, therefore, against unitary models. As a consequence of the rejection of unitary models, non-unitary models of household behavior have been developed. The two main non-unitary models of household behavior are collective models of household behavior and intra-household bargaining models. One policy implication of these non-unitary models is that income or resources from an assistance program received by mothers or fathers have different effects with regard to expenditures on both food at home and food away from home.

While economic theory has developed models that study the impact that incomes from different sources have on the purchases of different commodities (e.g. Lundberg and Pollak, 1993; Phipps and Burton, 1998), it has not fully considered the effect that different family financial structures may have on expenditures on food at home and food away from home, and therefore, living standards of different household members. Sociological studies have shown that family financial structure is an important

determinant of household expenditures and, therefore, the standard of living of different household members. In sociology, the most important research in the area of family financial structures comes from Pahl (1990) in which she develops her family financial structure typology. Pahl studies the effect that earning income and types of bank accounts have on household expenditures as well as the effect that managing, and more importantly, control of income have on household expenditures. The inclusion of management and control of income in Pahl's (1990) typology is an important development in the literature because there are differences between earning, managing and controlling income as they relate to household expenditures.

B. Model Specification

There are many ways to model the intra-household allocation of resources. In this study, two versions of a simple model are presented where there is no altruism in the utility function. The outcome of the intrahousehold allocation process in both cases is assumed to result in a Pareto efficient outcome which means that chosen consumption bundles and allocations of time are such that an individual's welfare cannot be increased without decreasing the welfare of his/her spouse. The household in both versions is modeled as a two-person economy that faces fixed prices, and all the results of general equilibrium are available. The individuals are denoted by m and f where $m \neq f$. There are two types of goods: (1) private (non-public) consumption goods represented by the vectors, q_m and q_f, for individual m and f respectively with a

corresponding price vector p_m and p_f; and (2) a vector of public goods x_m and x_f whose price vector for both is p_x. In the first model, the conditional collective model of intrahousehold allocation, the utility functions of individuals m and f are functions of non-private and private goods *conditional* of the family financial structure and only q and x are choice variables. In the second model, the unconditional collective model of intrahousehold allocation, the utility functions of individuals, m and f, are functions of non-private goods, private goods and the family financial structure, and q, x and f_n are all choice variables.

The spouses, m and f, jointly choose a financial structure that is optimal for the household given the particular characteristics of the household. The families in our sample choose from Pahl's (1989) typology which has six family financial structures. There are five that represent separate spheres of responsibility: (1) male whole wage; (2) female whole wage; (3) male housekeeping allowance; (4) female housekeeping allowance; and (5) independent management. In the male and female whole wage systems, the male and female, respectively, make and manage all the money except their partner's personal spending money. In the male and female housekeeping allowance systems, the female and male, respectively, give their spouse an amount of money necessary to run the household plus their personal spending money and manage the rest of the money themselves. In the independent management system, each spouse manages his/her own income and they split the living expenses. The remaining management system is the pooling system which represents joint spheres of responsibility. The model that is proposed in this research uses six distinct types of

family financial structures. The family financial structures correspond to Pahl's (1989) typology, where *n=1* for male whole wage system, *n=2* for female whole wage system, *n=3* for husband allowance system, *n=4* for wife's allowance system, *n=5* for pooling system, and *n=6* for independent system. Therefore, f_n takes on the values that correspond to the chosen structure.

In the following section, I will first introduce the conditional and unconditional collective models maximization problems and then discuss their components. I will then discuss the solutions to both the conditional and unconditional collective household behavior models. This section will end with a comparison and contrast between the two collective models.

In both the conditional and unconditional models of household behavior, it is assumed that individuals have strictly quasi-concave and increasing, twice differentiable utilities. The wage rates, w_m and w_f, and non-wage incomes, N_m and N_f, are exogenously given. The difference between the conditional and unconditional models is that the former assumes that the choice of family financial structure is predetermined or exogenous.

The conditional collective model of household behavior is given by:

$$
\begin{aligned}
&\underset{q_m, x_m, T_{wm}}{Max} \; u^m\left(q_m, x_m; f_m\right) \\
&s.t. \quad u^f\left(q_f, x_f; f_n\right) \geq u_0^f\left(p_f, p_m, w_f, w_m, N_f, N_m; f_n\right) \\
&\qquad \sum_{i=m,f}\left[\left(p_i \times q_i\right)+\left(p_x \times x_i\right)\right]=\sum_{i=m,f}\left(N_i+T_{wi} w_i\right) \\
&\qquad T_{wm}+T_{cm}=T_m \\
&\qquad T_{wf}+T_{cf}=T_f
\end{aligned}
\tag{2.1}
$$

This setup is intuitive because the husband/wife is not only maximizing his/her utility with respect to time allocated to work, time allocated to non-work activities, non-public and public goods conditional on the family financial structure chosen subject to the budget constraint of the household, but also subject to utility of the spouse being greater than the reservation utility.

On the other hand, the unconditional collective model of household behavior is given by:

$$
\begin{aligned}
&\underset{q_m, x_m, T_{wm}, f_n}{Max}\; u^m\left(q_m, x_m, f_m\right) \\
&s.t.\quad u^f\left(q_f, x_f, f_n\right) \geq u_0^f\left(p_f, p_m, w_f, w_m, N_f, N_m, f_n\right) \\
&\qquad \sum\nolimits_{i=m,f}\left[\left(p_i \times q_i\right)+\left(p_x \times x_i\right)\right] = \sum\nolimits_{i=m,f}\left(N_i + T_{wi} w_i\right) \\
&\qquad T_{wm} + T_{cm} = T_m \\
&\qquad T_{wf} + T_{cf} = T_f
\end{aligned}
\tag{2.2}
$$

In the case of the unconditional collective model, the husband or wife maximizes his/her utility with respect to time allocated to work, time allocated to non-work activities, public goods, non-public *and* family financial structure subject not only to his/her spouse's utility being greater than his/her reservation utility but also subject to the household budget constraint which states that total household expenditures on non-private and private goods must be less than or equal to the households total earned and unearned income.

In both versions of the collective model, T_i denotes the total time available for individual i where $i = m, f$, T_{ci} is the time spent not working, and T_{wi} is the market labor supply. Each individual household member has a reservation utility denoted by U_m and U_f. These reservation utilities must be weakly exceeded within the confines of

the household or individual household members will exit the household. The reservation utility is defined as the minimum utility level that would keep individuals in the marriage. Reservation utilities indicate that the constrained utility level of the model, u_0^m, must belong to some interval $\left[U_m, V_m\right]$ where V_m is the maximum utility the husband can achieve when the utility attained by his wife is her reservation utility $\left(u^f = U_f\right)$. The value of u_0^i where $i = m, f$ that generates an observed household allocation is a differentiable function of the individual wage rates, w_f and w_m, unearned incomes, N_f and N_m, prices of private goods, p_f and p_m, prices of public goods, p_x, family financial structure, f_n, in the case of the unconditional model and conditional on family financial structure, f_n, in the case of the conditional model.

The conditional collective model of household behavior depicted in (2.1) results in conditional demands for public and non-public goods of the following form:

$$
\begin{aligned}
& q_i = q_i\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m, f_n\right) i = m, f \\
& x_i = x_i\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m, f_n\right) i = m, f \\
& T_{ij} = T_{ij}\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m, f_n\right) i = m, f \; j = m, f
\end{aligned} \tag{2.3}
$$

The endogenous variables: q_i, x_i and T_{ij} are functions of the exogenous variables in the conditional maximization problem (2.2), w_i, N_i and u_0^i which is not only a function of w_i, N_i but also a function of p_i and p_x conditional on the family financial structure chosen, f_n.

On the other hand, the unconditional collective model of household behavior depicted by (2.2) not only results in demands for public and non-public goods, but also

in the type of family financial structure that is chosen. These demands and choice of family financial structure are respectively given by[37]:

$$
\begin{aligned}
q_i &= q_i\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m\right) i = m, f \\
x_i &= x_i\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m\right) i = m, f \\
f_n &= f_n\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m\right) n = 1 \text{ or } 1,...,6 \\
T_{ij} &= T_{ij}\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m\right) i = m, f \ \ j = m, f
\end{aligned}
\tag{2.4}
$$

The public goods demands, nonpublic goods demands, labor supply, demand for non-work time, and family financial structure are functions of the parameters in the unconditional maximization problem (2.2), w_m, w_f, N_f, N_m and u_0^i which is a function of p_m, p_f, p_x, w_m, w_f, N_f and N_m.

There are several differences between the conditional and unconditional collective models. First, in the conditional version we assume that a family financial structure has been predetermined by the household. This implies that family financial structure is considered to be an exogenous variable that must enter the equations of labor supply, leisure, non-private and private goods. In the unconditional collective model, family financial structure is an endogenous variable that must be determined by the model as well as the demands for labor supply, leisure, non-private and private goods.

In this chapter, I introduced the conditional and unconditional models of household behavior. These models assumed that the choice of family financial structure is exogenous and endogenous, respectively. In both models, it is obvious that if family

[37] In the case of the discrete family financial structure variable, we have six distinct family financial structures which means that *n=1,…,6.* In the case of a continuous family financial structure variable, we would have only one family financial structure variable which implies that *n=1.* The continuous and discrete cases will be discussed later in this chapter.

financial structure is an important variable that is not including it in the analysis then we would have misspecification in the model. In the next chapter, we discuss two topics: misspecification if family financial structure is not included and the estimation procedures available.

CHAPTER III

ESTIMATION

A. Introduction

In the economic literature of intra-household allocation of resources, family financial structure has not been used as an explanatory variable of household expenditures. If family financial structure is a variable that should be included in the analysis of household expenditures but is not included, the resulting structural expenditure system suffers from specification error. The parameter estimates would be reduced form not structural parameters. The structural parameter estimates, therefore, will be biased and inconsistent. The reduced form parameters of the husband's and wife's wages would not only contain the effects of wages on expenditures but also the effects of wages on family financial structure.

The second part of this chapter deals with the estimation and identification of the variables from the conditional and unconditional models in the case of a discrete family financial structure variable. We will outline an estimation procedure that can be used to estimate the parameters of the expenditure functions of the conditional and unconditional models when the family financial structure is discrete.

B. Analysis of Misspecification

We will now examine the consequences for both the conditional and unconditional versions of the collective model of household behavior when family financial structure is an important determinant of household expenditures but is not included in the analysis. We will first examine the simple case when family financial structure is a continuous variable and then examine the case when family financial structure is a discrete variable.

For the most part, the economic literature of intra-household allocation has not examined time allocation. This research will analyze the above mentioned theoretical models without the estimation of time allocation, because the inclusion of time allocation would not lead to efficiency gains since all of the independent variables are the same for all equations.

1. A Simple Example with a Continuous Family Financial Structure Variable

In this section for simplicity purposes, we will assume that the family financial structure is a continuous variable. In the next section, we will explore what happens when family financial structure is a discrete variable as is our case in this study.

The relationship between the conditional and unconditional models for a continuous family financial structure variable can be easily established with a linear specification of the expenditure function in (2.3) and a linear specification of the expenditure function in (2.4) and the family financial structure equation (2.4). In the

conditional version of the collective model, the expenditure system that accounts for family financial structure when this variable is continuous is:

$$E_i^c = \beta_{i0} + \beta_{i1} w_m + \beta_{i2} w_f + \beta_{i3} f_n + \beta_{i4} N_m + \beta_{i5} N_f + \sum_{j=6}^{k} \beta_{ij} X_{ij} + \varepsilon_i \tag{3.1}$$

where E_i^c are expenditures in the conditional model on the i^{th} expenditure category, w_m denotes the total earned income of the mother, w_f denotes the total earned income of the father, N_m denotes the total unearned income of the mother, N_f denotes the total earned income of the father, f_n denotes the family financial structure, X_{ij} denotes a matrix of demographic characteristics of the mother, father and household, $\beta's$ are the parameters and v_i denotes the error term.

In the unconditional version of the collective model, the expenditure system that accounts for family financial structure as an endogenous variable is given:

$$E_i^u = \pi_{i0} + \pi_{i1} w_m + \pi_{i2} w_f + \pi_{i3} N_m + \pi_{i4} N_f + \sum_{j=5}^{k} \pi_{ij} X_{ij} + v_i \tag{3.2}$$

How are (3.1) and (3.2) related? If family financial structure can be represented by:

$$f_n = \gamma_{i0} + \gamma_{i1} w_m + \gamma_{i2} w_f + \gamma_{i3} N_m + \gamma_{i4} N_f + \sum_{j=6}^{k} \gamma_{ij} X_{ij} + \varepsilon \tag{3.3}$$

When we substitute (3.3) into (3.1) and we collect terms, we get the unconditional equations (3.2) which is given by:

$$\begin{aligned} E_i^u &= (\beta_{i0} + \beta_{i3}\gamma_0) + (\beta_{i1} + \beta_{i3}\gamma_1) w_m + (\beta_{i2} + \beta_{i3}\gamma_2) w_f + (\beta_{i4} + \beta_{i3}\gamma_3) N_m + (\beta_{i5} + \beta_{i3}\gamma_4) N_f + \sum_{j=6}^{k} \pi_{ij} X_{ij} + e_i \\ &= \pi_{i0} + \pi_{i1} w_m + \pi_{i2} w_f + \pi_{i4} N_m + \pi_{i5} N_f + \sum_{j=6}^{k} \pi_{ij} X_{ij} + e_i \end{aligned} \tag{3.4}$$

where $\pi_{i0} = (\beta_{i0} + \beta_{i3}\gamma_0)$, $\pi_{i1} = (\beta_{i1} + \beta_{i3}\gamma_1)$, $\pi_{i2} = (\beta_{i2} + \beta_{i3}\gamma_2)$, $\pi_{i3} = (\beta_{i4} + \beta_{i3}\gamma_3)$, $\pi_{i4} = (\beta_{i5} + \beta_{i3}\gamma_4)$, $\pi_{ij} = (\beta_{ij} + \beta_{i3}\gamma_j)$ j=5,…,k, and $v_i = (e_i + \beta_{i3}\varepsilon_n)$.

The parameter of the expenditure equations from the unconditional model, π_{ik}'s, are reduced form parameter estimates. These reduced form parameters depict the total effect of wages and unearned income on expenditures which have two parts.
If family financial structure is a choice variable then as shown in (3.4) the coefficients contain three effects. For example, mother's wages contain three distinct effects: the effects of mothers' wages holding family financial structure constant $\left(\beta_{ij}\right)$, the effect that family financial structure has on expenditures $\left(\beta_{i3}\right)$ and the effect that mothers' wages have on the family financial structure $\left(\gamma_{im}\right)$.

More generally as can be observed, the coefficients of the reduced form model have two parts. The first part is the corresponding coefficient of the conditional model, β_{ih}, where *h=0,1,…,5,…,k.* The second part is $\beta_{i3}\gamma_j$. This second part is the multiplication the family financial structure parameter from the conditional model, β_{i3}, in (3.4), times the corresponding effects from the family financial structure equation, γ_j, where *j=0,1,…,k* when f_n is a continuous variable. This second term is the difference between the structural and reduced form models. When family financial structure is continuous, we are able to identify the parameters of the family financial equation by dividing by the family financial structure used for identification.

From a public policy point of view, it is very important to discern the result of each

of these three effects since *a priori* we cannot determine their effects[38]. For example, if some exogenous variable of interest gives us the following results $\left(\bar{\beta}_{il}\right) < \left(\left(\bar{\beta}_{i3}\right)^{+}\left(\bar{\gamma}_{k}\right)\right)$, the total effect would conclude that a change in the exogenous variable of interest has a positive effect on the given expenditure category. From a policy perspective, the government may erroneously conclude that there is no need for intervention when there is a change in the exogenous variable of interest. If each of the effects was known with respect to the exogenous variable of interest, the government could design a program that could mitigate the effects that a change in the exogenous variable of interest would have on the choice of family financial structure or the effect that the redistribution of power within the household has on given expenditure category.

2. The Case of Discrete Family Financial Structure Variable

When the family financial structure variable is discrete and not continuous, the coefficients of the expenditure equations are not the same as in the previous model. The relationship between the conditional and unconditional models for a discrete family financial structure variable can be easily established with a linear specification of the expenditure function in (2.3) and a linear specification of the expenditure function in (2.4) and the family financial structure equation (2.4). In this section, the system of

[38] Assume f_n represents a continuum of family financial structures within the interval $[0,1]$, the wife has all of the control over finances when $f_n = 0$ and the husband has all of the control over finances when $f_n = 1$. Also, assume that expenditure category i represents expenditures on the category of interest.

linear expenditure functions for the conditional model with discrete family financial structure is estimated by:

$$(3.5)\quad E_i^c = \beta_{i0} + \beta_{i1} w_m + \beta_{i2} w_f + \beta_{i3} N_m + \beta_{i4} N_f + \sum_{n=1}^{5} \beta_{i3n} f_n + \sum_{j=6}^{k} \beta_{ij} X_{ij} + \varepsilon_i$$

Equation (3.5) shows that family financial structure can take on one of six different types of family financial structures. In (3.5), family financial structure is represented by five dichotomous variables since the base case is left out.

In the unconditional version of the collective model, the expenditure system for the conditional model that accounts for family financial structure as an endogenous variable is given:

$$(3.6)\qquad E_i^u = \pi_{i0} + \pi_{i1} w_m + \pi_{i2} w_f + \pi_{i4} N_m + \pi_{i5} N_f + \sum_{j=6}^{k} \pi_{ij} X_{ij} + \nu_i$$

The equation for the discrete case of family financial structure is given by:

$$(3.7)\qquad f_n = \gamma_{n0} + \gamma_{n1} w_m + \gamma_{n2} w_f + \gamma_{n3} N_m + \gamma_{n4} N_f + \sum_{j=5}^{k} \gamma_{nj} X_{ij} + \varepsilon_n$$

where $n=1,\ldots,6$.

How are (3.5) and (3.6) related? If family financial structure can be represented by a specification such as (3.7), when we substitute (3.7) into (3.5) and we collect terms, we get the unconditional equations (3.6) which is given by:

$$\begin{aligned} E_i^c &= \beta_{i0} + \beta_{i1} w_m + \beta_{i2} w_f + \beta_{i3} N_m + \beta_{i4} N_f \\ &+ \sum_{n=1}^{5} \beta_{i3n} \left(\gamma_{n0} + \gamma_{n1} w_m + \gamma_{n2} w_f + \gamma_{n3} N_m + \gamma_{n4} N_f + \sum_{j=5}^{k} \gamma_j X_{ij} + \varepsilon_n \right) \\ &+ \sum_{j=6}^{k} \beta_{ij} X_{ij} + \varepsilon_i \end{aligned} \qquad (3.8)$$

When like terms are gathered and we simplify, the following result emerges:

$$E_i^u = \left(\beta_{i0} + \sum_{n=1}^{5} \beta_{i3n}\gamma_{n0}\right) + \left(\beta_{i1} + \sum_{n=1}^{5} \beta_{i3n}\gamma_{n1}\right) w_m + \left(\beta_{i2} + \sum_{n=1}^{5} \beta_{i3n}\gamma_{n2}\right) w_f$$

(3.9) $$+ \left(\beta_{i3} + \sum_{n=1}^{5} \beta_{i3n}\gamma_{n3}\right) N_m + \left(\beta_{i4} + \sum_{n=1}^{5} \beta_{i3n}\gamma_{n4}\right) N_f$$

$$+ \sum_{j=5}^{k} \left(\beta_{ij} + \sum_{n=1}^{5} \beta_{i3n}\gamma_{nj}\right) X_{ij} + \left(e_i + \sum_{j=1}^{5} \beta_{i3n}\varepsilon_n\right)$$

or in reduced form notation:

(3.2) $$E_i^u = \pi_{i0} + \pi_{i1} w_m + \pi_{i2} w_f + \pi_{i3} N_m + \pi_{i4} N_f + \sum_{j=5}^{k} \pi_{ij} X_{ij} + v_i$$

Where $\pi_{i0} = \left(\beta_{i0} + \sum_{i=1}^{6} \beta_{i3n}\gamma_{n0}\right)$, $\pi_{i1} = \left(\beta_{i1} + \sum_{i=1}^{6} \beta_{i3n}\gamma_{n1}\right)$, $\pi_{i2} = \left(\beta_{i2} + \sum_{i=1}^{6} \beta_{i3n}\gamma_{n2}\right)$, $\pi_{i3} = \left(\beta_{i3} + \sum_{i=1}^{6} \beta_{i3n}\gamma_{n3}\right)$, $\pi_{i4} = \left(\beta_{i4} + \sum_{i=1}^{6} \beta_{i3n}\gamma_{n4}\right)$, $\pi_{ij} = \left(\beta_{ij} + \sum_{i=1}^{6} \beta_{i3n}\gamma_{j}\right)$ $j=5,\ldots,k$, and $v_i = \left(e_i + \sum_{i=1}^{6} \beta_{i3n}\varepsilon_n\right)$.

As can be observed, the coefficients of the second model again have two parts. The first part is the corresponding coefficient of the conditional model as before, β_{ih}, where $h=0,1,\ldots,6,\ldots,k$. The second part is now $\sum_{i=1}^{6} \beta_{i3n}\gamma_{nj}$. This second part is the sum of the multiplication of the family financial structure parameter from the conditional model, β_{i3n}, in (3.4), times the corresponding effects from the family financial structure equation, γ_{nj}, where $j=0,1,\ldots,k$ when f_n is a discrete variable. This second term is the difference between the structural and reduced form models. When family financial structure is discrete, we are unable to identify the parameters of the family financial equation. The only parameter that can be identified is $\sum_{i=1}^{k} \beta_{i3n}\gamma_{nj}$ where $j=0,1,\ldots,k$.

C. Estimation with Discrete Family Financial Structure

We will now discuss the estimation procedures that would be used when a discrete family financial structure variable is observed, which is how family financial structure must be measured in this study.

The estimation of the discrete case involves the joint estimation of equations (3.5) and (3.2)[39]. Therefore, this model is given by:

$$\begin{aligned} E_i^c &= \beta_{i0} + \beta_{i1} w_m + \beta_{i2} w_f + \beta_{i3} N_m + \beta_{i4} N_f + \sum_{n=1}^{5} \beta_{i3n} f_n + \sum_{j=6}^{k} \beta_{ij} X_{ij} + \varepsilon_i \\ E_i^u &= \pi_{i0} + \pi_{i1} w_m + \pi_{i2} w_f + \pi_{i3} N_m + \pi_{i4} N_f + \sum_{j=5}^{k} \pi_{ij} X_{ij} + \nu_i \end{aligned} \tag{3.10}$$

In the discrete case, we can only identify the parameters of the conditional model and the reduce form parameters from the expenditure equations of the conditional model. The identification of the parameters of the family financial structure equation are not possible. We can only identify $\sum_{n=1}^{k} \beta_{i3n} \gamma_{nj}$ where *j=0,1,…,k.* In this case, the reduced form parameters are such that $\pi_{ij} = \left(\beta_{ij} + \sum_{n=1}^{5} \beta_{i3n} \gamma_{nj} \right)$. When the family financial structure variable is not statistically significant, the second part of the reduced form parameters $\sum_{n=1}^{5} \beta_{i3n} \gamma_{nj} = 0$ and therefore the reduced form parameters are structural parameters. This means that in the case of a discrete family financial structure variable the hypothesis tests are based on whether $\sum_{n=1}^{5} \beta_{i3n} \gamma_{nj}$ which implies that jointly all β_{i3n} where *n=1,…,5.*

[39] The results of the indirect method of estimation can be found in the appendix C.

1. Estimation of the Engle Curves

This research estimates Engle curves and not demands functions since the data used consist of expenditures in a number of different categories and not quantities purchased of individual goods and services. While the dataset used in this research contains information on household expenditures in eleven different categories, this research only deals with expenditures on food at home and food away from home. This research derives a reduced form test of the hypothesis of income pooling for two expenditures categories. The demand functions of the unitary models should only be dependent on prices and total household income, given demographic characteristics of the household when the income pooling hypothesis holds. The restrictions of the income pooling hypothesis imply that mothers and fathers spend money in the same manner. This research uses total earned and unearned income of fathers and mothers. There is little time flexibility observed in the work schedule of the participating household members. For 97.35% of the fathers, the work schedule is the same every week. For 95.42% of working mothers, the work schedule is fixed every week. For 90% of the households, the source of earn income came from sources other than hourly wages. We can therefore assume that the work schedule is inflexible and exogenously determined. However, total earn income which is used instead of wages in the analysis of the Engle curves is endogenous to the analysis.

2. Hypothesis Tests

When prices are held constant, Engle curves indicate how expenditures by the household on category i, E_i, depend upon the mother's and father's total earned and

unearned incomes which are denoted by w_i and N_i respectively, where *i*=*m* and *f*, given a matrix of other demographic characteristics of the husband, wife and household, X_{ij}. In the case of unitary models, household income is assumed to be pooled which implies that income from both parents is spent in the same manner. The conditional collective model has been discussed not only allows for the earned and unearned incomes of both spouses to be spent differently but also takes into account the effect of family financial structure.

As can be observed, the unitary model implies that three restrictions must be placed on the more general Engle curves of the estimated systems (3.10) when we have a discrete family financial structure variable. Since the unitary model is nested within conditional and unconditional collective models, the validity of the Engle curves prescribed by unitary models becomes a straight-forward empirical question.

For implementation purposes, this research chose to use a linear specification of the Engle curves depicted by (3.10) where E_i^c is such that $i = FAH, FAFH$ represents expenditures on food at home and food away from home respectively, X_{ij}, $i = 1,...,m$ are demographic variables including the difference between the ages of the father and mother, the difference between the fathers' and mothers' years of education, ethnicity of father and mother[40], sociological factors such as job importance for the father and mother, f_n represents the type of family financial structure *n*, and where v_i denotes the random error term.

[40] Ethnicity is defined as a dichotomous variable which takes on the value of 1 for Anglo and 0 otherwise.

The *unitary* restrictions implied by equation (3.10), which denotes the conditional collective model, require that $\beta_{i1} = \beta_{i2}$, $\beta_{i3} = \beta_{i4}$, and that jointly all $\beta_{i3n} = 0$. All of these restriction can be tested using the conditional model equation. When either or both of the coefficients of total earned and unearned incomes of husband and wife are not equal to one another, $\beta_{i1} \neq \beta_{i2}$ and $\beta_{i3} \neq \beta_{i4}$, this means that the income of the husband and wife are not pooled. Therefore, the incomes of the husband and wife are spent differently. The coefficients of family financial structure tell what effect family financial structure has on the given expenditure category. When the unitary (reduced form) model is estimated and family financial structure is an important determinant of household expenditures, the omission of family financial structure as shown by (3.2) leads to the estimation of a reduced form model. However, if jointly all $\beta_{i3n} = 0$, this would mean that family financial structure has no structural effect on expenditures in a given category and there is no bias in the coefficients of the estimated structural model. Table 5 summarizes the hypothesis of interest and the restrictions that they imply.

In this section, this research has shown that only when the family financial structure variable is continuous can the parameters of the family financial structure equation be identified in the unconditional model. However, the validity of the unitary model can still be tested via the income pooling hypothesis and the effect that family financial structure have on expenditures in different categories can still be determine since we only need to use the conditional model. This research will now turn its attention to the data collection process and description of variables.

CHAPTER IV

DATA COLLECTION AND DATA DESCRIPTION

A. Introduction

This section deals with the data collection process and the description of the data used in the empirical analysis of this research. The three main purposes of this section are (1) the examination of the demographic characteristics of the location in which the study took place; (2) the examination of the data collection process; and (3) the description of the data used in the empirical estimation of this study.

The data used in this research comes from the "Parental Time, Role Strain and Children's Fat Intake and Obesity Related Outcomes". The goal of this project was to collect a dataset that would allow for the investigation of the effect of parental time constraints, role strains, coping mechanisms, and household resources on child nutrient intake and health outcomes. This research also placed emphasis on the analysis of single female-headed households. For this reason, this research project set out to over sample single female households. The data were collected between July 2001 and June 2002 in Harris County, Texas. Data from both parents and children were collected with the use of five survey instruments: father's telephone interview, mother's telephone interview, father's self-administered questionnaire, mother's self-administered questionnaire, and children's interview.

This research will use the data from the parent's telephone interview along with the data from the parent's self-administered questionnaire in order to study the intrahousehold allocation of resources. The telephone interview of the parents contains sociological information about work commitment, work spillover, spouse's work flexibility, spouse's spillover of work to home, and socio-demographic information of the household and both spouses. The parent's self-administered questionnaire provides a rich dataset on earned and unearned income of each spouse, household expenditures and the type of family financial structure of the household.

B. Demographic Characteristics of Harris County, Texas

Harris County, Texas served as the site of the study. With a population of 3,400,578 inhabitants which accounts for 16.23% of the Texas population[41], Harris County is the most populated county in the state of Texas. This county has the largest concentration of minority groups of all the counties in the state. It has a minority population of over five and a half million people[42]. It is an urban county but does include a number or rural communities.

While the median household income in Harris County, Texas was $42,598[43], the per capita income was $21,435. The labor force in Harris County was divided in the following manner: 32% in managerial or professional positions, 27% in sales and office

[41] According to the 2000 census, the state of Texas has a population of 20,851,820.
[42] The minority population of Harris county is 5, 537, 682.
[43] The base year for the 2000 census median household income was 1999 dollars.

occupations, 15% in service occupations, 14% in production and transportation occupations, and 12% in production, extraction and maintenance occupations[44]. The number of people that live below the poverty line in Harris County was 503,234 with 192,871 individuals under the age of 18. These statistics are all from the 2000 census.

Harris County, according to the 2000 American Community Survey, had 113,211 single female-headed households. This means that 25.7% of the households with their own children under 18 years of age in Harris County were headed by single mothers. There were 43,512 single female-headed households that lived below the poverty level. This means that 42.79% of single female headed household found themselves below the poverty level. Harris County had 299,502 married couple families with children under 18 years of age. Therefore, 54.06% of the total households (families) in Harris County were married couples.

C. Data Collection Instruments

1. The Telephone Center

The telephone center was established in the fall of 2001. The three purposes of the telephone center were first to establish initial contacts with families living in Harris County in order to recruit them to participate in the project, second, set the time and date of the child interview at home and of the parents' interviews over the phone, and third to conduct telephone interviews of the parents.

[44] Information comes from the 2000 U.S. census.

The initial contact with families was made via cold calls from the telephone center. Cold calls are random calls made by telephone operators in the telephone center with the purpose of obtaining mailing addresses from families interested in participating. Then, to these addresses would be mailed consent forms for the parents and assent forms for the children that described the purpose of the study, the requirements and compensation of each participating member. From the random digit dialing (RDD) numbers purchased from Survey Sampling, Inc., there were six possible outcomes to a cold call: (1) the call can reach a household that agrees to receive information, (2) the call can reach a household that is ineligible to participate, (3) the call can reach a household that is eligible but refuses to participate, (4) the call can reach a number that is busy or does not answer, (5) the call can reach a number that is out of service, or (6) the call can reach a non-residential number such as a business or a fax.

When we reached a household that agreed to receive information, their mailing information was recorded and we mailed them a packet containing two copies of the consent and assent forms, one copy was for their records in the event that they agree to participate and one copy which was to be signed and mailed back to the Department of Rural Sociology at Texas A&M University in the self-addressed envelop provided.

When the telephone center reached the number of an ineligible household, a disconnected number, or a non-residential number, these numbers were taken out of use. In the case of ineligible households, disconnected numbers, and non-residential numbers, the research team did not count them against the acceptance or participation rate. When the telephone center reached an eligible household that did not desire to

participate, the caller not only took the number out of use but also counted the call as a *refusal to participate and to receive information*. Finally, when the telephone center reached a number that was busy or did not answer, the caller made a note of it in the call log and called back later that night and/or the next day at a different time.

Scheduling telephone interviews and child interviews was conducted by one individual in the telephone center. When the telephone center received signed consent and assent forms from participating families, the administrative team of the research project working out of the Department of Rural Sociology created a folder for each family and assigned a household ID to the participating family. The folders were given to the scheduler who contacted the family by phone and set up the day and time of the telephone interview of the parents or single mother and also set the day and time for the in-home child interview.

The telephone center was in charge of conducting the parent's telephone interviews. On the day and time of the scheduled interview, a caller from the telephone center would contact the participating household by phone. Parent's telephone interviews lasted about 45 minutes. The parental telephone interviews were designed to gather information about the employment status of the parents, parenting styles, parental control over food and expenditures, parental feeding styles, parental concerns about children's eating habits, parental self-reported health and health behavior, children's health and family socio-demographics.

The parents were asked a standard battery of questions regarding employment that followed those used by the General Social Survey (Davis and Smith 1995). These

questions were used to determine whether or not the person works, the type of work they do, and the work schedule they have. The telephone interview also asked questions regarding the importance the parents placed on their work and their work commitment. There were questions about the degree of flexibility in the work schedule of the parents or flextime available to parents and the amount of overtime they work. Parents also were asked about whether they experience job stress and/or work-family role conflict.

The parent telephone interview also included standard questions for obtaining information about who in the household was more responsible for household tasks such as grocery shopping, meal preparation and cleanup, childcare, and other household tasks. The telephone questionnaire also included a 30-item scale developed by Devereux et al. (1962) to measure the dimensions of parental warmth and involvement in their children's lives, the presence of clear behavioral standards and child involvement in decisions that affect him/her. The questions employ a Likert response format.

We now turn our attention to the discussion of the five data collection field instruments. Four of these field instruments deals with the data that is collected from the children: the children's interview, the twenty-four hour activity recall, the twenty-four hour diet recall and the Tanner scale for sexual development. One of the field instruments deals with data that is collected from the parents: self-administered questionnaire.

2. Self-Administered Questionnaire

The self-administered questionnaire was designed to obtain both sociological and economic information from the household. In addition, parents were asked to keep track of their time in the form of a time diary that corresponds to the same days their children kept an activity and diet record. With regard to the sociological aspects of the self-administered questionnaire, the questionnaire asked the parents to indicate how they deal with the discipline of their children. They were given specific violations or rules and were asked to circle which of the discipline methods provided came closest to the one they used for each of the cases mentioned.

With regard to the economic aspect of the self-administered questionnaire, the questionnaire asked parents about the different sources of their income since different types of income have been shown to have an important impact on a child's nutrition. Parents were asked to provide information about their sources of earned income such as wages, salaries, commissions, etc., as well as their sources of unearned income such as investment incomes, rental income, interest income, etc. Information about earned and unearned income was collected because past research has found that earned and unearned income of individual parents in a given household are not spent in the same manner on children, food and clothing.

The self-administered questionnaire also contained a section asking about the type of family financial structure of the household. In both the sociological and economic literature, the type of family financial structure has been found to have different effects on household purchases. Different financial structures have been found to lead to

different degrees of autonomy in purchasing decisions. Because of the previously mentioned gender bias in purchases, the degree of autonomy could affect the degree of gender bias in purchases for children.

The self-administered questionnaire also asked the parents about the household's expenditure patterns. Parents were not only questioned about the monthly expenditures in a variety of different categories but also who was in charge of making the monthly expenditure in each of the expenditure categories and whether or not these expenditures were average, above average, or below average.

The last section of the self-administered questionnaire was the time diary. The time diary was designed to measure how the individual parents allocated time in a given day. One of the theses of the project was that as parent's lives became more hectic they looked for ways to save time, especially for time consuming activities such as meal preparation and clean up and child care. In general there were three ways in which a parent can save time. First, there is multitasking whereby someone does more than one job at a time. Second, in a household with many members, household members can work together to get a job done in less time. Third, time can be effectively bought which means that resources can be used to purchase goods and services in the market to reduce the amount of time it takes to carryout household chores. We asked each parent in a household to keep his/her own time diary because of the substitution possibilities of time between household members. Parents were asked to keep track of all of their activities during a 48-hour period, which was suppose to correspond to their children's dietary and activity recall. They were provided with an example of how to

fill out the time diary. They were asked to enter the first thing they did each day, whether or not they were doing something else at the same time, where the activity took place and whether or not someone helped them. The parents were asked to repeat this process for all of their activities during a day until they completed their last activity of the day.

The participating child in each family went through a personal interview, a twenty-four hour food recall, a twenty-four hour activity recall, and anthropometric measurements such as: subscapular and triceps skinfold thickness, waist and hip circumference, height and weight and a self-assessment of the Tanner scale. The children were also instructed on how to fill out food and activity diaries for two days.

3. Children's Interview

The children's interview took place at the child's home or in rare cases at a public facility or private home of the parents choosing. The child interview took anywhere from 45 minutes to 1 hour and 45 minutes. The time depended on the child's age, concentration and level of maturity. The longest interviews were those of 9-year-old boys. The child questionnaire included sections on relationships with parents, parenting styles, the child's health behavior, perceptions of body satisfaction and self-esteem, family meal rituals, parental criticism of child's weight and exercise, child's work for pay and expenditures, socio-demographics and child's dietary behavior.

Children's dietary behavior was an important area of concentration. The children's questionnaire included questions about the frequency that children/ adolescents

reported skipping meals, how often they ate dinner with at least one parent, and how often they ate in restaurants, fast food restaurants, at school, or in another child-care setting.

4. Twenty-four Hour Activity Recall

The purpose of the twenty-four hour activity record was to ascertain the amount of inactivity of children. The 24-hour activity record provided information about the activities undertaken by a child in the previous 24-hour period. The child first told the interviewer at what time he/she went to bed the previous day, where the child went to bed, if anyone was with the child when he/she went to bed, and for how long he/she slept. The child was then asked at what time he/she woke up, where he/she was, if anyone was with him/her, and how long it took him/her to wake up. The process then continued by asking the child at what time the next activity took place, what the next activity was, if anyone was with him/her while performing this activity, and how long the activity took place. This process was repeated until the child reported going to sleep.

5. Twenty-four Hour Diet Recall

The purpose of the twenty-four hour diet recall is to ascertain the nutrient intake of the child in the previous 24-hour period. The interviewer asked the child to tell him/her at what time the child first drank or ate food, then what was the first thing that the child drank or ate. Then the child is asked, with the aid of a food model book,

measurement cups, and a ruler, to indicate the amount of food or drink he/she consumed, where he/she consumed the food or drink, whether anyone was with him/her when he/she consumed the food or drink, and, finally, whether he/she consider the food or drink consumed to be a meal or a snack. This process was repeated for all of the food or drinks consumed during the 24-hour period.

6. Tanner Scale for Sexual Development

The purpose of the use of the Tanner scale was to determine the growth and sexual development of the child interviewed. The amount of vitamins and minerals needed by children and adolescents depends, in part, on their stage of growth and sexual development or puberty. The Tanner scale is composed of a series of drawings of children at various stages of puberty. The female drawings show different degrees of breast development and pubic hair growth. We will now examine the process used to recruit families for "Parental Time, Role Strain and Children's Fat Intake and Obesity Related Outcomes".

D. Data Collection Process

We will now discuss the steps that were taken in order to collect the data. We will start by discussing how we obtained approval from Texas A&M University and then turn our attention to the way in which the sampling of households took place. We will then explore the five different survey instruments that were used to collect the data.

The first step of the data collection process was to gain approval from the human subjects committee for the processes by which the families would be interviewed and the compensation they would receive. This process was time consuming given that all documentation had to be reviewed by the human subjects committee and modified by the research team a couple of times. This process took about four months. The second step of the data collection process was the sampling of the households in the study site, Harris County, Texas. A sample of 11,168 randomly generated phone numbers was obtained from Survey Sampling, Inc. The total number of ineligible families contacted was 6,911. The total number of eligible families contacted was 4,257. The overall acceptance rate to receive information about the project was 60%[45].

In order to be able to detect bivariate relationships that were significant at the 5% level (one tail test) with a power of 90%, we needed 212 adolescents and their parents[46]. Therefore, our goal was to have 300 participating families with 60 coming from single female-headed families. We finished with 325 families that participated at some level in the study. From the participating families, we had 61 single female-headed families that fully participated in the study. There were two sampling stages in the data collection process. In the first sampling stage, which took eight months, we were interested not only in the participation of two parent households but also in the participation of single female-headed households. During this time, we contacted 4,067 eligible households. There were 2,525 households that agreed to receive information

[45] The number of families that agreed to receive information was 2551 and the total number of eligible families was 4257. Therefore, the overall acceptance rate was 2551/4257=0.60.
[46] Kraemer, H. C. and Thiemann, S., 1987 *How Many Subjects? Statistical Power Analysis in Research.* Newbury Park: Sage.

from the project. In the first sampling stage, this gave us an acceptance rate for receipt of information of 62%. In order to be able to study single female-headed households, it was necessary in the last two months of the sampling stage to exclusively concentrate in the recruitment of single female-headed households. During this second sampling stage, we contacted 190 eligible households. There were 26 households that agreed to participate. This gave us an acceptance rate of 14% for single female-headed households in the second sampling stage. We will now look at the analysis of the data from "Parental Time, Role Strain and Children's Fat Intake and Obesity Related Outcomes".

E. Analysis of the Data

1. Introduction

From the data collected from the parent's telephone interviews and self-administered questionnaires, the dependent variables of interest for this research are reported in Table 1. Table 2 describes all of the independent variables, their units, and their descriptions. The following section describes how the dependent and independent variables were constructed.

2. Dependent Variables

The dependent variables in this research are household expenditures. Table 1 gives the variable names, units of measurement and description of the dependent variables. The first two household expenditures deal with food expenditures. Household

expenditures on food are divided into two categories: food at home (FAH) and food away from home (FAFH). FAH is defined as food that is purchased to be prepared at home. FAFH is defined as prepared food that is brought home for consumption, and food that is consumed away from home. The next three household expenditures are: household living expenditures (HLE), expenditures on transportation, healthcare and education (THE), and total sum of household living expenditures, transportation health and education expenditures (SLTHE). The last three household expenditures are: household expenditures on children's clothing (CCE), expenditures on women's clothing (WCE) and expenditures on men's clothing (MCE).

3. Independent Variables

i) Income Variables

There are two representations of total household income: HHInc1 and HHInc2. The first total household income variable is the sum of the total income of the husband (ftm) and wife (mtm) as it was reported by each spouse in his/her corresponding self-administered questionnaire. The second total household income variable is the sum of the father's and mother's total earned incomes, fem and mem, respectively, and unearned incomes, fum157 and mum157, respectively. The unearned incomes, fum157 and mum157, are defined as the difference between the reported total income and the earned income of each spouse.

There are two representations of total household unearned income: HHUInc1 and HHUInc2. The first total household unearned income variable is the difference between

the total household income, HHInc1, and the total household earned income, HHEInc. The second total unearned household income variable is the sum total of unearned income reported by mother and father, mum and fum, respectively.

ii) Work/Home Role Strain Variables

The effect that employment has on home life represents additional constraints for the household. These are reflected in the degree to which parents find that their work demands spill over into family life, the degree to which they are committed to their work and the degree to which they have job control. Household resources can be used to mitigate the effects that employment has on home life. Therefore, household purchases can be affected by the work/home role strains of the spouses.

Work spillover was measured in the parents' telephone interview surveys by a series of questions which were based on earlier work by Simon (1992). Employed spouses' answers were subjected to a principal factor analysis. For each spouse, a single factor resulted from this analysis. Work commitment was measured using standard scales, Knoke and Woods (1986) and Porter et al. (1974). The analysis of mothers' and fathers' questions that reflected job commitment produced one factor for mothers and one factor for fathers. Finally, individuals may be able to have additional time to deal with household issues if there is some level of work flexibility. In the parental telephone interview, parents were asked if they had flexibility in their work hours. Those parents that indicated that they had available some level of work flexibility were coded with a 1 and 0 otherwise.

iii. Control Variables

The parents control variables were constructed from the telephone interview data: (1) mothers' race (mrace) differentiated between Anglo and other races, (2) fathers race (frace) differentiated between Anglo and other races, (3) father's less mother's age (dage), and (4) father's less mother's education (dedu). The larger the age or educational difference between the father (mother) and mother (father) the larger the influence of the father (mother) is expected to be.

F. Descriptive Statistics

1. Introduction

Table 3 reports the descriptive statistics for the dependent variables which are the household expenditure categories or independent variables given by: (1) household income, (2) individual incomes' (3) sociological variables, and (4) control variables. This research presents means, medians, standard deviations, minimum, maximums and sample size for each relevant variable. The difference in sample sizes for different variables is reflected in different response rates.

2. Independent Variables

The descriptive statistics for the dependent variables are given in Table 3. The analysis of dependent variables will be divided in three different sections. In the first section, we will examine expenditures on food. In the second section, we will examine housing, transportation, healthcare and educational expenses. In the third section, we will examine the analysis of expenditures on children's, women's and men's clothing.

Household expenditures on food are divided into two categories: food at home and food away from home. Household expenditures on food at home had a mean of $559.99 and a median of $540.00 with a standard deviation of $242.84. The minimum expenditure on food at home was $200.00 while the maximum was $1,700.00. In comparison, household expenditures on food away from home had a mean of $155.51 and a median of $125.00 with a standard deviation of $116.60. The minimum household expenditures on food away home is $0.00 and the maximum is $600.00. There were four households that reported no expenditures on food away from home. The expenditures on food at home and away from home seem reasonable given the size and income of the participating households. It is important to note that the sample had a large percentage of affluent households as can be seen by the average household income.

Living expenses were divided into two groups: household housing expenses and total household expenditures on transportation, health and education. Household housing expenses had a mean of $2,039.51 and a median of $1,900.00 with a standard deviation of $1,213.98. The minimum expenditure on household housing expenses was

$310.00 with maximum of $9,500.00. Total household expenditures on transportation, health and education had a mean of $1,130.08 and a median of $842.25 with a standard deviation of $939.24. The minimum expenditure on total household expenditures on transportation, health and education was $90.00 with a maximum of $5,220.00. When we add together household housing expenses and total expenditures on transportation, health and education, we get a new expenditure category: total household expenditures. Total household expenditures had a mean of $3,132.46 and a median of $2,837.00 with a standard deviation of $1,833.00. The minimum expenditure in total household expenditure category was $609.00 with a maximum of $9,842.50. Household housing expenditures showed a large variation with extreme values at the tails of the distribution. Total household expenditures on transportation, health and education had a wide range of variation in relation to its mean. Likewise, total household expenditures had a large variation in relation to its mean and extreme values at the tails especially at the higher ranges.

Household expenditures on clothing were grouped into three categories: children's, women's and men's clothing. Household expenditures on children's clothing had a mean of $101.67 and a median of $61.00 with a standard deviation of $131.81. The minimum expenditure on household expenditures on children's clothing was $5.00 with a maximum of $1,200.00. Household expenditures on women's clothing had a mean of $72.27 and a median of $50.00 with a standard deviation of $84.65. The minimum expenditure on household expenditures on women's clothing was $3.00 with a maximum of $600.00. Household expenditures on men's clothing had a mean of

$56.99 and a median of $50.00 with a standard deviation of $56.58. The minimum expenditure on household expenditures on men's clothing was $5.00 with a maximum of $400.00. The largest expenditure on clothing came in the children's category followed by the women's and men's, respectively. The largest variation in expenditures by group followed the same pattern.

3. Independent Variables

Table 3 reports the descriptive statistics for the independent variables. The analysis of independent variables will be divided into three sections. In the first section we will examine individual incomes, in the second section we will examine household income, and in the third section we will examine the control variables.

In the case of individual incomes, we have mother and father earned, unearned and total incomes. Father's earned income had a mean of $78,408.98 and a median of $67,200.00 with a standard deviation of $48,479.38. Father's earned income had a minimum of $0 and a maximum of $208,992.00. There are two definitions of unearned incomes for fathers and mothers. The first definition of father's unearned income (fum1) is defined as equal to the sum of a number of different unearned income categories. The variable fum1 has a mean of $4,106.12 and a median of $0 with a standard deviation of $21,355.46. Fum1 has a minimum of $0 and a maximum of $240,000.00. There are 152 fathers in the study with 111 fathers have zero values for fum1, which explains why the median is zero. The second definition of father's unearned income (fum2) is defined as the difference between total and earned income

categories. Fum2 has a mean of $9,132.57 and a median $300.02 with a standard deviation of $24,539.29. Father's unearned income has a minimum of $0 and a maximum of $250,000.00. In the case of fum2, there are 100 fathers with non-zero values for unearned income. Father's total income has a mean of $87,541.54 and a median of $74,000.00 with a standard deviation of $57,303.32. Father's total income has a minimum of $8,400 and a maximum of $370,000.00.

Mother's earned income has a mean of $23,810.11 and a median of $8,730.00 with a standard deviation of $38,628.99. Mother's earned income has a minimum of $0 and a maximum of $264,000.00. There are two definitions of unearned incomes for mothers. The first definition of mother's unearned income (mum1) is defined as equal to the sum of a number of different unearned income categories. Mum1 has a mean of $1,313.70 and a median of $0 with a standard deviation of $5,593.19. Mother's unearned income has a minimum of $0 and a maximum of $48,000.00. There are 152 mothers in the study with 132 mothers having non-zero values for mum1, which explains why the median is zero. The second definition of mother's unearned income (mum2) is defined as the difference between total and earned income categories. Mum2 has a mean of $2,433.17 and a median of $0 with a standard deviation of $6,577.28. Mother's unearned income has a minimum of $0 and a maximum of $50,000.00. There are 81 cases in which the variable mum2 has a zero value. As a result the median is zero. Mother's total income has a mean of $26,243.28 and a median of $12,952.20, and a standard deviation of $39,088.81. Mother's total income has a minimum of $0 and a maximum of $264,000.00.

As has been previously discussed, the sample of participating two-parent households has a large percentage of affluent families. The main wage earners in the households are the fathers who have an average total income that is more than three times that of the mothers. While there is only one father with no total income, there are thirty-one mothers with no total income. The majority of each individual income comes from earned income. The average earned income of the fathers is more than three times that of the mothers. The average unearned income of the fathers is almost four times that of the mothers.

Household income is divided into two categories: household earned and unearned income. The two different types of household earned income, HHInc1 and HHInc2, have previously been defined. HHInc1 has a mean of $113,784.83 and a median of $94,577.00 with a standard deviation of $66,861.48. The minimum household earned income as defined by HHInc1 is $16,800 with a maximum of $376,300.00. HHInc2 has a mean of $107,638.92 and a median of $86,599.96 with a standard deviation of $67,262.06. The minimum household earned income as defined by HHInc2 is $12,200 with a maximum of $366,300.00.

The sample of households contains a large number of affluent households. There are four households with incomes above $300,000.00, three households with incomes greater than $250,000.00 and less than $300,000.00, eleven households between $200,000 and $250,000, seventeen between $150,000 and $200,000, and thirty seven between $100,000 and $150,000. This means that almost half of all of the households surveyed have household incomes above $100,000.

There are two definitions of household unearned income. In the first definition of household unearned income, HHUInc1, unearned income is defined as the sum of fum1 and mum1. The variable HHUInc1 has a mean of $ 5,419.83 and a median of $0 with a standard deviation of $ 23,076.14. HHUInc1 has a minimum of $0 and a maximum of $240,000. In the sample of 152 households, there are only 52 with non-zero observations. In the second definition of household unearned income, HHUInc2, unearned income is defined as the sum of fum2 and mum2. The variable HHUInc has a mean of $11,565.74 and a median of $ 2,987.00 with a standard deviation of $ 25,831.64. HHUInc has a minimum of $0 and a maximum of $250,000. From the 152 households, 123 have non-zero observations.

The control variables used in this study are: the difference between the ages of the father and mother, the difference in the years of education of the father and mother, ethnicity of the mother and ethnicity of father. The self-reported difference between the ages of the father and mother is denoted by Dage. The variable Dage has a mean of 2.3377 and a median of 2 with a standard deviation of 4.1018490. The variable Dage has a minimum of -6 and a maximum of 18. The mean ages of the fathers and mothers are 44.2185430 and 41.9473684, respectively. The minimum ages of the fathers and mothers are quite similar at 29 and 31, respectively. The maximum ages of the fathers and mothers are also quiet close at 65 and 61, respectively. From the 151 households, there are no missing observations.

The differences in educational attainment of the fathers and mothers are denoted by educational categories. The educational categories are assigned a numerical value

corresponding to ascending educational attainment. The categories are as follows: 1=some grammar school, 2=completed grammar school, 3=some high school, 4=graduated high school, 5=some college, 6=college graduate, 7=some graduate school, and 8=completed graduate school. The self-reported difference between the education of the fathers and mothers is denoted by Dedu. The variable Dedu has a mean of 0.0662252 and a standard deviation of 1.5173173. The variable Dedu has a minimum of -3 and a maximum of 3. The educational distribution of the fathers is as follows: 2.65% had some high school, 10.60% graduated high school, 18.54% had some college, 41.72% were college graduates, 3.97% had some graduate school and 22.52% completed graduate school. The educational distribution of the mothers is as follows: 1.32% had some high school, 5.92% graduated high school, 29.61% had some college, 42.11% were college graduates, 3.29% had some graduate school and 17.76% completed graduate school. From the above information on educational attainment, it is clear that a greater percentage of mothers had at least some college education. Fathers and mothers have about the same percentage of college graduates with mothers having a slight advantage. However, the data shows that a greater percentage of fathers have some graduate school or completed graduate school.

The ethnic background of the parents is divided into three groups: white, Hispanic and other. These variables are coded as dummy variables. The category that is excluded is other. The ethnic background of the fathers is as follows: 82.89% white, 11.18% Hispanic, and 5.92% other. In the case of the mothers, the ethnic background is as follows: 85.53% white, 9.87% Hispanic, and 4.61% other. As we can see, the ethnic

backgrounds of the fathers and mothers are very similar. After some analysis of the statistical significance of the demographic categories, the three demographic groups were collapsed into two; white and non-white, for both mothers and fathers.

CHAPTER V

RESULTS

A. Introduction

This section is dedicated to the presentation of the estimated results and conclusions of this research. The results come from the joint estimation of the expenditure functions for food at and away from home from the conditional and unconditional models. This research utilizes the Generalized Method of Moments (GMM) in the estimation of the system of expenditures on food at and away from home. In this section, we will also discuss the result of the test of the three hypotheses of interest. First, we will analyze the validity of the income pooling hypothesis and therefore the validity of the unitary model. Second, we will analyze the effect of family financial structure as a determinant of intrahousehold allocation of resources. We will do this by analyzing the role of family financial structure as an explanatory variable for household expenditures on food at and away from home. Third, we will explore the reduced form nature of demand and/or expenditure models that do not include family financial structure as an explanatory variable. In order to do this, we must examine the three parts of the reduced form parameters. We will discuss the effect that earned income, unearned income and sociological variables have on household expenditures holding constant family financial structures. We will also discuss how household expenditures

on food at and away from home change as family's financial structure changes. We will conclude this discussion by examining the change in the type of family financial structure that comes about from a change in the variables of interest. Before beginning the discussion of these three hypotheses we will discuss the choice of estimation technique employed and report the parameter estimates of the conditional and unconditional models of household behavior.

B. Estimation Methodology

The estimation of (3.10) with the use of ordinary least squares or seemingly unrelated regressions would be inefficient since there is unknown heteroscedasticity. From table 5, we can see that there is heteroscedasticity, according to White's test for heteroscedasticity at the 10% level, for the food at home equation in both the conditional and unconditional representation, $HFAH^c$ and $HFAH^u$, respectively. The generalized method of moments (GMM) is able to deal with unknown heteroscedasticity and achieve asymptotic efficiency.

We also have the endogeneity of the earned income of the fathers and mothers. The GMM estimators have the advantage that they do not require the strict assumption that the independent variables be strictly exogenous but that instead they be predetermined or allowed to be endogenous. In our research, the choice of work is assumed to be endogenous given that earned income of parents and household expenditures are jointly determined. The system of GMM equations that we employed had as

instrumental variables not only job importance to the parent and a variable that indicated the type of employment but also the independent variables that are not endogenous to the system: fathers' and mothers' unearned income, father's and mother's ethnicity, difference in the years of education of the spouses, difference in the age of the spouses, total number of children under 18 years of age and father's and mother's job stress.

When the system of expenditures of food at home and food away from home is estimated as a GMM system of equations then we get consistency and asymptotic efficiency as $N \to \infty$. Therefore, the GMM estimator is more appropriate in this case given that it can handle both the endogeneity of earned income of the parents and unknown heteroscedasticity.

C. Results

The system of estimated equations is not invariant to the family financial structure that is left out as the base case. In other words, the parameter estimates may be slightly different depending on which family financial structure is not included as an independent variable in the analysis. However, we only estimate one model. Therefore, there is only one base case. The base case is the independent family financial structure. The use of the independent family financial structure allows for an intuitive interpretation. We can think of the independent system as acting as if individuals were not married within a marriage. This model is denoted as M1 1245. It includes family

financial structures: 1, 2, 4 and 5 leaving out family financial structure number six which is the independent system[47].

This research estimates the system of equations given by (3.10). From the estimation of (3.10), we can recover the parameters of the two expenditure equations of the conditional model and the parameters of the two expenditure equations of the unconditional model. The parameters of the conditional model are given by the $\beta_{ij}'s$ in the conditional and the unconditional equations parameters are given by $\pi_{ij}'s$. The parameters of the first unconditional equation, the expenditure function, are in parentheses in the second equation of the system given by (3.10). These variables can also be denoted by π_{ij}. The parameters of the second equation of the unconditional model, the family financial structure equation, are given by the γ_{in}, which are found in the unconditional equation of the above system. We are not able to identify each of these parameters. The estimated system yields the $\beta_{ij}'s$ and $\pi_{ij}'s$ not the $\gamma_{in}'s$. We will now report the parameter estimates of the conditional and unconditional models.

Table 6 shows the parameter estimates and p-values for the food at home equation for the conditional model, unconditional model and the difference between the unconditional and conditional models, $\sum_{i=1}^{5}\beta_{i3n}\gamma_j$, which is the second term of the reduced form parameters. The first column of Table 6 shows the results for the food at home equation in the conditional model with endogenous earned income of the father

[47] The family financial structures correspond to Pahl's (1989) typology, where n=1 for male whole wage system, n=2 for female whole wage system, n=3 for male allowance system, n=4 for female allowance system, n=5 for pooling system , and n=6 for independent system.

and mother. We will discuss the variables that are significant at the 15% level given the small sample. In this model there are four variables that are significant at the 15% level of significance. The conditional specification of the food at home equation explains 19.09% of the variation in the model. We find that the intercept has a value of 278.53 and is significant at the 1% level. The fathers' earn income is found to be positive and significant at the 1% level. For an increase of $10,000.00 in earned income, we find that expenditures on food at home increase by $9.68. The coefficient of the family financial structure 1, which is the male whole wage system, is found to be positive and significant at the 1% level. It is important to note that the base case is the independent system. Since the male whole wage system has a coefficient of 45.19, the male whole wage system shows an increase of $45.19 over the independent system. This means that a move from the independent system to the male whole wage system increases household expenditures on food at home by $45.19. The coefficient of the family financial structure 4, which is the female allowance system, is found to be positive and significant at the 12% level. Since the coefficient of the female allowance system was found to be 138.87, the female allowance system shows an increase of $138.87 over the independent system. This means that a move from the independent system to the female allowance system increases household expenditures on food at home by $138.87.

The second column of Table 6 shows that in the case of the unconditional model with endogenous earned income of the father and mother, we find that there are four variables that are significant at the 15% level of significance. The unconditional specification of the food at home equation explains 14.30% of the variation in the model.

We find that the intercept has a value of 289.70 and is found to be significant at the 1% level. The fathers' earned income is found to be positive and significant at the 2% level. For an increase of $10,000.00 in earned income, we find that expenditures on food at home increase by $8.66. The mothers' earned income is found to be positive and significant at the 15% level. For an increase of $10,000.00 in earned income, we find that expenditures on food at home increase by $8.04. We also find that when the mother is Caucasian there is an increase of $71.77, which is significant at the 11% level, when compared to non-Caucasian mothers.

The third column of Table 6 shows that in the case of the difference between the unconditional and conditional models with endogenous earned income of the father and mother, we find that there are six variables that are significant at the 15% level. The difference in fathers' earned incomes is found to be positive and significant at the 14% level. For an increase of $10,000.00 in earned income, we find that there is a difference in expenditures on food at home between the unconditional and conditional models of $-1.02. This means that the coefficient of the unconditional model underestimates the effect of earn income. We also find that the difference between the two models when the father is Caucasian is significant at the 1% level and equal to $-18.98 when compared to non-Caucasian fathers. Likewise, we find that the difference between the two models when the mother is Caucasian is significant at the 1% level and equal to $24.94 when compared to non-Caucasian mothers. From the difference column in table 6, we can also see that the difference between the two models for the difference in years of education of the spouses (father – mother) is significant at the 8% level and

equal to $3.83. We can also see that the difference between the two models for the difference in age of the spouses (father – mother) is significant at the 2% level and equal to $-1.54. The difference for the sociological variable mothers' job stress between the two models is -6.76 and is found to be significant at the 3% level.

The coefficients of the unconditional model are reduced form parameters, π_{in}'s. These reduced form parameters depict the total effect that the variable of interest has on expenditure on the expenditure category of interest which in our case is either food at home or food away from home. If family financial structure is an explanatory variable when the expenditure function estimated is that of the unconditional model, the coefficient of the variable of interest would contain three effects: the effect that the variable of interest has on the expenditure category of interest holding constant family financial structure, β_{ij}, the effect that family financial structure has on the expenditure category of interest, β_{i3n} and the effect that the variable of interest has on family financial structure, γ_{in}. The relationship between the total effect of a change in the expenditure category of interest and its two components with three effects is as we have seen before given by:

$$\pi_{ij} = \left(\partial E_i / \partial x_j \Big|_{f_n} \right) + \left(\partial E_i / \partial f_n \right) \times \left(\partial f_n / \partial x_j \right) = \beta_{ij} + \sum_{n=1}^{5} \beta_{i3n} \gamma_{in} \tag{5.1}$$

where x_j denotes the variable of interest, the subscript i denotes the expenditure category and the subscript j is used to denote the variable of interest.

The differences between the unconditional and conditional models hinges on the reduced form nature of the unconditional parameters. The difference between the unconditional and conditional models is given by: $\sum_{n=1}^{5}\beta_{i3n}\gamma_{in}$. The difference between the models is the second term of the reduced form parameters which has two parts that capture two distinct effects. From a public policy point of view, it is important to understand the nature of each of these three effects since a priori we can not determine their effect. In the case of fathers' earned income, Caucasian fathers, difference in age of spouses and job stress, the coefficient of the difference, $\sum_{n=1}^{5}\beta_{i3n}\gamma_{in}$, is found to be negative. This implies that the sum from *n=1,…,5* of β_{i3n} times γ_{in} is negative. We do not know if all $\beta_{i3n}>0$ and all $\gamma_{in}<0$, or if all $\beta_{i3n}<0$ and all $\gamma_{in}>0$, or if some $\beta_{i3n}>0$ and some $\gamma_{in}<0$ such that $\beta_{i3l}\gamma_{il}>\sum_{m=1}^{n-1}\beta_{i3m}\gamma_{im}$, or if some $\beta_{i3l}<0$ and some $\gamma_{il}>0$ such that $\beta_{i3l}\gamma_{il}>\sum_{m=1}^{n-1}\beta_{i3m}\gamma_{im}$. The only thing we know for sure is that $\pi_{ij}<\beta_{ij}$ which implies that π_{ij} under estimates the value of β_{ij} since $\sum_{n=1}^{5}\beta_{i3n}\gamma_{in}<0$. In other words, the total effect perceived by the reduced form parameter is larger than the change on expenditures on food at home that comes about from a change in the variable of interest in our case fathers' earned income, Caucasian fathers, difference in age of spouses and job stress holding family financial structure constant.

In the case of Caucasian mothers and difference in years of education between the spouses, the coefficient of the difference, $\sum_{n=1}^{5}\beta_{i3n}\gamma_{in}$, is found to be positive. We do

not know if all $\beta_{i3n} > 0$ and all $\gamma_{in} > 0$, or if all $\beta_{i3n} < 0$ and all $\gamma_{in} < 0$, or if some $\beta_{i3l} > 0$ and some $\gamma_{il} > 0$ such that $\beta_{i3l}\gamma_{il} > \sum_{m=1}^{n-1} \beta_{i3m}\gamma_{im}$, or if some $\beta_{i3l} < 0$ and some $\gamma_{il} < 0$ such that $\beta_{i3l}\gamma_{il} > \sum_{m=1}^{n-1} \beta_{i3m}\gamma_{im}$. The only thing we know for sure is that $\pi_{ij} > \beta_{ij}$ which implies that π_{ij} overestimates the value of β_{ij} since $\sum_{n=1}^{5} \beta_{i3n}\gamma_{in} > 0$. In other words, the total effect perceived by the reduced form parameter is smaller than the change on expenditures on food at home that comes about from a change in the variable of interest in our case Caucasian mothers and difference in years of education between the spouses, holding family financial structure constant. From a policy perspective in the case of fathers' earned income, the government may erroneously conclude that a policy that reduces fathers' earned income may have a smaller decrease on expenditures on food at home than in reality if the unconditional model (i.e. reduced form model) is used in the estimation.

Table 7 shows the parameter estimates and p-values for the food away from home equation for the conditional model, unconditional model and the difference between the unconditional and conditional models. We will discuss the variables that are significant at the 15% level given the small sample. The first column of Table 7 shows the case of the conditional model with endogenous earned income of the father and mother. For this case, we find that there are ten variables that are significant at the 15% level of significance. This model explains 39.77% of the variation in the model. We find that the intercept has a value of 60.18 is found to be significant at the 2% level of significance. The fathers' earned income is found to be positive and significant at the

1% level. For an increase of $10,000.00 in earned income, we find that expenditures on food away from home increase by $12.07. The mothers' earned income is found to be positive and significant at the 1% level. For an increase of $10,000.00 in earned income, we find that expenditures on food away from home increase by $8.45. The coefficient of mothers' unearned income is found to be positive and significant at the 14% level. For an increase of $10,000.00 in earned income, we find that expenditures on food away from home increase by $31.17. The coefficient of the family financial structure 1 which is the male whole wage system is found to be positive and significant at the 1% level. It is important to note that the base case is given by the independent system. Since the male whole wage system has a coefficient of 17.14, the male whole wage system showed an increase of $17.14 over the independent system. This means that a move from the independent system to the male whole wage system increases household expenditures on food away from home by $17.14. The coefficient of family financial structure number 2, the female whole wage system, has a coefficient of 9.34 which is significant at the 1% level. The female whole wage system showed an increase of $9.34 over the independent system. This means that a move from the independent system to the female whole wage system increases household expenditures on food away from home by $9.34. The coefficient of the family financial structure 4 which is the female allowance system is found to be -28.32 and significant at the 6% level. Therefore, the female allowance system shows a decrease of $28.32 over the independent system. This means that a move from the independent system to the female allowance system decreases household expenditures on food away from home by $28.32. The coefficient

of the family financial structure 5, which is the joint system, is found to be -14.93 and significant at the 2% level. Therefore, the joint system shows a decrease of $14.93 over the independent system. This means that a move from the independent system to the female allowance system decreases household expenditures on food away from home by $14.93. We also find that when the father is Caucasian there is a decrease of $45.68 on expenditures on food away from home, which is significant at the 15% level, when compared to non-Caucasian fathers. Finally, we find that the coefficient for the difference in the years of education of the spouses is significant at the 5% level and has a value of -9.47. This implies that for every year of education that the father has over the mother the expenditures on food away from home decrease by $9.47.

The second column of Table 7 shows the case of the conditional model with endogenous earned income of the father and mother. We find that there are five variables that are significant at the 15% level of significance. This model explains 37.38% of the variation in the model. We find that the intercept has a value of 68.51 is found to be significant at the 1% level of significance. The fathers' earned income is found to be positive and significant at the 1% level. For an increase of $10,000.00 in earned income, we find that expenditures on food away from home increase by $11.59. The mothers' earned income is found to be positive and significant at the 1% level. For an increase of $10,000.00 in earned income, we find that expenditures on food away from home increase by $8.01. We also find that when the father is Caucasian there is a decrease of $53.01, which is significant at the 10% level, when compared to non-Caucasian fathers. Finally, we find that the coefficient for the difference in the years of

education of the spouses is significant at the 5% level and has a value of -9.38. This implies that for every year of education that the father has over the mother the expenditures on food away from home decrease by $9.38.

The third column of Table 7 shows the results of the difference between the unconditional and conditional models with endogenous earned income of the father and mother. We find that there are six variables that are significant at the 15% level. We find that the difference in intercepts has a value of 8.32 and is found to be significant at the 3% level of significance. The difference in fathers' earned incomes is found to be negative and significant at the 5% level. For an increase of $10,000.00 in earned income, we find that there is a difference in expenditures on food away from home between the conditional and unconditional models of $-0.48. The difference in mothers' unearned incomes is found to be negative and significant at the 15% level. For an increase of $10,000.00 in earned income, we find that there is a difference in expenditures on food away from home between the conditional and unconditional models of $-0.02. We also find that the difference in expenditures on food away from home between the two models when the father is Caucasian is significant at the 3% level and equal to $-7.33 when compared to non-Caucasian fathers. Likewise, we find that the difference in expenditures on food away from home between the two models when the mother is Caucasian is significant at the 2% level and equal to $9.84 when compared to non-Caucasian mothers. Finally, we find that the difference in expenditures on food away from home between the two models for fathers' job stress is significant at the 14% level and has a coefficient of 1.33.

In the case of fathers' earned income and Caucasian fathers, the coefficient of the difference, $\sum_{n=1}^{5}\beta_{i3n}\gamma_{in}$, is found to be negative. This implies that the sum from *n=1,…,5* of β_{i3n} times γ_{in} is negative. We do not know if all $\beta_{i3n}>0$ and all $\gamma_{in}<0$, or if all $\beta_{i3n}<0$ and all $\gamma_{in}>0$, or if some $\beta_{i3l}>0$ and some $\gamma_{il}<0$ such that $\beta_{i3l}\gamma_{il}>\sum_{m=1}^{n-1}\beta_{i3m}\gamma_{im}$, or if some $\beta_{i3l}<0$ and some $\gamma_{il}>0$ such that $\beta_{i3l}\gamma_{il}>\sum_{m=1}^{n-1}\beta_{i3m}\gamma_{im}$. The only thing we know for sure is that $\pi_{ij}<\beta_{ij}$ which implies that π_{ij} under estimates the value of β_{ij} since $\sum_{m=1}^{n-1}\beta_{i3m}\gamma_{im}<0$. In other words, the total effect perceived by the reduced form parameter is larger than the change on expenditures on food away from home that comes about from a change in the variable of interest in our case fathers' earned income and Caucasian fathers holding family financial structure constant.

In the case of Caucasian mothers and fathers' job stress, the coefficient of the difference, $\sum_{n=1}^{5}\beta_{i3n}\gamma_{in}$, is found to be positive. As we previously discussed, we do not know if all $\beta_{i3n}>0$ and all $\gamma_{in}>0$, or if all $\beta_{i3n}<0$ and all $\gamma_{in}<0$, or if some $\beta_{i3l}>0$ and some $\gamma_{il}>0$ such that $\beta_{i3l}\gamma_{il}>\sum_{m=1}^{n-1}\beta_{i3m}\gamma_{im}$, or if some $\beta_{i3l}<0$ and some $\gamma_{il}<0$ such that $\beta_{i3l}\gamma_{il}>\sum_{m=1}^{n-1}\beta_{i3m}\gamma_{im}$. The only thing we know for sure is that $\pi_{ij}>\beta_{ij}$ which implies that π_{ij} overestimates the value of β_{ij} since $\sum_{n=1}^{5}\beta_{i3n}\gamma_{in}>0$. In other words, the total effect perceived by the reduced form parameter is smaller than the change on expenditures on food at home that comes about from a change in the

variable of interest in our case Caucasian mothers and fathers' job stress, holding family financial structure constant. From a policy perspective in the case of fathers' earned income, the government may erroneously conclude that a policy that reduces fathers' earned income may have a smaller decrease on expenditures on food away from home than in reality if the unconditional model (i.e. reduced form model) is used in the estimation.

Table 8 shows the results of the hypothesis test for the food at home equation for the conditional and unconditional models. The restrictions implied by the unitary model in the case of the conditional model for the food at home equation are: $\beta_{11} = \beta_{12}$, $\beta_{13} = \beta_{14}$ and $\beta_{13j} = 0 \quad \forall j$. The test statistic has a p-value of <0.0001. The restrictions implied by the unitary model in the case of the unconditional model for the food at home equation are: $\pi_{11} = \pi_{12}$, $\pi_{13} = \pi_{14}$. The test statistic has a p-value of 0.9376. Therefore in the case of food at home, we reject the unitary conditional model at the 1% level of significance, while we fail to reject the unitary unconditional model. The restrictions for equality of earned income in the case of food at home for the conditional and unconditional model are: $\beta_{11} = \beta_{12}$ and $\pi_{11} = \pi_{12}$, respectively. The p-values for the test statistics are: 0.7655 and 0.9333, respectively. In the case of unearned income for the food at home equation, the restrictions for the conditional and unconditional models are given by: $\beta_{13} = \beta_{14}$ and $\pi_{13} = \pi_{14}$, respectively. The p-values for the test statistics are: 0.8024 and 0.7314, respectively. Therefore, in both the conditional and unconditional models, we find that the earned and unearned income is spent in the same manner on expenditures on food at home. The joint significance restrictions placed on the conditional model by family

financial structure are: $\beta_{13j} = 0 \quad \forall j$. The p-value of the test statistic for this test is: <0.0001. Therefore, we reject the null hypothesis that family financial structure has no effect on expenditures on food at home. It is important to note that the restriction that drives the rejection of the unitary model is the joint significance of the family financial structure in the case of the conditional model. The results for earned and unearned income of the father and mother are the same for both the conditional and unconditional models.

Table 9 shows the results of the hypothesis test for the food away from home equation for the conditional and unconditional models. The results are similar to those found in Table 8.

The restrictions implied by the unitary model in the case of the conditional model are: : $\beta_{21} = \beta_{22}$, $\beta_{23} = \beta_{24}$ and $\beta_{23j} = 0 \quad \forall j$. The test statistic has a p-value of <0.0001. The restrictions implied by the unitary model in the case of the unconditional model are: $\pi_{21} = \pi_{22}$, $\pi_{23} = \pi_{24}$. The test statistic has a p-value of 0.1597. Therefore for the food away from home equation in the case of the conditional model, we reject the unitary model at the 1% level of significance, while the unconditional model fails to reject the null hypothesis of the unitary model. The restrictions for equality of earned income in the case of food at home for the conditional and unconditional model are: $\beta_{21} = \beta_{22}$ and $\pi_{21} = \pi_{22}$, respectively. The p-values for the test statistics are: 0.2887 and 0.3156, respectively. In the case of unearned income for the food at home equation, the restrictions for the conditional and unconditional models are given by: $\beta_{23} = \beta_{24}$ and $\pi_{23} = \pi_{24}$, respectively. The p-values for the test statistics are: 0.1177 and 0.1704,

respectively. In both the conditional and unconditional models, we find that the earned income is spent in the same manner on expenditures on food at home since we fail to reject the null hypothesis that the coefficients of the mother and father earned incomes are equal. In the case of unearned income, we find that we reject that null that the fathers and mothers spend income in the same manner in the case of the conditional model. However, in the case of the unconditional model, we fail to reject the null that the mothers and fathers spend unearned income in the same manner at the 15% level of significance. The joint significance restrictions placed on the conditional model by family financial structure are: $\beta_{13j} = 0 \; \forall j$. The p-value of the test statistic for this test is: <0.0001. Therefore, we reject the null hypothesis that family financial structure has no effect on expenditures on food away from home. It is important to note that the restrictions that drive the rejection of the unitary model are the joint significance of the family financial structure and unearned income of the spouses in the case of the conditional model. The results for earned income of the father and mother are the same for both the conditional and unconditional models.

The test of the joint significance of the family financial structure parameters is a sufficient condition that can be used to determine whether the reduced form parameters are equal to the structural parameters. The test of equality between structural and reduced form parameters is given by:

(5.2) $$H_o : \beta_{ij} = \pi_{ij} \Rightarrow \beta_{ij} = \beta_{ij} + \sum_{n=1}^{5} \beta_{i3n}\gamma_{ni} = 0$$

The test of joint significance of the family financial structure parameters is given by:

(5.3) $$H_o : \beta_{i31} = \beta_{i32} = ... = \beta_{i35} = 0$$

Therefore, the rejection of (5.3) is sufficient to reject (5.2) but not necessary. The more direct testing procedure would be as shown in (5.2) would be to test $\sum_{n=1}^{5} \beta_{i3n}\gamma_{ni} = 0$. From Table 8, we find that family financial structure in the conditional model for the food at home and food away from home has a significant effect on expenditures on food at and away from home. In the case of food at home, the test statistic for the hypothesis of joint significance of family financial structure has a p-value of <0.0001. Therefore in the case of food at home, we reject (5.3) which in turn means that we can reject (5.2). Similarly in the case of food away from home, we find from Table 9 that the test statistic for the hypothesis of joint significance of family financial structure has a p-value of <0.0001. Therefore in the case of food away from home, we reject (5.3) which in turn means that we can reject (5.2). Therefore, the omission of family financial structure in the analysis of expenditures of food at and away from home will lead us to the wrong conclusion that the unitary model is the correct specification. In addition to the test of hypothesis test of joint significance of the family financial structure, we also tested the joint significance of the difference between the unconditional and conditional models. Table 10 shows these hypothesis test the restrictions that are implied and the p-values for the test statistics of the test for expenditures on food at and away from home. In the case of food at home, we find that for the null hypothesis given by:

(5.4) $$H_o : \sum_{n=1}^{5} \beta_{13n}\gamma_j = 0 \ \forall j$$

In the case of food at home, we find that the test statistic for the hypothesis of joint significance of the difference between the parameters of the unconditional and conditional model has a p-value of 0.1189. Therefore in the case of food at home, we

reject (5.4) at the 12% level of significance. Likewise in the case of food away from home, we find that the test statistic for the hypothesis test of joint significance of the difference between the parameters of the unconditional and conditional model has a p-value of 0.0447. Therefore in the case of food away from home, we reject (5.4) at the 5% level of significance. The results of Table 10 confirm the results from Tables 8 and 9. The conclusion is that the omission of family financial structure from the analysis of expenditures on food at and away from home would lead us to conclude that the unitary model is the correct framework from which to analyze intrahousehold allocation of resources. The collective models that were proposed in this research are found to be preferred to the unitary models. These two models, conditional and unconditional, not only allow for the effect of earned and unearned incomes of father's and mother's to be different but also incorporate family financial structure into the analysis of expenditures on food at and away from home.

CHAPTER VI

CONCLUSIONS

A. Introduction

Research on expenditures on food at home and food away from home usually employ the use of the unitary model, Becker (1965), which has as one of its implications the income pooling hypothesis. The income pooling hypothesis states that income from different sources is spent in the same manner. One policy implication of models based on the income pooling hypothesis is that regardless of which parent receives the sources from an assistance program, the outcome on household expenditures is the same.

There is, however, overwhelming evidence against the income pooling hypothesis such as: Lundberg, Pollak and Wales (1997), and Thomas (1990). As a consequence of the rejection of unitary models, non-unitary models of household behavior were developed in the economic literature. There are two main classifications of non-unitary models. The first set of non-unitary models are the collective models of household behavior, which is based on the assumption that the household decision process results in a Pareto efficient outcome (e.g. Chiappori (1988), Browning et. al (1994) and Chiappori (1997)). The second set of non-unitary models are the intra-household bargaining models (e.g. McElroy and Horney (1981), McElroy and Horney (1990) and McElroy (1990)) where the control of resources is essential because the outcome

depends on the threat point and on the feasible consumption set. One policy implication of the collective models of household behavior and intra-household bargaining models is that income or resources from an assistance program received by mothers or fathers have different effects with regard to expenditures on both food at home and food away from home.

While economic theory has developed models that study the impact that incomes from different sources have on the purchases of different commodities (e.g. Lundberg and Pollak (1993), Phipps and Burton (1998)), it has not fully considered the effect that different family financial structures may have on expenditures on food at home and food away from home, and therefore, living standards of different household members. Sociological studies have shown that family financial structure is an important determinant of household expenditures and, therefore, standard of living of different household members. In sociology, the most important research in the area of family financial structures comes from Pahl (1990) in which she develops her family financial structure typology. Pahl studies the effect that earning income and type of bank accounts have on household expenditures as well as the effect that managing, and more importantly, control of income has on household expenditures. The inclusion of management and control of income in Pahl's (1990) typology is an important development in the literature because there are differences between earning, managing and controlling income as they relate to household expenditures.

In the economic literature of intra-household allocation of resources, family financial structure has not been used as an explanatory variable of household expenditures. If

family financial structure is a variable that should be included in the analysis of household expenditures and is not included, the resulting expenditure system suffers from specification error in the form of omitted variable bias. The parameter estimates would therefore be rendered inconsistent. The parameter estimates of husband and wife's wages would be reduced form parameters that contain not only the effects of wages on expenditures but also the effects of wages on family financial structure. Therefore, these reduced form parameters show the total effect of wages, not only the effect of wages on expenditures but also the effect of wages on family financial structure of the household.

There are many ways to model the intra-household allocation of resources. This research showed two versions of a simple model where there is no altruism in the utility function. The outcome of the intrahousehold allocation process in both cases is assumed to result in a Pareto efficient outcome which means that chosen consumption bundles and allocations of time are such that an individual's welfare cannot be increased without decreasing the welfare of his/her spouse. The household in both versions is modeled as a two-person economy that faces fixed prices, and all the results of general equilibrium are available. The father and mother bargain over the household expenditure decisions. In both the conditional and unconditional models of household behavior, it is assumed that individuals have strictly quasi-concave and increasing, twice differentiable utilities. The wage rates, w_m and w_f, and non-wage incomes, N_m and N_f, are exogenously given. The difference between the conditional and

unconditional models is that the former assumes that the choice of family financial structure is predetermined or exogenous.

The conditional collective model of household behavior is given by:

$$
\begin{aligned}
&\underset{q_m, x_m, T_{wm}}{Max} \; u^m\left(q_m, x_m; f_m\right) \\
&s.t. \quad u^f\left(q_f, x_f; f_n\right) \geq u_0^f\left(p_f, p_m, w_f, w_m, N_f, N_m; f_n\right) \\
&\qquad \sum_{i=m,f}\left[\left(p_i \times q_i\right)+\left(p_x \times x_i\right)\right] = \sum_{i=m,f}\left(N_i + T_{wi} w_i\right) \\
&\qquad T_{wm} + T_{cm} = T_m \\
&\qquad T_{wf} + T_{cf} = T_f
\end{aligned}
\tag{6.1}
$$

The setup of this model is intuitive because the husband/wife is not only maximizing his/her utility with respect to time allocated to work, non-work activities, non-public goods and public goods conditional on the family financial structure chosen subject to the budget constraint of the household, but also subject to utility of the spouse being greater than the reservation utility.

The conditional collective model of household behavior results in conditional demands for public goods, non-public goods and time allocations given by:

$$
\begin{aligned}
&q_i = q_i\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m, f_n\right) i = m, f \\
&x_i = x_i\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m, f_n\right) i = m, f \\
&T_{ij} = T_{ij}\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m, f_n\right) i = m, f \; j = m, f
\end{aligned}
\tag{6.2}
$$

The endogenous variables: q_i, x_i and T_{ij} are functions of the exogenous variables in the conditional model w_i, N_i and u_0^i which is not only a function of w_i, N_i but also a function of p_i and p_x conditional on the family financial structure chosen, f_n.

On the other hand, the unconditional collective model of household behavior is given by:

$$
\begin{aligned}
&\underset{q_m, x_m, T_{wm}, f_n}{Max}\; u^m\left(q_m, x_m, f_m\right) \\
&s.t.\quad u^f\left(q_f, x_f, f_n\right) \geq u_0^f\left(p_f, p_m, w_f, w_m, N_f, N_m, f_n\right) \\
&\qquad \sum_{i=m,f}\left[\left(p_i \times q_i\right)+\left(p_x \times x_i\right)\right] = \sum_{i=m,f}\left(N_i + T_{wi} w_i\right) \\
&\qquad T_{wm} + T_{cm} = T_m \\
&\qquad T_{wf} + T_{cf} = T_f
\end{aligned}
\tag{6.3}
$$

In the case of the unconditional collective model, the husband or wife maximizes his/her utility with respect to time allocated to work, non-work activities, public goods, non-public goods and family financial structure subject not only to his/her spouse's utility being greater than his/her reservation utility but also subject to the household budget constraint which states that total household expenditures on non-private and private goods must be less than or equal to the households total earned and unearned income.

On the other hand, the unconditional collective model of household behavior results in demands for public, non-public goods and demands for family financial structure. These demands and choice of family financial structure are respectively given by:

$$
\begin{aligned}
q_i &= q_i\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m\right) i = m, f \\
x_i &= x_i\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m\right) i = m, f \\
f_n &= f_n\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m\right) n = 1 \text{ or } 1, ..., 6 \\
T_{ij} &= T_{ij}\left(p_m, p_f, p_x, w_m, w_f, N_m, N_f, T_f, T_m\right) i = m, f \;\; j = m, f
\end{aligned}
\tag{6.4}
$$

The public goods demands, nonpublic goods demands, labor supply, demand for non-work time, and family financial structure are functions of the parameters in the

unconditional model, w_m, w_f, N_m, N_f and u_o^i which is a function of p_m, p_f, p_x, w_m, w_f, N_f and N_m.

As we previously discuss, the estimation of the unitary model when family financial structures is a variable that should be included in the model makes the coefficients of the unitary model and those of the unconditional model expenditure functions reduced form parameters which show the total effect of the variables of interest which are denoted by: π_{ij}. The total effect is composed of two distinct effects. The first effect represents how a change in the variable of interest affects expenditures in a given household expenditure category holding family financial structure constant, β_{ij}. The second effect has two parts. The first part shows how a change in family financial structure affects expenditures on a given expenditure category, β_{i3n}. The second part shows how a change in the variable of interest affects family financial structure, γ_{in}.

The estimation procedures used when we have a discrete family financial structure variable, as in this study, involves the joint estimation of the conditional and unconditional expenditure functions. Therefore, this model estimated was:

$$
\begin{aligned}
E_i^c &= \beta_{i0} + \beta_{i1} w_m + \beta_{i2} w_f + \beta_{i3} N_m + \beta_{i4} N_f + \sum_{n=1}^{5} \beta_{i3n} f_n + \sum_{j=6}^{k} \beta_{ij} X_{ij} + \varepsilon_i \\
E_i^u &= \pi_{i0} + \pi_{i1} w_m + \pi_{i2} w_f + \pi_{i3} N_m + \pi_{i4} N_f + \sum_{j=6}^{k} \pi_{ij} X_{ij} + \nu_i
\end{aligned}
\tag{6.5}
$$

In the case of a discrete family financial structure, we can identify the parameters of the conditional model and the reduce form parameters from the expenditure equations of the conditional model. The identification of the parameters of the family financial structure equation is not possible because we can only identify $\sum_{n=1}^{k} \beta_{i3n} \gamma_{in}$. The

reduced form parameters are such that $\pi_{ij} = \left(\beta_{ij} + \sum_{n=1}^{5} \beta_{i3n}\gamma_{in}\right)$. When the family financial structure variable is not statistically significant, the second part of the reduced form parameters $\sum_{n=1}^{5} \beta_{i3n}\gamma_{in} = 0$ and therefore the reduced form parameters are structural parameters. This means that in the case of a discrete family financial structure variable the hypothesis tests are based on whether $\sum_{n=1}^{5} \beta_{i3n}\gamma_{in} = 0$ which implies that jointly all $\beta_{i3n} = 0$ where *n=1,…,5*.

B. Conclusions

This research estimated the system described above for expenditures on food at home and food away from home. The findings of this research can be summarized in the following five results: *(i)* For both food at home and food away from home, we fail to reject the income pooling hypothesis (equality of earn and unearned income parameter estimates for the spouses). *(ii)* However, family financial structure is found to be an important explanatory variable not used by the unitary models. *(iii)* Therefore, the omission of family financial structure and not the income pooling hypothesis would lead us to the incorrect assertion that the unitary model is the correct model for the analysis of intrahousehold allocation. *(iv)* The misspecification created when we use the unitary model instead of the conditional and unconditional models that we discussed in this research would render the parameters of the unitary model to be reduced form parameters. These reduced form parameters show the total effect which

is composed of three parts. First, the change in the expenditure category of interest that comes about from a change in the variable of interest when we holding family financial structure constant. Second, the change in the expenditure category of interest that comes about from a change in the family financial structure. Third, the change in family financial structure that comes about from a change in the variable of interest. *(v)* The total effect of the reduced form parameters is not equal to the desired effect that a change in the variable of interest has on the expenditure category being studied. In our research, we find that the reduced form parameters of fathers' earned income for both food at home and food away from home are larger than the desired change in expenditures on food at home and food away from home that come about from a change in fathers' earned income holding family financial structure constant.

There are several areas of future research that are worth while noting. The use of the minimum distance estimator (MDE) in the estimation of the conditional and unconditional models would allow us not only to recover the parameter estimates of the expenditure function for both the conditional and unconditional models but it will also allow us to recover the parameters of the family financial structure from the unconditional model . This would further our knowledge of how earned income of fathers and mothers, and socio-demographic variables affect the type of family financial structure chosen by the families. We could therefore explore the effect that policies designed to change the kind of family financial structure of families have on different household expenditure categories and therefore the wellbeing of women and children. The use of the conditional and unconditional models in the analysis of other household

expenditures would broaden the understanding of intrahousehold allocations of resources in expenditure categories such as: children's clothing, women's clothing, men's clothing, educational expenses and health expenses.

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APPENDIX A

TABLES

TABLE 1 — DEPENDENT VARIABLES, UNITS AND DESCRIPTION

Dependent Variables	Units	Description
HFAH	Dollars	Money spent by household on food at home.
HFAFH	Dollars	Money spent by the household on food away from home.

TABLE 2 – INDEPENDENT VARIABLES, UNITS AND DESCRIPTION

Independent Variables	Units	Description
Household Income		
HHInc1	Dollars	This is the first definition of total household income. It is the sum of the total income reported by the mother and the father.
HHUInc	Dollars	This is the first definition of household unearned income. It defines total household unearned income as the sum of the difference between the mothers and fathers total income and the mothers and fathers earned income.
HHEInc	Dollars	Household earned income is defined as the sum of the fathers, fem, and mothers earned income, mem.
Individual Incomes		
mtm	Dollars	Total income reported by the mother.
ftm	Dollars	Total income reported by the father.
mem	Dollars	Total earned income reported by the mother.
fem	Dollars	Total earned income reported by the father.
fum2	Dollars	Total unearned income of the father which is measured as the difference between total and earned income that he reports.
mum2	Dollars	Total unearned income of the mother which is measured as the difference between total and earned income that she reports.
Work/Home Role Strain Variables		
fwf	0 or 1	Father's work flexibility – 1 for some flexibility; 0 otherwise.
mwf	0 or 1	Mother's work flexibility – 1 for some flexibility; 0 otherwise.
fjs	factor	Father's job stress.
mjs	factor	Mother's job stress.
Control Variables		
mwhite	0 or 1	Race of the mother-is 1 for Anglo; 0 otherwise.
fwhite	0 or 1	Race of the father–is 1 for Anglo; 0 otherwise.
Dage	Years	Father's less mother's age.
dedu	Years	Father's less mother's years of education.

TABLE 3 — SUMMARY STATISTICS

Variable*	N	Mean	Median	Std.Dev.	Minimum	Maximum
Independent Variables						
Household Income						
HHInc1	152	113,784.83	94,577.00	66,861.48	16,800.00	376,300.00
HHInc2	152	107,638.92	86,599.96	67,262.06	12,200.00	366,300.00
HHUInc	152	11,565.74	2,987.00	25,831.64	0.00	250,000.00
HHUInc2	152	5,419.83	0.00	23,076.14	0.00	240,000.00
HHEInc	152	102,219.09	85,700.00	59,884.54	4,200.00	342,396.00
Individual Incomes						
mtm	152	26,243.28	12,952.20	39,088.81	0.00	264,000.00
ftm	152	87,541.54	74,000.00	57,303.32	8,400.00	370,000.00
mem	152	23,810.11	8,730.00	38,628.99	0.00	264,000.00
fem	152	78,408.98	67,200.00	48,479.38	0.00	208,992.00
mum1	152	1,313.70	0.00	5,593.19	0	48,000.00
fum1	152	4106.12	400	21,355.46	0	240,000.00
mum2	152	2,433.17	0.00	6,577.28	0.00	50,000.00
fum2	152	9,132.57	300.02	24,539.29	0.00	250,000.00
Dependent Variables						
HFAH	143	559.99	540.00	242.84	200.00	1,700.00
HFAFH	146	155.51	125.00	116.60	0.00	600.00
HHOUSE	145	2,039.51	1,900.00	1,213.98	310.00	9,500.00
HTHE	136	1,130.08	842.25	939.24	90.00	5,220.00
HHTHE	132	3,132.46	2,837.50	1,833.00	609.00	9,842.50
HCC	150	101.67	61.00	131.81	5.00	1,200.00
HWC	150	72.27	50.00	84.65	3.00	600.00
HMC	145	56.99	50.00	56.58	5.00	400.00

*Variables defined in Table 2

TABLE 4 — SUMMARY OF HYPOTHESIS TEST AND THEIR RESTRICTIONS

Hypothesis	Restrictions
Unitary Model FAH	$\beta_{11} = \beta_{12}$, $\beta_{13} = \beta_{14}$, $\beta_{13j} = 0 \; \forall j$
Unitary Model FAFH	$\beta_{21} = \beta_{22}$, $\beta_{23} = \beta_{24}$, $\beta_{23j} = 0 \; \forall j$
Equality of Earned Incomes FAH	$\beta_{11} = \beta_{12}$
Equality of Unearned Incomes FAH	$\beta_{13} = \beta_{14}$
Joint Significance of Family Financial Structure FAH	$\beta_{13j} = 0 \; \forall j$
Equality of Earned Incomes FAFH	$\beta_{21} = \beta_{22}$
Equality of Unearned Incomes FAFH	$\beta_{23} = \beta_{24}$
Joint Significance of Family Financial Structure FAFH	$\beta_{23j} = 0 \; \forall j$
Joint Significance of the Difference between the Unconditional and Conditional Model for FAH	$\sum_{n=1}^{5} \beta_{13n}\gamma_{nj} \; \forall j$
Joint Significance of the Difference between the Unconditional and Conditional Model for FAFH	$\sum_{n=1}^{5} \beta_{23n}\gamma_{nj} \; \forall j$

TABLE 5 — RESULTS OF WHITE'S TEST FOR HETEROSCEDASTICITY

Equation	Statistic	DF	Pr > ChiSq
$HFAH^{c}$	132.9	113	0.0978
$HFAFH^{c}$	115.6	113	0.4156
$HFAH^{u}$	96	75	0.0516
$HFAFH^{u}$	73.73	75	0.5198

The superscript c and u stand for conditional and unconditional models.

TABLE 6 — PARAMETER ESTIMATES OF THE CONDITIONAL AND UNCONDITIONAL MODELS AND THEIR P-VALUES FOR THE FOOD AT HOME EQUATION FOR THE FIVE MODELS OF THE CONDITIONAL MODEL (GMM ENDOGENOUS EARN INCOMES OF MOTHER AND FATHER)

Parameter	Conditional Model	Unconditional Model	Difference
Intercept	278.5256 (<0.0001)	289.7041 (<0.0001)	11.1785000 (0.1964)
Fathers' Earned Income	0.000968 (0.0091)	0.000866 (0.0167)	-0.0001020 (0.1343)
Mothers' Earned Income	0.000742 (0.1923)	0.000804 (0.1436)	0.0000620 (0.3860)
Fathers' Unearned Income	0.000339 (0.5582)	0.000337 (0.5738)	-0.0000020 (0.9771)
Mothers' Unearned Income	0.000786 (0.6420)	0.000964 (0.5711)	0.0001780 (0.5022)
f_1	45.18559 (<0.0001)		
f_2	-16.0919 (0.1683)		
f_4	138.872 (0.1170)		
f_5	-4.30764 (0.5528)		
Caucasian Father	16.33369 (0.7231)	-2.64997 (0.9557)	-18.9836600 (0.0092)
Caucasian Mother	46.83098 (0.2619)	71.77048 (0.1061)	24.9395000 (0.0033)
Difference in Years of Education of Spouses	-13.3491 (0.1532)	-9.51486 (0.3269)	3.8342400 (0.0737)
Difference in age of Spouses	4.56274 (0.2826)	3.018618 (0.4830)	-1.5441180 (0.0155)
Total Number of Children Under 18 in the Household	3.82526 (0.6252)	5.270318 (0.5091)	1.4450630 (0.3199)
Fathers' Job Stress	12.48596 (0.3857)	14.94986 (0.3121)	2.4639000 (0.2455)
Mothers' Job Stress	-2.11676 (0.8957)	-8.88142 (0.5815)	-6.7646600 (0.0237)
R^2	0.1909	0.1430	

TABLE 7 — PARAMETER ESTIMATES OF THE CONDITIONAL AND UNCONDITIONAL MODELS AND THEIR P-VALUES FOR THE FOOD AWAY FROM HOME EQUATION FOR THE FIVE MODELS OF THE CONDITIONAL MODEL
(GMM ENDOGENOUS EARN INCOMES OF MOTHER AND FATHER)

Parameter	Conditional Model	Unconditional Model	Difference
Intercept	60.1848 (0.0148)	68.50688 (0.0060)	8.3220800 (0.0223)
Fathers' Earned Income	0.001207 (<0.0001)	0.001159 (<0.0001)	-0.0000480 (0.0401)
Mothers' Earned Income	0.000845 (0.0014)	0.000801 (0.0013)	-0.0000440 (0.3691)
Fathers' Unearned Income	0.000201 (0.3763)	0.000142 (0.4833)	-0.0000590 (0.1556)
Mothers' Unearned Income	0.003117 (0.1340)	0.00292 (0.1654)	-0.0001970 (0.1452)
f_1	17.13664 (<0.0001)		
f_2	9.340541 (0.0001)		
f_4	-28.3227 (0.0575)		
f_5	-14.9298 (0.0199)		
Caucasian Father	-45.6893 (0.1428)	-53.0144 (0.0932)	-7.3251000 (0.0286)
Caucasian Mother	3.422318 (0.9010)	13.26697 (0.6303)	9.8446520 (0.0111)
Difference in Years of Education of Spouses	-9.47367 (0.0451)	-9.38049 (0.0492)	0.0931800 (0.8999)
Difference in age of Spouses	2.041676 (0.2606)	1.890604 (0.3031)	-0.1510720 (0.5254)
Total Number of Children Under 18 in the Household	-1.11234 (0.7445)	-1.18474 (0.7306)	-0.0724000 (0.8916)
Fathers' Job Stress	3.375445 (0.6616)	4.704651 (0.5425)	1.3292060 (0.1312)
Mothers' Job Stress	-6.55521 (0.4380)	-7.78539 (0.3551)	-1.2301800 (0.2616)
R^2	0.3977	0.3738	

TABLE 8 — HYPOTHESIS TEST FOR THE FOOD AT HOME EQUATION FOR THE CONDITIONAL AND UNCODITIONAL MODELS AND THEIR RESPECTIVE RESTRICTIONS AND P-VALUES (GMM ENDOGENOUS EARN INCOME OF THE MOTHER AND FATHER)

Hypothesis	Restrictions for the Conditional Model	p-values	Restrictions for the Unconditional Model	p-values
Unitary Model FAH	$\beta_{11} = \beta_{12}$, $\beta_{13} = \beta_{14}$, $\beta_{13j} = 0 \; \forall j$	<0.0001	$\pi_{11} = \pi_{12}$, $\pi_{13} = \pi_{14}$	0.9376
Equality of Earned Incomes FAH	$\beta_{11} = \beta_{12}$	0.7655	$\pi_{11} = \pi_{12}$	0.9333
Equality of Unearned Incomes FAH	$\beta_{13} = \beta_{14}$	0.8024	$\pi_{13} = \pi_{14}$	0.7314
Joint Significance of Family Financial Structure FAH	$\beta_{13j} = 0 \; \forall j$	<0.0001	N/A	N/A

TABLE 9 – HYPOTHESIS TEST FOR THE FOOD AWAY FROM HOME EQUATION FOR THE CONDITIONAL AND UNCODITIONAL MODELS AND THEIR RESPECTIVE RESTRICTIONS AND P-VALUES (GMM ENDOGENOUS EARN INCOME OF THE MOTHER AND FATHER)

Hypothesis	Restrictions for the Conditional Model	p-values	Restrictions for the Unconditional Model	p-values
Unitary Model FAFH	$\beta_{21} = \beta_{22}$, $\beta_{23} = \beta_{24}$, $\beta_{23j} = 0 \; \forall j$	<0.0001	$\pi_{21} = \pi_{22}$, $\pi_{23} = \pi_{24}$	0.1597
Equality of Earned Incomes FAFH	$\beta_{21} = \beta_{22}$	0.2887	$\pi_{21} = \pi_{22}$	0.3156
Equality of Unearned Incomes FAFH	$\beta_{23} = \beta_{24}$	0.1177	$\pi_{23} = \pi_{24}$	0.1704
Joint Significance of Family Financial Structure FAFH	$\beta_{23j} = 0 \; \forall j$	<0.0001	N/A	N/A

TABLE 10 – HYPOTHESIS TEST FOR THE JOINT SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE UNCONDITONAL AND CONDITONAL MODELS IN THE CASE OF FOOD AT HOME AND FOOD AWAY FROM HOME WITH THEIR RESPECTIVE RESTRICTIONS AND P-VALUES (GMM ENDOGENOUS EARN INCOME OF THE MOTHER AND FATHER)

Hypothesis	Restrictions for the Conditional Model	p-values
Joint Significance of the Difference between the Unconditional and Conditional Model for FAH	$\sum_{n=1}^{5} \beta_{13n}\gamma_{nj} \ \forall j$	0.1189
Joint Significance of the Difference between the Unconditional and Conditional Model for FAFH	$\sum_{n=1}^{5} \beta_{23n}\gamma_{nj} \ \forall j$	0.0447

APPENDIX B

PROGRAMS

```
/*************************************************************************
** SAS Program used to compute the conditional and unconditional     **
** collective models of household behavior                           **
** By Ernesto Perusquia Corres                                       **
** May 8, 2006                                                       **
*************************************************************************/

/*This program is designed to check the continuous measures of income for the fathers.
Opening the data set and saving new dataset*/

data final.FinalData050205;
        set Income.FinalData050805;
        if safath_subject_number=. then delete;
        if safath_Subject_Number=5202 then delete;
        if safath_Subject_Number=4302 then delete;
        if safath_Subject_Number=25702 then delete;

/*Conditions salaries, wages and commission income   */

/* If the individual answer yes to whether or not he or she earns that type of income
and they have entered a positive income for the given item and a positive number of
months they earned that income then we compute the yearly income from salaries
wages, tips and other income and commissions for the individuals meeting the
aforementioned requirements.  If they did not enter a positive amount earned from that
source of income or a positive*/

nsafq7a1=nmiss(safath_q7_a1);
nsafq7a2=nmiss(safath_q7_a2);
nsafq7a3=nmiss(safath_q7_a3);
nsafq7b1=nmiss(safath_q7_b1);
nsafq7b2=nmiss(safath_q7_b2);
nsafq7b3=nmiss(safath_q7_b3);
nsafq7b4=nmiss(safath_q7_b4);
nsafq7b5=nmiss(safath_q7_b5);
nsafq7c1=nmiss(safath_q7_c1);
nsafq7c2=nmiss(safath_q7_c2);
nsafq7c3=nmiss(safath_q7_c3);
nsafq8=nmiss(safath_q8);
nsafq131b=nmiss(safath_q13_1b);
```

```
nsafq132b=nmiss(safath_q13_2b);
nsafq133b=nmiss(safath_q13_3b);
nsafq134b=nmiss(safath_q13_4b);
nsafq135b=nmiss(safath_q13_5b);
nsafq136b=nmiss(safath_q13_6b);
nsafq137b=nmiss(safath_q13_7b);
nsafq138b=nmiss(safath_q13_8b);
nsafq139b=nmiss(safath_q13_9b);
nsafq1310b=nmiss(safath_q13_10b);
nsafq1311b=nmiss(safath_q13_11b);
nsafq1312b=nmiss(safath_q13_12b);
nsafq1313b=nmiss(safath_q13_13b);
nsafq1314b=nmiss(safath_q13_14b);
nsafq131c=nmiss(safath_q13_1c);
nsafq132c=nmiss(safath_q13_2c);
nsafq133c=nmiss(safath_q13_3c);
nsafq134c=nmiss(safath_q13_4c);
nsafq135c=nmiss(safath_q13_5c);
nsafq136c=nmiss(safath_q13_6c);
nsafq137c=nmiss(safath_q13_7c);
nsafq138c=nmiss(safath_q13_8c);
nsafq139c=nmiss(safath_q13_9c);
nsafq1310c=nmiss(safath_q13_10c);

nsafq1311c=nmiss(safath_q13_11c);
nsafq1312c=nmiss(safath_q13_12c);
nsafq1313c=nmiss(safath_q13_13c);
nsafq1314c=nmiss(safath_q13_14c);
nsafq14a=nmiss(safath_q14_you);
nsafq14b=nmiss(safath_q14_your_spouse);
nsafq14c=nmiss(safath_q14_child);
nsafq14d=nmiss(safath_q14_other);
nsafq15a1=nmiss(safath_q15_you_amount);
nsafq15b1=nmiss(safath_q15_your_amount);
nsafq15c1=nmiss(safath_q15_child_amount);
nsafq15d1=nmiss(safath_q15_other_amount);
nsafq15a2=nmiss(safath_q15_you_months);
nsafq15b2=nmiss(safath_q15_your_months);
nsafq15c2=nmiss(safath_q15_child_months);
nsafq15d2=nmiss(safath_q15_other_months);
nsafq16=nmiss(safathq_16);

/*if earn income is earned and not reported (missing value -999) then this statement
will report missing earn income */
```

```
if safath_subject_number>0 and safath_q7_a1=1 and safath_q7_a2<0 then mssgsal=1;

if safath_subject_number>0 and safath_q7_b1=1 and safath_q7_b2<0 then mssgwage=1;

if safath_subject_number>0 and safath_q7_c1=1 and safath_q7_c2<0 then
mssgcomm=1;

/* no individual income category reported*/

if safath_subject_number>0 and safath_q8<1 then mssgincat=1;

/*initializing variables for fathers total salaries, total wages, total tip and other income,
and total commision*/

If safath_subject_number>0 then totsal=0;
If safath_subject_number>0 then totwag=0;
If safath_subject_number>0 then tottipoc=0;
If safath_subject_number>0 then totcomm=0;

/*these statements compute total salaries, total wages, total tip and other income, and
total commision for fathers*/

If safath_Q7_A2>0 and safath_Q7_A3>0 then totsal=safath_Q7_A2*safath_Q7_A3;

If safath_q7_a1=1 and safath_Q7_A2>0 and safath_Q7_A3>0 then
totsal1=safath_Q7_A2*safath_Q7_A3;

If safath_Q7_B2>0 and safath_Q7_B3>0 then totwag=safath_Q7_B2*safath_Q7_B3;

If safath_Q7_B1=1 and safath_Q7_B2>0 and safath_Q7_B3>0 then
totwag1=safath_Q7_B2*safath_Q7_B3;

If safath_Q7_B4=1 and safath_Q7_B5>0 and safath_Q7_B3>0 then
totTipOc1=safath_Q7_B5*safath_Q7_B3;

If safath_Q7_B5>0 and safath_Q7_B3>0 then totTipOc=safath_Q7_B5*safath_Q7_B3;

If safath_Q7_C2>0 and safath_Q7_C3>0 then totcomm=safath_Q7_C2*safath_Q7_C3;

If safath_Q7_C1=1 and safath_Q7_C2>0 and safath_Q7_C3>0 then
totcomm1=safath_Q7_C2*safath_Q7_C3;
```

```
/*computing total earn income for fathers which are the sum of total salaries, total
wages, total tips and other income and total commissions*/

/*fathers total earn income*/


FEM=totsal+totwag+totTipOc+totcomm;

/*INITIALIZING VARIABLES FOR FATHERS UNEARNED INCOME
COMPUTATION*/


if safath_subject_number>0 then q131=0;
if safath_subject_number>0 then q132=0;
if safath_subject_number>0 then q133=0;
if safath_subject_number>0 then q134=0;
if safath_subject_number>0 then q135=0;
if safath_subject_number>0 then q136=0;
if safath_subject_number>0 then q137=0;
if safath_subject_number>0 then q138=0;
if safath_subject_number>0 then q139=0;
if safath_subject_number>0 then q1310=0;
if safath_subject_number>0 then q1311=0;
if safath_subject_number>0 then q1312=0;
if safath_subject_number>0 then q1313=0;
if safath_subject_number>0 then q1314=0;

/*COMPUTING TOTAL UNEARNED INCOME FOR FATHERS*/

/*The ones commented out are joint unearned*/


If safath_q13_1b>0 and safath_q13_1c>0 then q131=safath_q13_1b*safath_q13_1c;

If safath_q13_1b>0 and safath_q13_1c>0 then cq131=safath_q13_1b*safath_q13_1c;

else cq131=.;

If safath_q13_2b>0 and safath_q13_2c>0 then q132=safath_q13_2b*safath_q13_2c;

If safath_q13_2b>0 and safath_q13_2c>0 then cq132=safath_q13_2b*safath_q13_2c;

else cq132=.;
```

```
If safath_q13_3b>0 and safath_q13_3c>0 then q133=safath_q13_3b*safath_q13_3c;

If safath_q13_3b>0 and safath_q13_3c>0 then cq133=safath_q13_3b*safath_q13_3c;

else cq133=.;

If safath_q13_4b>0 and safath_q13_4c>0 then q134=safath_q13_4b*safath_q13_4c;

If safath_q13_4b>0 and safath_q13_4c>0 then cq134=safath_q13_4b*safath_q13_4c;

else cq134=.;

If safath_q13_5b>0 and safath_q13_5c>0 then q135=safath_q13_5b*safath_q13_5c;

If safath_q13_5b>0 and safath_q13_5c>0 then cq135=safath_q13_5b*safath_q13_5c;

else cq135=.;

If safath_q13_6b>0 and safath_q13_6c>0 then q136=safath_q13_6b*safath_q13_6c;

If safath_q13_6b>0 and safath_q13_6c>0 then cq136=safath_q13_6b*safath_q13_6c;

else cq136=.;

If safath_q13_7b>0 and safath_q13_7c>0 then q137=safath_q13_7b*safath_q13_7c;

If safath_q13_7b>0 and safath_q13_7c>0 then cq137=safath_q13_7b*safath_q13_7c;

else cq137=.;

If safath_q13_8b>0 and safath_q13_8c>0 then q138=safath_q13_8b*safath_q13_8c;
If safath_q13_8b>0 and safath_q13_8c>0 then cq138=safath_q13_8b*safath_q13_8c;
else cq138=.;

If safath_q13_9b>0 and safath_q13_9c>0 then q139=safath_q13_9b*safath_q13_9c;
If safath_q13_9b>0 and safath_q13_9c>0 then cq139=safath_q13_9b*safath_q13_9c;
else cq139=.;

If safath_q13_10b>0 and safath_q13_10c>0 then q1310=safath_q13_10b*safath_q13_10c;
If safath_q13_10b>0 and safath_q13_10c>0 then cq1310=safath_q13_10b*safath_q13_10c;
else cq1310=.;

If safath_q13_11b>0 and safath_q13_11c>0 then q1311=safath_q13_11b*safath_q13_11c;
If safath_q13_11b>0 and safath_q13_11c>0 then cq1311=safath_q13_11b*safath_q13_11c;
```

```
else cq1311=.;

If safath_q13_12b>0 and safath_q13_12c>0 then q1312=safath_q13_12b*safath_q13_12c;
If safath_q13_12b>0 and safath_q13_12c>0 then cq1312=safath_q13_12b*safath_q13_12c;
else cq1312=.;

If  safath_q13_13b>0 and safath_q13_13c>0 then q1313=safath_q13_13b*safath_q13_13c;
If  safath_q13_13b>0 and safath_q13_13c>0 then
cq1313=safath_q13_13b*safath_q13_13c;
else cq1313=.;

If  safath_q13_14b>0 and safath_q13_14c>0 then q1314=safath_q13_14b*safath_q13_14c;
If  safath_q13_14b>0 and safath_q13_14c>0 then
cq1314=safath_q13_14b*safath_q13_14c;
else cq1314=.;



/*Adding all of the sources of total unearned income*/


/*FATHERS UNEARNED INCOME Associated only with Father*/


FUM=q1314+q1313+q1312+q1311+q1310+q138+q136+q134+q133+q132;
Ftmsum=Fem+fum;



/*FATHERS REPORTED CHILD SURVEYED INCOME*/

if safath_subject_number>0 and safath_q15_you_amount>0 then
FTM=safath_q15_you_amount;
else FTM=0;


/*CHECK 1 FOR FATHERS*/


check1=FTM-ftmsum;
if check1>0 then chk1dum=1;
if check1=0 then chk1dum=0;
if check1<0 then chk1dum=-1;
```

```
/*CHECK 2 FOR FATHERS*/


check2=FTM-fem;
if check2>0 then chk2dum=1;
if check2=0 then chk2dum=0;
if check2<0 then chk2dum=-1;

/*Assigning income categories to total earned income of the FATHERS*/


iF fem=. THEN CKQ7=.;
If fem<5000 and fem>=0 then CKQ7=1;
If fem>=5000 and fem<9999 then CKQ7=2;
If fem>=10000 and fem<14999 then CKQ7=3;
If fem>=15000 and fem<19999 then CKQ7=4;
If fem>=20000 and fem<29999 then CKQ7=5;
If fem>=30000 and fem<39999 then CKQ7=6;
If fem>=40000 and fem<49999 then CKQ7=7;
If fem>=50000 and fem<69999 then CKQ7=8;
If fem>=70000 and fem<79999 then CKQ7=9;
If fem>=80000 and fem<89999 then CKQ7=10;
If fem>=90000 and fem<99999 then CKQ7=11;
If fem>=100000 and fem<109999 then CKQ7=12;
If fem>=110000 and fem<119999 then CKQ7=13;
If fem>=120000 and fem<129999 then CKQ7=14;
If fem>=130000 and fem<139999 then CKQ7=15;
If fem>=140000 and fem<149999 then CKQ7=16;
If fem>=150000 then CKQ7=17;


/*CHECK 3 FOR FATHERS*/


If safath_subject_number>0 and fem>=0 and safath_Q8>0
then CHECK3=safath_Q8-CKQ7;
if check3>0 then chk3dum=1;
if check3=0 then chk3dum=0;
if check3<0 then chk3dum=-1;

/*check 3 for fathers. Comparing sum of fem and fum to categories*/
/*Assigning income categories to total income of the FATHERS*/
```

```
iF ftmsum=. THEN ckq13=.;
If ftmsum<5000 and ftmsum>=0 then ckq13=1;
If ftmsum>=5000 and ftmsum<9999 then ckq13=2;
If ftmsum>=10000 and ftmsum<14999 then ckq13=3;
If ftmsum>=15000 and ftmsum<19999 then ckq13=4;
If ftmsum>=20000 and ftmsum<29999 then ckq13=5;
If ftmsum>=30000 and ftmsum<39999 then ckq13=6;
If ftmsum>=40000 and ftmsum<49999 then ckq13=7;
If ftmsum>=50000 and ftmsum<69999 then ckq13=8;
If ftmsum>=70000 and ftmsum<79999 then ckq13=9;
If ftmsum>=80000 and ftmsum<89999 then ckq13=10;
If ftmsum>=90000 and ftmsum<99999 then ckq13=11;
If ftmsum>=100000 and ftmsum<109999 then ckq13=12;
If ftmsum>=110000 and ftmsum<119999 then ckq13=13;
If ftmsum>=120000 and ftmsum<129999 then ckq13=14;
If ftmsum>=130000 and ftmsum<139999 then ckq13=15;
If ftmsum>=140000 and ftmsum<149999 then ckq13=16;
If ftmsum>=150000 then ckq13=17;


/*CHECK 4 FOR FATHERS*/

If safath_subject_number>0 and ftmsum>=0 and safath_Q8>0
then CHECK4=safath_Q8-ckq13;
if check4>0 then chk4dum=1;
if check4=0 then chk4dum=0;
if check4<0 then chk4dum=-1;

/*computing reported total income by fathers in question 15 part a*/

If safath_subject_number>0 and safath_q14_you=1 and safath_Q15_YOU_AMOUNT>0
then ftm=safath_Q15_YOU_AMOUNT;
Else if safath_subject_number>0 and safath_q14_you=1 and
safath_Q15_YOU_AMOUNT<=0 then ftm=. AND mftm=1;

/*Assigning income categories to total REPORTED FATHERS INCOME*/

iF ftm=. THEN CKQ15A=.;
If ftm<5000 and ftm>=0 then CKQ15A=1;
If ftm>=5000 and ftm<9999 then CKQ15A=2;
If ftm>=10000 and ftm<14999 then CKQ15A=3;
If ftm>=15000 and ftm<19999 then CKQ15A=4;
```

```
If ftm>=20000 and ftm<29999 then CKQ15A=5;
If ftm>=30000 and ftm<39999 then CKQ15A=6;
If ftm>=40000 and ftm<49999 then CKQ15A=7;
If ftm>=50000 and ftm<69999 then CKQ15A=8;
If ftm>=70000 and ftm<79999 then CKQ15A=9;
If ftm>=80000 and ftm<89999 then CKQ15A=10;
If ftm>=90000 and ftm<99999 then CKQ15A=11;
If ftm>=100000 and ftm<109999 then CKQ15A=12;
If ftm>=110000 and ftm<119999 then CKQ15A=13;
If ftm>=120000 and ftm<129999 then CKQ15A=14;
If ftm>=130000 and ftm<139999 then CKQ15A=15;
If ftm>=140000 and ftm<149999 then CKQ15A=16;
If ftm>=150000 then CKQ15A=17;

/*CHECK 5 FOR FATHERS*/

If safath_subject_number>0 and ftm>=0 and safath_Q8>0
then CHECK5=safath_Q8-CKQ15a;
if check5>0 then chk5dum=1;
if check5=0 then chk5dum=0;
if check5<0 then chk5dum=-1;

if saMoth_subject_number=. then delete;
if samoth_Subject_Number=5201 then delete;
if samoth_Subject_Number=4301 then delete;
if samoth_Subject_Number=25701 then delete;

/*Conditions salaries, wages and commission income   */

/* If the individual answer yes to whether or not he or she earns that type of income
and they have entered a positive income for the given item and a positive number of
months they earned that income then we compute the yearly income from salaries
wages, tips and other
income and commissions for the individuals meeting the aforementioned requirements.
If they did not enter a positive amount earned from that source of income or a
positive*/
```

```
nsamq7a1=nmiss(saMoth_q7_a1);
nsamq7a2=nmiss(saMoth_q7_a2);
nsamq7a3=nmiss(saMoth_q7_a3);
nsamq7b1=nmiss(saMoth_q7_b1);
nsamq7b2=nmiss(saMoth_q7_b2);
nsamq7b3=nmiss(saMoth_q7_b3);
nsamq7b4=nmiss(saMoth_q7_b4);
nsamq7b5=nmiss(saMoth_q7_b5);
nsamq7c1=nmiss(saMoth_q7_c1);
nsamq7c2=nmiss(saMoth_q7_c2);
nsamq7c3=nmiss(saMoth_q7_c3);
nsamq8=nmiss(saMoth_q8);
nsamq131b=nmiss(saMoth_q13_1b);
nsamq132b=nmiss(saMoth_q13_2b);
nsamq133b=nmiss(saMoth_q13_3b);
nsamq134b=nmiss(saMoth_q13_4b);
nsamq135b=nmiss(saMoth_q13_5b);
nsamq136b=nmiss(saMoth_q13_6b);
nsamq137b=nmiss(saMoth_q13_7b);
nsamq138b=nmiss(saMoth_q13_8b);
nsamq139b=nmiss(saMoth_q13_9b);
nsamq1310b=nmiss(saMoth_q13_10b);
nsamq1311b=nmiss(saMoth_q13_11b);
nsamq1312b=nmiss(saMoth_q13_12b);
nsamq1313b=nmiss(saMoth_q13_13b);
nsamq1314b=nmiss(saMoth_q13_14b);
nsamq131c=nmiss(saMoth_q13_1c);
nsamq132c=nmiss(saMoth_q13_2c);
nsamq133c=nmiss(saMoth_q13_3c);
nsamq134c=nmiss(saMoth_q13_4c);
nsamq135c=nmiss(saMoth_q13_5c);
nsamq136c=nmiss(saMoth_q13_6c);
nsamq137c=nmiss(saMoth_q13_7c);
nsamq138c=nmiss(saMoth_q13_8c);
nsamq139c=nmiss(saMoth_q13_9c);
nsamq1310c=nmiss(saMoth_q13_10c);
nsamq1311c=nmiss(saMoth_q13_11c);
nsamq1312c=nmiss(saMoth_q13_12c);
nsamq1313c=nmiss(saMoth_q13_13c);
nsamq1314c=nmiss(saMoth_q13_14c);
nsamq14a=nmiss(saMoth_q14_you);
nsamq14b=nmiss(saMoth_q14_your_spouse);
nsamq14c=nmiss(saMoth_q14_child);
nsamq14d=nmiss(saMoth_q14_other);
```

```
nsamq15a1=nmiss(saMoth_q15_you_amount);
nsamq15b1=nmiss(saMoth_q15_your_amount);
nsamq15c1=nmiss(saMoth_q15_child_amount);
nsamq15d1=nmiss(saMoth_q15_other_amount);
nsamq15a2=nmiss(saMoth_q15_you_months);
nsamq15b2=nmiss(saMoth_q15_your_months);
nsamq15c2=nmiss(saMoth_q15_child_months);
nsamq15d2=nmiss(saMoth_q15_other_months);
nsamq16=nmiss(saMothq_16);

/*if earn income is earned and not reported (missing value -999) then this statement
will report missing earn income */

if saMoth_subject_number>0 and saMoth_q7_a1=1 and saMoth_q7_a2<0 then
mssgsal=1;

if saMoth_subject_number>0 and saMoth_q7_b1=1 and saMoth_q7_b2<0 then
mssgwage=1;

if saMoth_subject_number>0 and saMoth_q7_c1=1 and saMoth_q7_c2<0 then
mssgcomm=1;

/* no individual income category reported*/

if saMoth_subject_number>0 and saMoth_q8<1 then mssgincat=1;

/*initializing variables for Mothers total salaries, total wages, total tip and other
income, and total commision*/

If saMoth_subject_number>0 then totsal=0;
If saMoth_subject_number>0 then totwag=0;
If saMoth_subject_number>0 then tottipoc=0;
If saMoth_subject_number>0 then totcomm=0;

/*these statements compute total salaries, total wages, total tip and other income, and
total commision for Mothers*/

If saMoth_Q7_A2>0 and saMoth_Q7_A3>0 then
totsal=saMoth_Q7_A2*saMoth_Q7_A3;

If saMoth_q7_a1=1 and saMoth_Q7_A2>0 and saMoth_Q7_A3>0 then
totsal1=saMoth_Q7_A2*saMoth_Q7_A3;
```

```
If saMoth_Q7_B2>0 and saMoth_Q7_B3>0 then
totwag=saMoth_Q7_B2*saMoth_Q7_B3;
If saMoth_Q7_B1=1 and saMoth_Q7_B2>0 and saMoth_Q7_B3>0 then
totwag1=saMoth_Q7_B2*saMoth_Q7_B3;

If saMoth_Q7_B4=1 and saMoth_Q7_B5>0 and saMoth_Q7_B3>0 then
totTipOc1=saMoth_Q7_B5*saMoth_Q7_B3;

If saMoth_Q7_B5>0 and saMoth_Q7_B3>0 then
totTipOc=saMoth_Q7_B5*saMoth_Q7_B3;

If saMoth_Q7_C2>0 and saMoth_Q7_C3>0 then
totcomm=saMoth_Q7_C2*saMoth_Q7_C3;

If saMoth_Q7_C1=1 and saMoth_Q7_C2>0 and saMoth_Q7_C3>0 then
totcomm1=saMoth_Q7_C2*saMoth_Q7_C3;

/*computing total earn income for Mothers which are the sum of total salaries, total
wages, total tips and other income and total commissions*/

/*Mothers total earn income*/

MEM=totsal+totwag+totTipOc+totcomm;

/*INITIALIZING VARIABLES FOR MothERS UNEARNED INCOME
COMPUTATION*/

if saMoth_subject_number>0 then q131=0;
if saMoth_subject_number>0 then q132=0;
if saMoth_subject_number>0 then q133=0;
if saMoth_subject_number>0 then q134=0;
if saMoth_subject_number>0 then q135=0;
if saMoth_subject_number>0 then q136=0;
if saMoth_subject_number>0 then q137=0;
if saMoth_subject_number>0 then q138=0;
if saMoth_subject_number>0 then q139=0;
if saMoth_subject_number>0 then q1310=0;
if saMoth_subject_number>0 then q1311=0;
if saMoth_subject_number>0 then q1312=0;
if saMoth_subject_number>0 then q1313=0;
if saMoth_subject_number>0 then q1314=0;

/*COMPUTING TOTAL UNEARNED Individual INCOME FOR Mothers*/
```

```
/*The ones commented out are joint unearned*/

If saMoth_q13_1b>0 and saMoth_q13_1c>0 then q131=saMoth_q13_1b*saMoth_q13_1c;
If saMoth_q13_1b>0 and saMoth_q13_1c>0 then
cq131=saMoth_q13_1b*saMoth_q13_1c;
else cq131=.;

If saMoth_q13_2b>0 and saMoth_q13_2c>0 then q132=saMoth_q13_2b*saMoth_q13_2c;
If saMoth_q13_2b>0 and saMoth_q13_2c>0 then
cq132=saMoth_q13_2b*saMoth_q13_2c;
else cq132=.;

If saMoth_q13_3b>0 and saMoth_q13_3c>0 then q133=saMoth_q13_3b*saMoth_q13_3c;
If saMoth_q13_3b>0 and saMoth_q13_3c>0 then
cq133=saMoth_q13_3b*saMoth_q13_3c;
else cq133=.;

If saMoth_q13_4b>0 and saMoth_q13_4c>0 then q134=saMoth_q13_4b*saMoth_q13_4c;
If saMoth_q13_4b>0 and saMoth_q13_4c>0 then
cq134=saMoth_q13_4b*saMoth_q13_4c;
else cq134=.;

If saMoth_q13_5b>0 and saMoth_q13_5c>0 then q135=saMoth_q13_5b*saMoth_q13_5c;
If saMoth_q13_5b>0 and saMoth_q13_5c>0 then
cq135=saMoth_q13_5b*saMoth_q13_5c;
else cq135=.;

If saMoth_q13_6b>0 and saMoth_q13_6c>0 then q136=saMoth_q13_6b*saMoth_q13_6c;
If saMoth_q13_6b>0 and saMoth_q13_6c>0 then
cq136=saMoth_q13_6b*saMoth_q13_6c;
else cq136=.;

If saMoth_q13_7b>0 and saMoth_q13_7c>0 then q137=saMoth_q13_7b*saMoth_q13_7c;
If saMoth_q13_7b>0 and saMoth_q13_7c>0 then
cq137=saMoth_q13_7b*saMoth_q13_7c;
else cq137=.;

If saMoth_q13_8b>0 and saMoth_q13_8c>0 then q138=saMoth_q13_8b*saMoth_q13_8c;
If saMoth_q13_8b>0 and saMoth_q13_8c>0 then
cq138=saMoth_q13_8b*saMoth_q13_8c;
else cq138=.;

If saMoth_q13_9b>0 and saMoth_q13_9c>0 then q139=saMoth_q13_9b*saMoth_q13_9c;
```

```
If saMoth_q13_9b>0 and saMoth_q13_9c>0 then
cq139=saMoth_q13_9b*saMoth_q13_9c;
else cq139=.;

If saMoth_q13_10b>0 and saMoth_q13_10c>0 then
q1310=saMoth_q13_10b*saMoth_q13_10c;
If saMoth_q13_10b>0 and saMoth_q13_10c>0 then
cq1310=saMoth_q13_10b*saMoth_q13_10c;
else cq1310=.;

If saMoth_q13_11b>0 and saMoth_q13_11c>0 then
q1311=saMoth_q13_11b*saMoth_q13_11c;
If saMoth_q13_11b>0 and saMoth_q13_11c>0 then
cq1311=saMoth_q13_11b*saMoth_q13_11c;
else cq1311=.;

If saMoth_q13_12b>0 and saMoth_q13_12c>0 then
q1312=saMoth_q13_12b*saMoth_q13_12c;
If saMoth_q13_12b>0 and saMoth_q13_12c>0 then
cq1312=saMoth_q13_12b*saMoth_q13_12c;
else cq1312=.;

If  saMoth_q13_13b>0 and saMoth_q13_13c>0 then
q1313=saMoth_q13_13b*saMoth_q13_13c;
If  saMoth_q13_13b>0 and saMoth_q13_13c>0 then
cq1313=saMoth_q13_13b*saMoth_q13_13c;
else cq1313=.;

If  saMoth_q13_14b>0 and saMoth_q13_14c>0 then
q1314=saMoth_q13_14b*saMoth_q13_14c;
If  saMoth_q13_14b>0 and saMoth_q13_14c>0 then
cq1314=saMoth_q13_14b*saMoth_q13_14c;
else cq1314=.;

/*Adding all of the sources of total unearned income*/

/*MothERS UNEARNED INCOME*/

MUM=q1314+q1313+q1312+q1311+q1310+q138+q136+q134+q133+q132;
Mtmsum=Mem+Mum;

/*Mothers REPORTED CHILD SURVEYED INCOME*/
```

```
if saMoth_subject_number>0 and saMoth_q15_you_amount>0 then
mtm=saMoth_q15_you_amount;
else MTM=0;

/*CHECK 1 FOR Mothers*/

check1=MTM-Mtmsum;
if check1>0 then chk1dum=1;
if check1=0 then chk1dum=0;
if check1<0 then chk1dum=-1;

/*CHECK 2 FOR Mothers*/

check2=MTM-Mem;
if check2>0 then chk2dum=1;
if check2=0 then chk2dum=0;
if check2<0 then chk2dum=-1;

/*Assigning income categories to total earned income of the Mothers*/

iF mem=. THEN CKQ7=.;
If mem<5000 and mem>=0 then CKQ7=1;
If mem>=5000 and mem<9999 then CKQ7=2;
If mem>=10000 and mem<14999 then CKQ7=3;
If mem>=15000 and mem<19999 then CKQ7=4;
If mem>=20000 and mem<29999 then CKQ7=5;
If mem>=30000 and mem<39999 then CKQ7=6;
If mem>=40000 and mem<49999 then CKQ7=7;
If mem>=50000 and mem<69999 then CKQ7=8;
If mem>=70000 and mem<79999 then CKQ7=9;
If mem>=80000 and mem<89999 then CKQ7=10;
If mem>=90000 and mem<99999 then CKQ7=11;
If mem>=100000 and mem<109999 then CKQ7=12;
If mem>=110000 and mem<119999 then CKQ7=13;
If mem>=120000 and mem<129999 then CKQ7=14;
If mem>=130000 and mem<139999 then CKQ7=15;
If mem>=140000 and mem<149999 then CKQ7=16;
If mem>=150000 then CKQ7=17;

/*CHECK 3 FOR Mothers*/

If saMoth_subject_number>0 and mem>=0 and saMoth_Q8>0
then CHECK3=saMoth_Q8-CKQ7;
if check3>0 then chk3dum=1;
```

```
if check3=0 then chk3dum=0;
if check3<0 then chk3dum=-1;

/*check 3 for Mothers. Comparing sum of fem and mum to categories*/

/*Assigning income categories to total income of the Mothers*/

iF mtmsum=. THEN ckq13=.;
If mtmsum<5000 and mtmsum>=0 then ckq13=1;
If mtmsum>=5000 and mtmsum<9999 then ckq13=2;
If mtmsum>=10000 and mtmsum<14999 then ckq13=3;
If mtmsum>=15000 and mtmsum<19999 then ckq13=4;
If mtmsum>=20000 and mtmsum<29999 then ckq13=5;
If mtmsum>=30000 and mtmsum<39999 then ckq13=6;
If mtmsum>=40000 and mtmsum<49999 then ckq13=7;
If mtmsum>=50000 and mtmsum<69999 then ckq13=8;
If mtmsum>=70000 and mtmsum<79999 then ckq13=9;
If mtmsum>=80000 and mtmsum<89999 then ckq13=10;
If mtmsum>=90000 and mtmsum<99999 then ckq13=11;
If mtmsum>=100000 and mtmsum<109999 then ckq13=12;
If mtmsum>=110000 and mtmsum<119999 then ckq13=13;
If mtmsum>=120000 and mtmsum<129999 then ckq13=14;
If mtmsum>=130000 and mtmsum<139999 then ckq13=15;
If mtmsum>=140000 and mtmsum<149999 then ckq13=16;
If mtmsum>=150000 then ckq13=17;

/*CHECK 4 FOR Mothers*/

If saMoth_subject_number>0 and mtmsum>=0 and saMoth_Q8>0
then CHECK4=saMoth_Q8-ckq13;
if check4>0 then chk4dum=1;
if check4=0 then chk4dum=0;
if check4<0 then chk4dum=-1;

/*computing reported total income by Mothers in question 15 part a*/
If saMoth_subject_number>0 and saMoth_q14_you=1 and
saMoth_Q15_YOU_AMOUNT>0 then mtm=saMoth_Q15_YOU_AMOUNT;
Else if saMoth_subject_number>0 and saMoth_q14_you=1 and
saMoth_Q15_YOU_AMOUNT<=0 then mtm=. AND mmtm=1;

/*Assigning income categories to total REPORTED Mothers INCOME*/

iF mtm=. THEN CKQ15A=.;
If mtm<5000 and mtm>=0 then CKQ15A=1;
```

```
If mtm>=5000 and mtm<9999 then CKQ15A=2;
If mtm>=10000 and mtm<14999 then CKQ15A=3;
If mtm>=15000 and mtm<19999 then CKQ15A=4;
If mtm>=20000 and mtm<29999 then CKQ15A=5;
If mtm>=30000 and mtm<39999 then CKQ15A=6;
If mtm>=40000 and mtm<49999 then CKQ15A=7;
If mtm>=50000 and mtm<69999 then CKQ15A=8;
If mtm>=70000 and mtm<79999 then CKQ15A=9;
If mtm>=80000 and mtm<89999 then CKQ15A=10;
If mtm>=90000 and mtm<99999 then CKQ15A=11;
If mtm>=100000 and mtm<109999 then CKQ15A=12;
If mtm>=110000 and mtm<119999 then CKQ15A=13;
If mtm>=120000 and mtm<129999 then CKQ15A=14;
If mtm>=130000 and mtm<139999 then CKQ15A=15;
If mtm>=140000 and mtm<149999 then CKQ15A=16;
If mtm>=150000 then CKQ15A=17;

/*CHECK 5 FOR MothERS*/

If saMoth_subject_number>0 and mtm>=0 and saMoth_Q8>0
then CHECK5=saMoth_Q8-CKQ15a;
if check5>0 then chk5dum=1;
if check5=0 then chk5dum=0;
if check5<0 then chk5dum=-1;

if MTI_Q1=1 then momwork2=1;else momwork2=0;
if MTI_Q1=2 then momwork=0;if MTI_Q3=1 then momwork=1;else if MTI_Q3=2 then
momwork=2;
else if MTI_Q3=3 then momwork=3;
if FTI_Q1=2 then dadwork=0;if FTI_Q3=1 then dadwork=1;else if FTI_Q3=2 then
dadwork=3;
else if FTI_Q3=3 then dadwork=3;
if FTI_Q3=2 and MTI_Q3=2 then bothfull=1;else bothfull=0;if FTI_Q3=2 and MTI_Q3=1
then dfmp=1;
else dfmp=0;
if bothfull=1 then pwork=3;else if dfmp=1 then pwork=2;else if dadwork=2 or
dadwork=3 and momwork=0
then pwork=1;
array allb (I) MTI_Q3 -- MTI_Q16i FTI_Q3 -- FTI_Q16i FTI_Q19A -- FTI_Q19D
FTI_Q20A -- FTI_Q20F ;
do over allb;
if allb in ( -999) then allb = .;
if allb in (-888) then allb =0;
end;
```

```
if FTI_Q6 in(2 3 4 5) then fregschd1=1;else if FTI_Q6=1 then fregschd1=0;else if
FTI_Q6=.
then fregschd1=.;
if FTI_Q7 in(2 3 4 5) then fregschd2=1;else if FTI_Q7=1 then fregschd2=0;else if
FTI_Q7=. then fregschd2=.;
if MTI_Q6 in(2 3 4 5) then mregschd1=1;else if MTI_Q6=1 then mregschd1=0;else if
MTI_Q6=.
then mregschd1=.;
if MTI_Q7 in(2 3 4 5) then mregschd2=1;else if MTI_Q7=1 then mregschd2=0;else if
MTI_Q7=. then mregschd2=.;
if mregschd1=1 and fregschd1=1 then mfregs1=1;else mfregs1=0;if mregschd2=1 and
fregschd2=1
then mfregs2=1;else mfregs2=0;
if FTI_Q6 in(1 2 3 4)then fnoset1=0;else if FTI_Q6=5 then fnoset1=1;else if FTI_Q6=. then
fnoset1=.;
if MTI_Q6 in(1 2 3 4) then mnoset1=0;else if MTI_Q6=5 then mnoset1=1;else if
MTI_Q6=. then
mnoset1=.;
if FTI_Q7 in(1 2 3 5) then fnoset2=0;else if FTI_Q7=4 then fnoset2=1;else if FTI_Q7=.
then fnoset2=.;
if MTI_Q7 in(1 2 3 5) then mnoset2=0;else if MTI_Q7=4 then mnoset2=1;else if
MTI_Q7=.
then mnoset2=.;
if fnoset1=1 and mnoset1=1 then noset1=1;else noset1=0;if fnoset2=1 and mnoset2=1
then noset2=1;
else noset2=0;
if fnoset1=1 and mnoset1=0 then noset3=1;else noset3=0;if fnoset2=1 and mnoset2=0
then noset4=1;
else noset4=0;
if FTI_Q8=. then inflexp1=.;else if FTI_Q8=3 or FTI_Q8=2 and MTI_Q8=1 then
inflexp1=1;
else inflexp1=0;
if FTI_Q9=. or MTI_Q9=. then inflexp2=.;else if FTI_Q9=3 or FTI_Q9=2 and MTI_Q9=1
then inflexp2=1;
else inflexp2=0;
if FTI_Q9=. or MTI_Q9=. then inflexp3=.;else if FTI_Q9=1 and MTI_Q9=1 then
inflexp3=1;else inflexp3=0;
if FTI_Q8=. or MTI_Q8=. then inflexp4=.;else if FTI_Q8=1 and MTI_Q8=1 then
inflexp4=1;
else inflexp4=0;
if FTI_Q8=. or MTI_Q8=. then inflexp5=.;else if FTI_Q8=1 and MTI_Q8=2 or MTI_Q8=3
then inflexp5=1;
else inflexp5=0;
```

```
if FTI_Q9=. or MTI_Q9=. then inflexp6=.;else if FTI_Q9=1 and MTI_Q9=2 or MTI_Q9=3
then inflexp6=1;
else inflexp6=0;

if MTI_Q64 in(1,6)then notmarried=0;else if MTI_Q64=. then notmarried=.;else
notmarried=1;
if FTI_Q8=. then inflexf=.;else if FTI_Q8=1 or FTI_Q8=2 then inflexf=1;else if FTI_Q8=3
then inflexf=0;
if MTI_Q8=. then inflexm=.;else if MTI_Q8=1 or MTI_Q8=2 then inflexm=1;else if
MTI_Q8=3 then inflexm=0;

if fti_q13b=5 then fti_q13bx=1;
if fti_q13b=4 then fti_q13bx=2;
if fti_q13b=3 then fti_q13bx=3;
if fti_q13b=2 then fti_q13bx=4;
if fti_q13b=1 then fti_q13bx=5;
if fti_q13b=. then fti_q13bx=.;
if mti_q13b=5 then mti_q13bx=1;
if mti_q13b=4 then mti_q13bx=2;
if mti_q13b=3 then mti_q13bx=3;
if mti_q13b=2 then mti_q13bx=4;
if mti_q13b=1 then mti_q13bx=5;
if mti_q13b=. then mti_q13bx=.;

array famstress mti_q16f mti_q16h mti_q16i
 fti_q16f fti_q16h fti_q16i;
 do over famstress;
 if famstress=1 then famstress=5;
 else if famstress=2 then famstress=4;
 else if famstress=3 then famstress=3;
 else if famstress=4 then famstress=2;
 else if famstress=5 then famstress=1;
 else if famstress=. then famstress=.;
end;

if fti_q17=1 then fti_q17=3;
else if fti_q17=3 then fti_q17=1;
if mti_q17=1 then mti_q17=3;
else if mti_q17=3 then mti_q17=1;


/* Factors */

/* Jobstress father and mother */
```

```
proc factor simple outstat=alex1 msa scree residuals rotate=varimax score
data=final.FinalData050205;
var fti_q13f fti_q13g;
proc score score=alex1 data=final.FinalData050205 out=childnut1;
data childnut2;set childnut1 (rename=(factor1=fjobstress));
proc factor simple outstat=alex2 msa scree residuals rotate=varimax score
data=childnut2;
var mti_q13f mti_q13g;
proc score score=alex2 data=childnut2 out=childnut3;
data childnut4;set childnut3 (rename=(factor1=mjobstress));

proc factor simple outstat=alex3 priors=SMC msa scree residuals rotate=varimax score
data=childnut4;
var fti_q13a fti_q13c -- fti_q13g fti_q13bx;
proc score score=alex3 data=childnut4 out=childnut5;
data childnut6;set childnut5 (rename=(factor1=fspillover1));
proc factor simple outstat=alex4 priors=SMC msa scree residuals rotate=varimax score
data=childnut6;
var mti_q13a mti_q13c -- mti_q13g mti_q13bx;
proc score score=alex4 data=childnut6 out=childnut7;
data childnut8;set childnut7 (rename=(factor1=mspillover1 factor2=mspillover2));
proc factor simple outstat=alex5 priors=smc msa scree residuals rotate=varimax score
data=childnut8;
var fti_q13a fti_q13c -- fti_q13e fti_q13bx;
proc score score=alex5 data=childnut8 out=childnut9;
data childnut10;set childnut9 (rename=(factor1=fspillover3));
proc factor simple outstat=alex6 priors=smc msa scree residuals rotate=varimax score
data=childnut10;
var mti_q13a mti_q13c -- mti_q13e mti_q13bx;
proc score score=alex6 data=childnut10 out=childnut11;
data childnut12;set childnut11 (rename=(factor1=mspillover3));

proc factor simple outstat=alex7 priors=smc msa scree residuals rotate=varimax score
data=childnut12;
var fti_q16d fti_q16e fti_q16g -- fti_q16i;
proc score score=alex7 data=childnut12 out=childnut13;
data childnut14;set childnut13 (rename=(factor1=fmaritals));
proc factor simple outstat=alex8 priors=smc msa scree residuals rotate=varimax score
data=childnut14;
var mti_q16d mti_q16e mti_q16g -- mti_q16i;
proc score score=alex8 data=childnut14 out=childnut15;
data childnut16;set childnut15 (rename=(factor1=mmaritals));
proc factor simple outstat=alex9 priors=smc msa rotate=varimax score data=childnut16;
```

```
var fti_q14a -- fti_q14d;
proc score score=alex9 data=childnut16 out=childnut17;
data childnut18;set childnut17 (rename=(factor1=fjobstress1));
proc factor simple outstat=alex10 priors=smc msa rotate=varimax score
data=childnut18;
var mti_q14a -- mti_q14d;
proc score score=alex10 data=childnut18 out=childnut19;
data childnut20;set childnut19 (rename=(factor1=mjobstress1));
proc factor simple outstat=alex11 priors=smc msa rotate=varimax score
data=childnut20;
var mti_q10a -- mti_q10e;
proc score score=alex11 data=childnut20 out=childnut21;
data childnut22;set childnut21 (rename=(factor1=mjobimp1));
proc factor simple outstat=alex12 priors=smc msa rotate=varimax score
data=childnut22;
var fti_q10a -- fti_q10e;
proc score score=alex12 data=childnut22 out=childnut23;
data childnut24;set childnut23(rename=(factor1=fjobimp1));
```

```
/* mother in states that she is incharge of making expenditure and does not have an
amount*/

/* missing mothers expenditure */

if samoth_q17_1a=0 and samoth_q17_1b=1 then mmq171a=1;
if samoth_q17_2a=0 and samoth_q17_2b=1 then mmq172a=1;
if samoth_q17_3a=0 and samoth_q17_3b=1 then mmq173a=1;
if samoth_q17_4a=0 and samoth_q17_4b=1 then mmq174a=1;
if samoth_q17_5a=0 and samoth_q17_5b=1 then mmq175a=1;
if samoth_q17_6a=0 and samoth_q17_6b=1 then mmq176a=1;
if samoth_q17_7a=0 and samoth_q17_7b=1 then mmq177a=1;
if samoth_q17_8a=0 and samoth_q17_8b=1 then mmq178a=1;
if samoth_q17_9a=0 and samoth_q17_9b=1 then mmq179a=1;
if samoth_q17_10a=0 and samoth_q17_10b=1 then mmq1710a=1;
if samoth_q17_11a=0 and samoth_q17_11b=1 then mmq1711a=1;

/* mother states that she is in charge of making expenditure and she has a positive
amount*/

/* mothers expenditure */
```

```
if samoth_q17_1a>0 and samoth_q17_1b=1 then mq171a=samoth_q17_1a;
if samoth_q17_2a>0 and samoth_q17_2b=1 then mq172a=samoth_q17_2a;
if samoth_q17_3a>0 and samoth_q17_3b=1 then mq173a=samoth_q17_3a;
if samoth_q17_4a>0 and samoth_q17_4b=1 then mq174a=samoth_q17_4a;
if samoth_q17_5a>0 and samoth_q17_5b=1 then mq175a=samoth_q17_5a;
if samoth_q17_6a>0 and samoth_q17_6b=1 then mq176a=samoth_q17_6a;
if samoth_q17_7a>0 and samoth_q17_7b=1 then mq177a=samoth_q17_7a;
if samoth_q17_8a>0 and samoth_q17_8b=1 then mq178a=samoth_q17_8a;
if samoth_q17_9a>0 and samoth_q17_9b=1 then mq179a=samoth_q17_9a;
if samoth_q17_10a>0 and samoth_q17_10b=1 then mq1710a=samoth_q17_10a;
if samoth_q17_11a>0 and samoth_q17_11b=1 then mq1711a=samoth_q17_11a;

/* mother in states that her husband is in charge of making expenditure and she does
not have an amount*/

/* mother does not know amount of husband expenditure */

if samoth_q17_1a=0 and samoth_q17_1b=0 then mmq171a=2;
if samoth_q17_2a=0 and samoth_q17_2b=0 then mmq172a=2;
if samoth_q17_3a=0 and samoth_q17_3b=0 then mmq173a=2;
if samoth_q17_4a=0 and samoth_q17_4b=0 then mmq174a=2;
if samoth_q17_5a=0 and samoth_q17_5b=0 then mmq175a=2;
if samoth_q17_6a=0 and samoth_q17_6b=0 then mmq176a=2;
if samoth_q17_7a=0 and samoth_q17_7b=0 then mmq177a=2;
if samoth_q17_8a=0 and samoth_q17_8b=0 then mmq178a=2;
if samoth_q17_9a=0 and samoth_q17_9b=0 then mmq179a=2;
if samoth_q17_10a=0 and samoth_q17_10b=0 then mmq1710a=2;
if samoth_q17_11a=0 and samoth_q17_11b=0 then mmq1711a=2;

/* father in states that she is in charge of making expenditure and does not have an
amount*/

/* missing fathers expenditure */

if safath_q17_1a=0 and safath_q17_1b=1 then mfq171a=1;
if safath_q17_2a=0 and safath_q17_2b=1 then mfq172a=1;
if safath_q17_3a=0 and safath_q17_3b=1 then mfq173a=1;
if safath_q17_4a=0 and safath_q17_4b=1 then mfq174a=1;
if safath_q17_5a=0 and safath_q17_5b=1 then mfq175a=1;
if safath_q17_6a=0 and safath_q17_6b=1 then mfq176a=1;
if safath_q17_7a=0 and safath_q17_7b=1 then mfq177a=1;
if safath_q17_8a=0 and safath_q17_8b=1 then mfq178a=1;
if safath_q17_9a=0 and safath_q17_9b=1 then mfq179a=1;
```

```
if safath_q17_10a=0 and safath_q17_10b=1 then mfq1710a=1;
if safath_q17_11a=0 and safath_q17_11b=1 then mfq1711a=1;

/*father states that he is in charge of making expenditure and he has a positive
amount*/

/* fathers expenditure */

if safath_q17_1a>0 and safath_q17_1b=1 then fq171a=safath_q17_1a;
if safath_q17_2a>0 and safath_q17_2b=1 then fq172a=safath_q17_2a;
if safath_q17_3a>0 and safath_q17_3b=1 then fq173a=safath_q17_3a;
if safath_q17_4a>0 and safath_q17_4b=1 then fq174a=safath_q17_4a;
if safath_q17_5a>0 and safath_q17_5b=1 then fq175a=safath_q17_5a;
if safath_q17_6a>0 and safath_q17_6b=1 then fq176a=safath_q17_6a;
if safath_q17_7a>0 and safath_q17_7b=1 then fq177a=safath_q17_7a;
if safath_q17_8a>0 and safath_q17_8b=1 then fq178a=safath_q17_8a;
if safath_q17_9a>0 and safath_q17_9b=1 then fq179a=safath_q17_9a;
if safath_q17_10a>0 and safath_q17_10b=1 then fq1710a=safath_q17_10a;
if safath_q17_11a>0 and safath_q17_11b=1 then fq1711a=safath_q17_11a;

/* father states that his wife is incharge of making expenditure and he does not know
the amount*/

/* father does not know amount of his wife's expenditure */

if safath_q17_1a=0 and safath_q17_1b=0 then mfq171a=2;
if safath_q17_2a=0 and safath_q17_2b=0 then mfq172a=2;
if safath_q17_3a=0 and safath_q17_3b=0 then mfq173a=2;
if safath_q17_4a=0 and safath_q17_4b=0 then mfq174a=2;
if safath_q17_5a=0 and safath_q17_5b=0 then mfq175a=2;
if safath_q17_6a=0 and safath_q17_6b=0 then mfq176a=2;
if safath_q17_7a=0 and safath_q17_7b=0 then mfq177a=2;
if safath_q17_8a=0 and safath_q17_8b=0 then mfq178a=2;
if safath_q17_9a=0 and safath_q17_9b=0 then mfq179a=2;
if safath_q17_10a=0 and safath_q17_10b=0 then mfq1710a=2;
if safath_q17_11a=0 and safath_q17_11b=0 then mfq1711a=2;

/* mother and father agree that mother makes the expenditure but the
amount is missing */

if mmq171a=1 and mfq171a=2 then mHH171a=1;
if mmq172a=1 and mfq172a=2 then mHH172a=1;
if mmq173a=1 and mfq173a=2 then mHH173a=1;
if mmq174a=1 and mfq174a=2 then mHH174a=1;
```

```
if mmq175a=1 and mfq175a=2 then mHH175a=1;
if mmq176a=1 and mfq176a=2 then mHH176a=1;
if mmq177a=1 and mfq177a=2 then mHH177a=1;
if mmq178a=1 and mfq178a=2 then mHH178a=1;
if mmq179a=1 and mfq179a=2 then mHH179a=1;
if mmq1710a=1 and mfq1710a=2 then mHH1710a=1;
if mmq1711a=1 and mfq1711a=2 then mHH1711a=1;

/* mother and father agree that father makes the expenditure but the
amount is missing */

if mmq171a=2 and mfq171a=1 then mHH171a=1;
if mmq172a=2 and mfq172a=1 then mHH172a=1;
if mmq173a=2 and mfq173a=1 then mHH173a=1;
if mmq174a=2 and mfq174a=1 then mHH174a=1;
if mmq175a=2 and mfq175a=1 then mHH175a=1;
if mmq176a=2 and mfq176a=1 then mHH176a=1;
if mmq177a=2 and mfq177a=1 then mHH177a=1;
if mmq178a=2 and mfq178a=1 then mHH178a=1;
if mmq179a=2 and mfq179a=1 then mHH179a=1;
if mmq1710a=2 and mfq1710a=1 then mHH1710a=1;
if mmq1711a=2 and mfq1711a=1 then mHH1711a=1;

/* both mother and father say the other is in charge of the expenditure but the amount
is missing */

if mmq171a=2 and mfq171a=2 then mHH171a=1;
if mmq172a=2 and mfq172a=2 then mHH172a=1;
if mmq173a=2 and mfq173a=2 then mHH173a=1;
if mmq174a=2 and mfq174a=2 then mHH174a=1;
if mmq175a=2 and mfq175a=2 then mHH175a=1;
if mmq176a=2 and mfq176a=2 then mHH176a=1;
if mmq177a=2 and mfq177a=2 then mHH177a=1;
if mmq178a=2 and mfq178a=2 then mHH178a=1;
if mmq179a=2 and mfq179a=2 then mHH179a=1;
if mmq1710a=2 and mfq1710a=2 then mHH1710a=1;
if mmq1711a=2 and mfq1711a=2 then mHH1711a=1;

 /* both mother and father say that they are in charge of the expenditure but the
amount is missing */

if mmq171a=1 and mfq171a=1 then mHH171a=1;
if mmq172a=1 and mfq172a=1 then mHH172a=1;
if mmq173a=1 and mfq173a=1 then mHH173a=1;
```

```
if mmq174a=1 and mfq174a=1 then mHH174a=1;
if mmq175a=1 and mfq175a=1 then mHH175a=1;
if mmq176a=1 and mfq176a=1 then mHH176a=1;
if mmq177a=1 and mfq177a=1 then mHH177a=1;
if mmq178a=1 and mfq178a=1 then mHH178a=1;
if mmq179a=1 and mfq179a=1 then mHH179a=1;
if mmq1710a=1 and mfq1710a=1 then mHH1710a=1;
if mmq1711a=1 and mfq1711a=1 then mHH1711a=1;

/*Defining Household Expenditures*/

if samoth_q17_1a>0 and samoth_q17_1b=1 then Mq171a=samoth_q17_1a;
Else Mq171a=0;
if safath_q17_1a>0 and safath_q17_1b=1 then Fq171a=safath_q17_1a;
Else Fq171a=0;
if samoth_q17_1a>0 and samoth_q17_1b=0 then nM171a=samoth_q17_1a;
if safath_q17_1a>0 and safath_q17_1b=0 then nF171a=safath_q17_1a;

if samoth_q17_2a>0 and samoth_q17_2b=1 then Mq172a=samoth_q17_2a;
Else Mq172a=0;
if safath_q17_2a>0 and safath_q17_2b=1 then Fq172a=safath_q17_2a;
Else Fq172a=0;
if samoth_q17_2a>0 and samoth_q17_2b=0 then nM172a=samoth_q17_2a;
if safath_q17_2a>0 and safath_q17_2b=0 then nF172a=safath_q17_2a;

if samoth_q17_3a>0 and samoth_q17_3b=1 then Mq173a=samoth_q17_3a;
Else Mq173a=0;
if safath_q17_3a>0 and safath_q17_3b=1 then Fq173a=safath_q17_3a;
Else Fq173a=0;
if samoth_q17_3a>0 and samoth_q17_3b=0 then nM173a=samoth_q17_3a;
if safath_q17_3a>0 and safath_q17_3b=0 then nF173a=safath_q17_3a;

if samoth_q17_4a>0 and samoth_q17_4b=1 then Mq174a=samoth_q17_4a;
Else Mq174a=0;
if safath_q17_4a>0 and safath_q17_4b=1 then Fq174a=safath_q17_4a;
Else Fq174a=0;
if samoth_q17_4a>0 and samoth_q17_4b=0 then nM174a=samoth_q17_4a;
if safath_q17_4a>0 and safath_q17_4b=0 then nF174a=safath_q17_4a;

if samoth_q17_5a>0 and samoth_q17_5b=1 then Mq175a=samoth_q17_5a;
Else Mq175a=0;
if safath_q17_5a>0 and safath_q17_5b=1 then Fq175a=safath_q17_5a;
Else Fq175a=0;
if samoth_q17_5a>0 and samoth_q17_5b=0 then nM175a=samoth_q17_5a;
```

```
if safath_q17_5a>0 and safath_q17_5b=0 then nF175a=safath_q17_5a;

if samoth_q17_6a>0 and samoth_q17_6b=1 then Mq176a=samoth_q17_6a;
Else Mq176a=0;
if safath_q17_6a>0 and safath_q17_6b=1 then Fq176a=safath_q17_6a;
Else Fq176a=0;
if samoth_q17_6a>0 and samoth_q17_6b=0 then nM176a=samoth_q17_6a;
if safath_q17_6a>0 and safath_q17_6b=0 then nF176a=safath_q17_6a;

if samoth_q17_7a>0 and samoth_q17_7b=1 then Mq177a=samoth_q17_7a;
Else Mq177a=0;
if safath_q17_7a>0 and safath_q17_7b=1 then Fq177a=safath_q17_7a;
Else Fq177a=0;
if samoth_q17_7a>0 and samoth_q17_7b=0 then nM177a=samoth_q17_7a;
if safath_q17_7a>0 and safath_q17_7b=0 then nF177a=safath_q17_7a;

if samoth_q17_8a>0 and samoth_q17_8b=1 then Mq178a=samoth_q17_8a;
Else Mq178a=0;
if safath_q17_8a>0 and safath_q17_8b=1 then Fq178a=safath_q17_8a;
Else Fq178a=0;
if samoth_q17_8a>0 and samoth_q17_8b=0 then nM178a=samoth_q17_8a;
if safath_q17_8a>0 and safath_q17_8b=0 then nF178a=safath_q17_8a;

if samoth_q17_9a>0 and samoth_q17_9b=1 then Mq179a=samoth_q17_9a;
Else Mq179a=0;
if safath_q17_9a>0 and safath_q17_9b=1 then Fq179a=safath_q17_9a;
Else Fq179a=0;
if samoth_q17_9a>0 and samoth_q17_9b=0 then nM179a=samoth_q17_9a;
if safath_q17_9a>0 and safath_q17_9b=0 then nF179a=safath_q17_9a;

if samoth_q17_10a>0 and samoth_q17_10b=1 then Mq1710a=samoth_q17_10a;
Else Mq1710a=0;
if safath_q17_10a>0 and safath_q17_10b=1 then Fq1710a=safath_q17_10a;
Else Fq1710a=0;
if samoth_q17_10a>0 and samoth_q17_10b=0 then nM1710a=samoth_q17_10a;
if safath_q17_10a>0 and safath_q17_10b=0 then nF1710a=safath_q17_10a;

if samoth_q17_11a>0 and samoth_q17_11b=1 then Mq1711a=samoth_q17_11a;
Else Mq1711a=0;
if safath_q17_11a>0 and safath_q17_11b=1 then Fq1711a=safath_q17_11a;
Else Fq1711a=0;
if samoth_q17_11a>0 and Fq1711a=0 then nM1711a=samoth_q17_11a;
if safath_q17_11a>0 and safath_q17_11b=0 then nF1711a=safath_q17_11a;
```

```
if Mq171a>0 and Fq171a=0 then HHHq171a=Mq171a;
else if Mq171a=0 and Fq171a>0 then HHHq171a=Fq171a;
else if Mq171a>0 and Fq171a>0 then HHHq171a=(Mq171a + Fq171a)/2;
else if nM171a>0 and nF171a>0 then HHHq171a=(nMq171a + nFq171a)/2;
else if nM171a>0 and Fq171a=0 then HHHq171a=nM171a;
else if nF171a>0 and Mq171a=0 then HHHq171a=nF171a;
else if samoth_q17_1a=0 and safath_q17_1a=0 then HHHq171a=0;


if Mq172a>0 and Fq172a=0 then HHHq172a=Mq172a;
else if Mq172a=0 and Fq172a>0 then HHHq172a=Fq172a;
else if Mq172a>0 and Fq172a>0 then HHHq172a=(Mq172a + Fq172a)/2;
else if nM172a>0 and nF172a>0 then HHHq172a=(nMq172a + nFq172a)/2;
else if nM172a>0 and Fq172a=0 then HHHq172a=nM172a;
else if nF172a>0 and Mq172a=0 then HHHq172a=nF172a;
else if samoth_q17_2a=0 and safath_q17_2a=0 then HHHq172a=0;


if Mq173a>0 and Fq173a=0 then HHHq173a=Mq173a;
else if Mq173a=0 and Fq173a>0 then HHHq173a=Fq173a;
else if Mq173a>0 and Fq173a>0 then HHHq173a=(Mq173a + Fq173a)/2;
else if nM173a>0 and nF173a>0 then HHHq173a=(nMq173a + nFq173a)/2;
else if nM173a>0 and Fq173a=0 then HHHq173a=nM173a;
else if nF173a>0 and Mq173a=0 then HHHq173a=nF173a;
else if samoth_q17_3a=0 and safath_q17_3a=0 then HHHq173a=0;

if Mq174a>0 and Fq174a=0 then HHHq174a=Mq174a;
else if Mq174a=0 and Fq174a>0 then HHHq174a=Fq174a;
else if Mq174a>0 and Fq174a>0 then HHHq174a=(Mq174a + Fq174a)/2;
else if nM174a>0 and nF174a>0 then HHHq174a=(nMq174a + nFq174a)/2;
else if nM174a>0 and Fq174a=0 then HHHq174a=nM174a;
else if nF174a>0 and Mq174a=0 then HHHq174a=nF174a;
else if samoth_q17_4a=0 and safath_q17_4a=0 then HHHq174a=0;

if Mq175a>0 and Fq175a=0 then HHHq175a=Mq175a;
else if Mq175a=0 and Fq175a>0 then HHHq175a=Fq175a;
else if Mq175a>0 and Fq175a>0 then HHHq175a=(Mq175a + Fq175a)/2;
else if nM175a>0 and nF175a>0 then HHHq175a=(nMq175a + nFq175a)/2;
else if nM175a>0 and Fq175a=0 then HHHq175a=nM175a;
else if nF175a>0 and Mq175a=0 then HHHq175a=nF175a;
else if samoth_q17_5a=0 and safath_q17_5a=0 then HHHq175a=0;

if Mq176a>0 and Fq176a=0 then HHHq176a=Mq176a;
else if Mq176a=0 and Fq176a>0 then HHHq176a=Fq176a;
```

```
else if Mq176a>0 and Fq176a>0 then HHHq176a=(Mq176a + Fq176a)/2;
else if nM176a>0 and nF176a>0 then HHHq176a=(nMq176a + nFq176a)/2;
else if nM176a>0 and Fq176a=0 then HHHq176a=nM176a;
else if nF176a>0 and Mq176a=0 then HHHq176a=nF176a;
else if samoth_q17_6a=0 and safath_q17_6a=0 then HHHq176a=0;

if Mq177a>0 and Fq177a=0 then HHHq177a=Mq177a;
else if Mq177a=0 and Fq177a>0 then HHHq177a=Fq177a;
else if Mq177a>0 and Fq177a>0 then HHHq177a=(Mq177a + Fq177a)/2;
else if nM177a>0 and nF177a>0 then HHHq177a=(nMq177a + nFq177a)/2;
else if nM177a>0 and Fq177a=0 then HHHq177a=nM177a;
else if nF177a>0 and Mq177a=0 then HHHq177a=nF177a;
else if samoth_q17_7a=0 and safath_q17_7a=0 then HHHq177a=0;

if Mq178a>0 and Fq178a=0 then HHHq178a=Mq178a;
else if Mq178a=0 and Fq178a>0 then HHHq178a=Fq178a;
else if Mq178a>0 and Fq178a>0 then HHHq178a=(Mq178a + Fq178a)/2;
else if nM178a>0 and nF178a>0 then HHHq178a=(nMq178a + nFq178a)/2;
else if nM178a>0 and Fq178a=0 then HHHq178a=nM178a;
else if nF178a>0 and Mq178a=0 then HHHq178a=nF178a;
else if samoth_q17_8a=0 and safath_q17_8a=0 then HHHq178a=0;

if Mq179a>0 and Fq179a=0 then HHHq179a=Mq179a;
else if Mq179a=0 and Fq179a>0 then HHHq179a=Fq179a;
else if Mq179a>0 and Fq179a>0 then HHHq179a=(Mq179a + Fq179a)/2;
else if nM179a>0 and nF179a>0 then HHHq179a=(nMq179a + nFq179a)/2;
else if nM179a>0 and Fq179a=0 then HHHq179a=nM179a;
else if nF179a>0 and Mq179a=0 then HHHq179a=nF179a;
else if samoth_q17_9a=0 and safath_q17_9a=0 then HHHq179a=0;

if Mq1710a>0 and Fq1710a=0 then HHHq1710a=Mq1710a;
else if Mq1710a=0 and Fq1710a>0 then HHHq1710a=Fq1710a;
else if Mq1710a>0 and Fq1710a>0 then HHHq1710a=(Mq1710a + Fq1710a)/2;
else if nM1710a>0 and nF1710a>0 then HHHq1710a=(nMq1710a + nFq1710a)/2;
else if nM1710a>0 and Fq1710a=0 then HHHq1710a=nM1710a;
else if nF1710a>0 and Mq1710a=0 then HHHq1710a=nF1710a;
else if samoth_q17_10a=0 and safath_q17_10a=0 then HHHq1710a=0;

if Mq1711a>0 and Fq1711a=0 then HHHq1711a=Mq1711a;
else if Mq1711a=0 and Fq1711a>0 then HHHq1711a=Fq1711a;
else if Mq1711a>0 and Fq1711a>0 then HHHq1711a=(Mq1711a + Fq1711a)/2;
else if nM1711a>0 and nF1711a>0 then HHHq1711a=(nMq1711a + nFq1711a)/2;
else if nM1711a>0 and Fq1711a=0 then HHHq1711a=nM1711a;
else if nF1711a>0 and Mq1711a=0 then HHHq1711a=nF1711a;
```

```
else if samoth_q17_11a=0 and safath_q17_11a=0 then HHHq1711a=0;

/* Household income as defined by question 15 of mother and father */

if saMoth_subject_number>0 and safath_subject_number>0 then HHTinc15=mtm +
ftm;
/* Household income as defined by question 7 and 13 of mother and father */
if saMoth_subject_number>0 and safath_subject_number>0 then
HHTinc1713=mtmsum + ftmsum;

/*Defining unearned income as the difference between total income from q15 and
earned income q7*/

if saMoth_subject_number>0 and mtm>0 then mum157=mtm - mem;Else mum157=0;

/*Defining unearned income as the difference between total income from q15 and
earned income q7*/

if safath_subject_number>0 and ftm>0 then fum157=ftm - fem;Else fum157=0;

/*Defining household unearned income*/

if saMoth_subject_number>0 and safath_subject_number>0 then HHUIn157=fum157 +
mum157;
if saMoth_subject_number>0 and HHUIn157<0 then Lhh=samoth_subject_number;

/*mem and fem in 1000's of dollars*/
memm=1000*mem;
femm=1000*fem;

if HHUIn157<0 then HHNU157=HHUIn157;
Else HHNU157=.;

/*Defining household unearned income*/

if saMoth_subject_number>0 and safath_subject_number>0 then HHUInc=fum + mum;

/*Total household earned income*/

if saMoth_subject_number>0 and safath_subject_number>0 then HHEInc=mem + fem;

/* Grouping Expenditure Categories */

/* Food at Home */
```

```
HHFoodH=HHHq171a;

/* Food away from home */

HHFoodA=HHHq173a  ;

/*Preprepared food and takeout*/

HHFoodTO= HHHq172a;

/* All Houshold Expenditures (housing, transportation, health and education */

HHExpT=HHHq174a + HHHq175a + HHHq176a + HHHq177a;

/* Housing and Household Expenditures */

HHExp=HHHq174a;

/* Transportation, healthcare and education */

HHTHE=HHHq175a + HHHq176a + HHHq177a;

/* Childrens Clothing and Shoes */

HHExpC=HHHq178a;

/* Womens Clothing and Shoes */

HHExpW=HHHq179a;

/* Mens Clothing and Shoes */

HHExpM=HHHq1710a;

/* Other Houshold members Clothing and Shoes */

HHExpO=HHHq1711a;

/*ALL HOUSEHOLD EXP BESIDES FOOD AT HOME*/

HHEAllO=HHExpT+HHTHE+HHExpC+HHExpW+HHExpM+HHFoodA;

/* FAMILY FINANCIAL STRUCTURE */
```

```
/* CHECKING FOR DIFFERENCES BETWEEN REPORTED FFS BY HUSBANDS AND
WIVES*/

/* DEFINITION */

/* FATHER FFS */

FaFFS=SAFATH_Q18;

/* MOTHER FFS */

MoFFS=SAMOTH_Q18;

if samoth_q18=1 AND SAFATH_Q18=2 THEN dFFS=1;/*MOTHER MAN AND
MAKES ALL DES*/

IF SAMOTH_Q18=2 AND SAFATH_Q18=1 THEN dFFS=2; /*FATHER MAN AND
MAKES ALL DES*/

if samoth_q18=3 AND SAFATH_Q18=4 THEN dFFS=3; /*MOTHER GIVES ALLOW
TO HUS*/

IF SAMOTH_Q18=4 AND SAFATH_Q18=3 THEN dFFS=4; /*FATHER GIVES ALLOW
TO WIFE*/

IF SAMOTH_Q18=5 AND SAFATH_Q18=5 THEN dFFS=5; /*INDIVIDUAL*/

IF SAMOTH_Q18=6 AND SAFATH_Q18=6 THEN dFFS=6; /*JOINT*/

/* if no expenditures on food consumed at home we are deleting the family*/

/*if HHFoodH=0 then delete;*/

if HHTinc15=0 then delete;

/*if hhexp=0 then delete;*/

if dFFS<1 then delete; /*dFFS=0;*/
if HHExpC  = 0 then delete;

if HHExpW=0 then delete;
if HHExpM=0 then delete;
```

```
/*UNCONDITIONAL EXPENDITURES*/

HHExpCW=HHExpC+HHExpW;
UHHfoodH=HHfoodH*1;
UHHFoodA=HHFoodA*1;
UHHFoodTO=HHFoodTO*1;
UHHExp=HHExp*1;
UHHExpT=HHExpT*1;
UHHTHE=HHTHE*1;
UHHExpC=((HHExpC*1));
UHHExpW=HHExpW*1;
UHHExpM=HHExpM*1;
UHHExpCW=UHHExpC+UHHExpW;
UHHEAllO=HHEAllO*1;

/*ethnicity*/

/*father*/
if fti_q62=5 then fwhite=1;else fwhite=0;
if fti_q62=4 then fhisp=1;else fhisp=0;
if fti_q62=1 then fother=1;else if fti_q62=2 then fother=1;else if fti_q62=3 then fother=1;
else fother=0;

/*mother*/

if mti_q62=5 then mwhite=1;else mwhite=0;
if mti_q62=3 then mhisp=1;else mhisp=0;
if mti_q62=1 then mother=1;else if mti_q62=2 then mother=1;else if mti_q62=4 then
mother=1;
else mother=0;
dage=fti_q60-mti_q60;
dedu=fti_q63-mti_q63;

/*Household family financial structure*/

/*creation of dummy variables for conditional model*/

/*Wife whole wage*/

if dFFS=1 then ffs1=1;else ffs1=0;

/*husband whole wage*/

if dFFS=2 then ffs2=1;else ffs2=0;
```

```
/*husband allowance*/

if dFFS=3 then ffs3=1;else ffs3=0;

/*wife allowance*/

if dFFS=4 then ffs4=1;else ffs4=0;

/*individaul*/

if dFFS=5 then ffs5=1;else ffs5=0;

/*joint*/

if dFFS=6 then ffs6=1;else ffs6=0;

/*infants and adolescents*/

if samoth_q6_1a>0 and samoth_q6_1a<5 then infant=1;
if samoth_q6_1a>0 and samoth_q6_1a>5 then infant=0;
if samoth_q6_1a>0 and samoth_q6_1a=5 then infant=0;

if samoth_q6_1a>4.999 and samoth_q6_1a<18.1 then adolecent=1;
if samoth_Q6_1A>0 and samoth_Q6_1A<5 then mINF1=1;
ELSE mINF1=0;
if samoth_Q6_2A>0 and samoth_Q6_2A<5 then mINF2=1;
ELSE mINF2=0;
if samoth_Q6_3A>0 and samoth_Q6_3A<5 then mINF3=1;
ELSE mINF3=0;
if samoth_Q6_4A>0 and samoth_Q6_4A<5 then mINF4=1;
ELSE mINF4=0;
if samoth_Q6_5A>0 and samoth_Q6_5A<5 then mINF5=1;
ELSE mINF5=0;
if samoth_Q6_6A>0 and samoth_Q6_6A<5 then mINF6=1;
ELSE mINF6=0;
if samoth_Q6_7A>0 and samoth_Q6_7A<5 then mINF7=1;
ELSE mINF7=0;
if samoth_Q6_8A>0 and samoth_Q6_8A<5 then mINF8=1;
ELSE mINF8=0;
if samoth_Q6_9A>0 and samoth_Q6_9A<5 then mINF9=1;
ELSE mINF9=0;
if samoth_Q6_10A>0 and samoth_Q6_10A<5 then mINF10=1;
ELSE mINF10=0;
```

```
MINF=mINF1+mINF2+mINF3+mINF4+mINF5+mINF6+mINF7+mINF8+mINF9+mIN
F10;

/*if samoth_Q6_1A>0 and samoth_Q6_1A>5 then INF=0;
if samoth_Q6_1A>0 and samoth_Q6_1A=5 then INF=0;*/

if samoth_Q6_1A>4.999 and samoth_Q6_1A<18.1 then mADO1=1;
ELSE mADO1=0;
if samoth_Q6_2A>4.999 and samoth_Q6_2A<28.2 then mADO2=2;
ELSE mADO2=0;
if samoth_Q6_3A>4.999 and samoth_Q6_3A<38.3 then mADO3=3;
ELSE mADO3=0;
if samoth_Q6_4A>4.999 and samoth_Q6_4A<48.4 then mADO4=4;
ELSE mADO4=0;
if samoth_Q6_5A>4.999 and samoth_Q6_5A<58.5 then mADO5=5;
ELSE mADO5=0;
if samoth_Q6_6A>4.999 and samoth_Q6_6A<68.6 then mADO6=6;
ELSE mADO6=0;
if samoth_Q6_7A>4.999 and samoth_Q6_7A<78.7 then mADO7=7;
ELSE mADO7=0;
if samoth_Q6_8A>4.999 and samoth_Q6_8A<88.8 then mADO8=8;
ELSE mADO8=0;
if samoth_Q6_9A>4.999 and samoth_Q6_9A<98.9 then mADO9=9;
ELSE mADO9=0;
if samoth_Q6_10A>4.999 and samoth_Q6_10A<108.10 then mADO10=10;
ELSE mADO10=0;

MADO=mADO1+mADO2+mADO3+mADO4+mADO5+mADO6+mADO7+mADO8+
mADO9+mADO10;

TCHILD=mINF+mADO;

FHOURW=FTI_Q4 * 4;

MHOURW=MTI_Q4 * 4;

IF SAMOTH_Q8<6 THEN LM1=1;
ELSE LM1=0;
IF SAMOTH_Q8>5 AND SAMOTH_Q8<11 THEN LM2=1;
ELSE LM2=0;
IF SAMOTH_Q8>11 AND SAMOTH_Q8<14 THEN LM3=1;
ELSE LM3=0;
IF SAMOTH_Q8>13 THEN LM4=1;
ELSE LM4=0;
```

```
IF SAFATH_Q8<6 THEN LF1=1;
ELSE LF1=0;
IF SAFATH_Q8>5 AND SAFATH_Q8<11 THEN LF2=1;
ELSE LF2=0;
IF SAFATH_Q8>11 AND SAFATH_Q8<14 THEN LF3=1;
ELSE LF3=0;
IF SAFATH_Q8>13 THEN LF4=1;
ELSE LF4=0;
MW=MEM/(4*MTI_Q4);
FW=FEM/(4*FTI_Q4);
IF MW<0 THEN MW=.;
IF FW<0 THEN FW=.;


PROC CORR;
VAR FEM MEM ;
WITH FHOURW MHOURW MO1 FA1 FJOBIMP1 MJOBIMP1 FSPILLOVER1
MSPILLOVER1
        FMARITALS MMARITALS MTM FTM FJOBSTRESS1 MJOBSTRESS1
        SAFATH_Q8 SAMOTH_Q8 MW FW ;RUN;


/*COMBINED MODEL*/

TITLE ' Combined GMM 1245 ID FFS1 USING IV';
proc model;
exogenous fum157 mum157 FFS1 ffs2 ffs4 ffs5 fwhite mwhite dedu dage TCHILD
mjobstress fjobstress ;
parms B10 B11 B12 B13 B14 B15 B16 B17 B18 B19 B112 B114 B115 B116 B117     B118
         B20 B21 B22 B23 B24 B25 B26 B27 B28 B29 B212 B214 B215 B216 B217 B218
          C10 C11 C12 C13 C14 C19 C112 C114 C115 C116 C117 C118
          C20 C21 C22 C23 C24 C29 C212 C214 C215 C216 C217 C218;
INSTRUMENTS fum157 mum157 FFS1 ffs2 ffs4 ffs5 fwhite mwhite dedu dage TCHILD
        mjobstress fjobstress FJOBIMP1 MJOBIMP1 MO1 FA1;

    HHFoodH = B10 + B11 * fem + B12 * mem + B13 * fum157 + B14 * mum157
          + B15 * ffs1 + B16 * FFS2 + B17 * ffs4 + B18 * ffs5 + B19 * fwhite
          + B112 * mwhite  + B114 * dedu + B115 * dage + B116 * TCHILD
          + B117 * fjobstress + B118 * mjobstress;

    HHFoodA = B20 + B21 * fem + B22 * mem + B23 * fum157 + B24 * mum157
          + B25 * ffs1 + B26 * FFS2 + B27 * ffs4 + B28 * ffs5 + B29 * fwhite
          + B212 * mwhite  + B214 * dedu + B215 * dage + B216 * TCHILD
          + B217 * fjobstress + B218 * mjobstress;
```

```
UHHFoodH = C10 + C11 * fem + C12 * mem + C13 * fum157 + C14 * mum157 + C19 *
        fwhite  + C112 * mwhite  + C114 * dedu + C115 * dage + C116 * TCHILD + C117
        * fjobstress + C118 * mjobstress;

UHHFoodA = C20 + C21 * fem + C22 * mem + C23 * fum157 + C24 * mum157 + C29 *
        fwhite + C212 * mwhite  + C214 * dedu + C215 * dage + C216 * TCHILD
        + C217 * fjobstress + C218 * mjobstress;

/*Test of variables across ALL Conditional equations*/

/*Test of variables across EXPENDITUES ON FOOD AT AND AWAY FROM HOME
in the conditional model*/

test B10-B20=0;
TEST B11-B21=0;
TEST B12-B22=0;
TEST B13-B23=0;
TEST B14-B24=0;
TEST B15-B25=0;
TEST B16-B26=0;
TEST B17-B27=0;
TEST B18-B28=0;
TEST B19-B29=0;
TEST B112-B212=0;
TEST B114-B214=0;
TEST B115-B215=0;
TEST B116-B216=0;
TEST B117-B217=0;
TEST B118-B218=0;

/*Differences between the conditional and unconditional models*/

TEST B11-C11=0;
TEST B12-C12=0;
TEST B13-C13=0;
TEST B14-C14=0;
TEST B19-C19=0;
TEST B112-C112=0;
TEST B114-C114=0;
TEST B115-C115=0;
TEST B116-C116=0;
TEST B117-C117=0;
TEST B118-C118=0;
```

```
TEST B21-C21=0;
TEST B22-C22=0;
TEST B23-C23=0;
TEST B24-C24=0;
TEST B29-C29=0;
TEST B212-C212=0;
TEST B214-C214=0;
TEST B215-C215=0;
TEST B216-C216=0;
TEST B217-C217=0;
TEST B218-C218=0;
```

/*Test of variables across ALL unconditional equations*/

/*Test of variables across EXPENDITUES ON FOOD AT AND AWAY FROM HOME in the unconditional model. This is the test of whether pie (total ffects) variables across equations are equal*/

```
test C10-C20=0;
TEST C11-C21=0;
TEST C12-C22=0;
TEST C13-C23=0;
TEST C14-C24=0;
TEST C19-C29=0;
TEST C112-C212=0;
TEST C114-C214=0;
TEST C115-C215=0;
TEST C116-C216=0;
TEST C117-C217=0;
TEST C118-C218=0;
```

/*Test of family financial structure in each equation in the conditional model*/

```
TEST B15, B16, B17, B18;
TEST B25, B26, B27, B28;
```

/*TEST WETHER EARNED INCOME OF FATHERS AND MOTHERS IS EQUALLY SPENT in the conditional model*/

```
TEST B11-B12=0;
TEST B21-B22=0;
```

```
/*TEST WETHER EARNED INCOME OF FATHERS AND MOTHERS IS EQUALLY
SPENT in the unconditional model*/

TEST C11-C12=0;
TEST C21-C22=0;

/*TEST WETHER UNEARNED INCOME OF FATHERS AND MOTHERS IS
EQUALLY SPENT in the conditional model*/

TEST B13-B14=0;
TEST B23-B24=0;

/*TEST WETHER UNEARNED INCOME OF FATHERS AND MOTHERS IS
EQUALLY SPENT in the unconditional model*/

TEST C13-C14=0;
TEST C23-C24=0;

/*TEST WETHER EARNED AND UNEARNED INCOMES OF FATHERS ARE
EQUALLY SPENT in the conditional model*/

TEST B11-B13=0;
TEST B21-B23=0;

/*TEST WETHER EARNED AND UNEARNED INCOMES OF FATHERS ARE
EQUALLY SPENT in the unconditional model*/

TEST C11-C13=0;
TEST C21-C23=0;

/*TEST WETHER EARNED AND UNEARNED INCOMES OF moTHERS ARE
EQUALLY SPENT in the conditional model*/

TEST B12-B14=0;
TEST B22-B24=0;

/*TEST WETHER EARNED AND UNEARNED INCOMES OF moTHERS ARE
EQUALLY SPENT in the unconditional model*/

TEST C11-C14=0;
TEST C21-C24=0;
```

```
/*TEST WHETHER EARNED INCOME OF MOTHERS IS THE SAME FOR THE FOOD
AT HOME AND FOOD AWAY FROM HOME EQUATIONS IN THE CONDITIONAL
MODEL*/

TEST B11-B21=0;

/*FOR UNEARNED INCOMES*/

TEST B13-B23=0;

/*FATHERS EARNED INCOME*/

TEST B12-B22=0;

/*FATHERS UNEARNED INCOME*/

TEST B14-B24=0;

/*TESTING THE SUM OF THE PRODUCT OF THE EFFECT THAT THE FAMILY
FINANCIAL STRUCTURES HAS ON THE EXPENDITURE CATEGORY OF INTEREST
TIMES THE EFFECT THAT THE VARIABLE OF INTEREST HAS ON FAMILY
FINANCIAL STRUCTURE*/

TEST C10-B10;
TEST C11-B11;
TEST C12-B12;
TEST C13-B13;
TEST C14-B14;
TEST C15-B15;
TEST C19-B19;
TEST C112-B112;
TEST C114-B114;
TEST C115-B115;
TEST C116-B116;
TEST C117-B117;
TEST C118-B118;

TEST C20-B20;
TEST C21-B21;
TEST C22-B22;
TEST C23-B23;
TEST C24-B24;
TEST C25-B25;
TEST C29-B29;
```

```
TEST C212-B212;
TEST C214-B214;
TEST C215-B215;
TEST C216-B216;
TEST C217-B217;
TEST C218-B218;

tEST C11-C12;
TEST C13-C14;
tEST C11-C12, C13-C14;
TEST C21-C22, C23-C24;
TEST ((C11+C13)-(C12+C14));
TEST ((C21+C23)-(C22+C24));
TEST ((B11+B13)-(B12+B14)), B15, B16, B17, B18;
TEST ((B21+B23)-(B22+B24)), B25, B26, B27, B28;

TEST ((B11+B13)-(B12+B14));
TEST ((B21+B23)-(B22+B24));
TEST (B11-B12), (B13-B14), B15, B16, B17, B18;
TEST (B21-B22), (B23-B24), B25, B26, B27, B28;

TEST C11-C13,C12-C14;
TEST C21-C23,C22-C24;
TEST (C10-B10), (C11-B11), (C12-B12), (C13-B13), (C14-B14), (C19-B19), (C112-B112),
(C114-B114), (C115-B115), (C116-B116), (C117-B117), (C118-B118);
TEST (C20-B20), (C21-B21), (C22-B22), (C23-B23), (C24-B24), (C29-B29), (C212-B212),
(C214-B214), (C215-B215), (C216-B216), (C217-B217), (C218-B218);
fit HHFoodH HHFoodA UHHFoodH UHHFoodA  / GMM WHITE;
run;
```

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