VALUATION OF HOUSEHOLD PRODUCTION TIME: CONCEPTUAL AND EMPIRICAL REFINEMENTS OF THE STANDARD OPPORTUNITY COST OF TIME METHODOLOGY

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by
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VALUATION OF HOUSEHOLD PRODUCTION TIME:
CONCEPTUAL AND EMPIRICAL REFINEMENTS
OF THE STANDARD OPPORTUNITY
COST OF TIME METHODOLOGY

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a candidate for the degree of **Doctor of Philosophy**

and hereby certify that in their opinion it is worthy of acceptance.

This dissertation is dedicated to my beloved parents,

Claude and Colette Robitaille (born Marier), and to

the loving memory of Lorette Marier (born Falardeau)

and Thérèse Robitaille (born Pelletier),

all of whom have importantly contributed in

the realization of the man I have become.

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ABSTRACT

Addressing important conceptual and empirical problems associated with the standard opportunity cost approach to assessing the economic value of home production time, this study used the fundamentals of time-allocation theory (Becker, 1965) in conjunction with the two-stage recurrent estimation model proposed by Heckman (1976) to develop and test practical solutions that make it possible to derive opportunity cost measures which provide for a more valid assessment of the value of this time from a household perspective than has heretofore been achieved.

Specifically, the assumption of perfectly continuous budget lines—the assumption that there are no labor market constraints affecting individuals' time-allocation behavior—and the assumption of linearly homogeneous home production functions, which characterize the standard opportunity cost methodology to valuing home production time, are shown to be unrealistic and to introduce substantial biases in the opportunity cost measures obtained under such assumptions. Hence, in an effort to reconcile the opportunity cost methodology with reality, and thus alleviate the biases resulting from such unrealistic assumptions, simple conceptual refinements are developed and tested with a sample of

857 Missouri wives in this study.

The use of desired (rather than observed) labor supply behavior in Heckman's two-stage estimation model is proposed as an efficient solution to control for the adverse effects of market constraints on opportunity cost measures derived for the valuation of home labor time. Further, a procedure is developed for the derivation of an *average* shadow price of home production time that provides for an opportunity cost measure which, in contrast to standard measures such as market and reservation wages, fully accounts for the decreasing returns to scale of this time. In addition to these conceptual refinements, it is empirically shown that Heckman's correction procedure for sample selection bias may not be required when important labor supply regressors such as the wife's gender-role attitude and her state of health are included along with the regressors usually considered in the standard formulation of the estimation model.

Basically, three versions of the general econometric model developed by Heckman were utilized and compared in terms of their estimation results in this study. While the first version of the model only replicated the standard specification of the recurrent system of equations used by home and family economists to derive opportunity cost measures, the two other formulations improved on this standard version by refining its econometric specification. Specifically, the first variant included regressors generally missing from the standard specification, but believed to be of substantial consequences in the determination of opportunity cost measures, as well as on the very issue of sample selection bias. These new regressors were the wife's gender-role attitude with respect to what she views as the proper role of women in the family, her husband's attitude on the same gender-role construct, her state of health, her husband's state of health, her assessment of the adequacy of her home technology, and her perception regarding the adequacy of her household's income. In addition to these new regressors, the second variant of the standard model was further refined by replacing the wives' observed labor supply behavior with their desired, unconstrained, behavior to control for market constraints which, from the economic theory of time allocation, are known to generate biases in the opportunity cost measures of home labor time.

The fit of each different specification of the estimation model was investigated in order to assess the impact of these refinements from a statistical perspective. Particularly, while distinct pseudo R-square statistics were used to gauge the discriminatory power of the first stage Probit analysis of the wives' labor-force participation behavior, the adjusted R-squares and standard errors of the estimates were utilized to assess the explanatory power and the precision of the second stage OLS analysis of the wage and hours of market work regressions. Also, reservation and market wages, as standard opportunity cost measures for home production time, were derived from each particular specification of the model for both employed and nonemployed Missouri wives. While comparisons between the figures obtained from the standard formulation of the model and the first variant of it permitted assessment of the biases due to the omission of important non-standard labor supply determinants in the recurrent system of equations, direct comparisons between the figures obtained from the first variant of the standard specification and the second variant of it allowed evaluation of the biases due to labor market restraints in the opportunity cost of time estimates. Lastly, for both employed and nonemployed wives, average shadow prices of home production time were computed from each particular specification of the estimation model and contrasted to the reservation and market wage figures to assess the biases induced by the assumption of linearly homogeneous home production functions.

Comparisons between the estimation results of the standard specification and the first variant of it reveal that the addition of the non-standard regressors, notably the wife's state of health and gender-role attitude, importantly contributes to predicting the labor-force participation behavior of the sampled Missouri wives. While an increase of nearly 45% is recorded in the explanatory power of the labor-force participation Probit analysis according to Efron's goodness-of-fit statistic, increases in the order of 39% and 50% are found based on Cragg-Uhler's and McFadden's pseudo R-square statistics. As such, when included along with the standard regressors, the new regressors appear 'profitable' enough to make lambda statistically non-significant in the OLS market wage regression. Clearly, the inclusion of these non-standard regressors in the recurrent estimation model may be regarded as a sensible alternative to Heckman's sample-selection correction instrument (i.e. lambda).

For nonemployed wives, the bias due to the omission of the non-standard regressors in the recurrent system of equations is not only detrimental to their reservation wage estimates, but also to their market wage estimates. On average, the potential market wages of these housewives are downward biased by 23% as a result of omitting such regressors, whereas their reservation wages are downward biased by 53%. For employed wives, since market wages are known, the bias due to the omission of such non-standard regressors is only relevant in their estimated reservation wages. In fact, the reservation wage estimates of employed wives are downward biased by 50% when these important non-standard regressors are omitted from the estimation model.

Comparisons between the results obtained from the first and second variants of the standard estimation model reveal substantial biases in the opportunity cost measures—particularly in reservation wages—derived under the standard assumption of perfectly continuous budget lines. Specifically, on average, without the appropriate control of the market constraints affecting 436 of the 857 sampled wives, reservation wage estimates of nonemployed wives are upward biased by 37%, whereas those of employed wives are upward biased by nearly 45%. To a lesser extent, potential market wages derived for the nonemployed wives are upward biased by almost 5%, on average, due to the non-control of those constraints.

Lastly, under the usual, but yet unrealistic, assumption of linearly homogeneous (i.e. CRS) home production functions, it is shown that standard opportunity cost measures for the time devoted to home production activities are simply not appropriate for the valuation of this time from a household perspective. In fact, based on the most refined variant of the standard estimation model (i.e. the second variant), taking the reservation wage of the nonemployed wife as the opportunity cost for all her hours of home production severely understates the true economic value of this time by as much as 78%, on average. Likewise, using the market wage of the employed wife as the opportunity cost measure for all her hours of home production time overstates the value she actually places on this time by as much as 69%, on average.

Thus, as evidenced by the results obtained in this study, it shall be clear that a wife's state of health and gender-role attitude may be a sensible alternative to Heckman's lambda in deriving opportunity cost measures for household production time. Additionally, if the opportunity cost approach is to enable derivation of the authentic monetary value of home production time from an individual (i.e. household) perspective, then the conceptual refinements proposed and implemented in this study are indispensable to ensure the validity of the opportunity cost estimates one obtains for this productive time. Undeniably, it is of utmost importance that the reality of institutional labor market constraints and decreasing returns to scale of household production functions be effectively modeled through the opportunity cost of time methodology, else tremendous biases will continue to plague estimates of the economic value of home production time, and hence obscure the (our) understanding of household members' time-allocation.

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CHAPTER 1

INTRODUCTION

In its most comprehensive economic sense, the concept of production is defined as the use of scarce resources to generate satisfaction or, more precisely, *utility*. Consequently, 'utility'—defined as the want-satisfying power of goods and services (i.e. commodities)—conveys the ultimate motivation at the basis of any productive process. Although most economic analysis generally focuses on the array of productive activities that are remunerated, and hence which take place in the market, it is clear that production also occurs in unpaid non-market settings. To portray the extent of this unremunerated production, a recent study using data drawn from the National Survey of Families and Households (NSFH)—a national probability sample of 13,017 adults interviewed between March 1987 and May 1988—reports that typical married-couple households were, at that time, allocating 54.5 hours per week on average (i.e. almost one-third of their total weekly time) to unpaid household production, excluding time allocated to childcare-related labor (South & Spitze, 1994)[1]. Contrasting this figure with the fact that, in 1989, typical married-couple households were supplying 62.6 hours per week on average (i.e. roughly 37 percent of their total weekly time) to the paid labor market (Mishel et al., 1997), it would simply be unthinkable to limit the concept of 'production' only to those activities occurring in the paid labor market.

[1] The authors of the study report that their estimate is probably downward biased since they could not include childcare in their measure of household labor. In fact, their measure was restricted to time allocated to meal preparation, dishes washing, house cleaning, laundry and ironing , outdoor maintenance, shopping for the household, paying bills, car maintenance, and transportation for family members.

Indeed, it has long been recognized that household work represents a considerable array of productive activities through which individuals and families substantially enhance their economic well-being and the true national product of our society. Unquestionably, household work such as cooking, gardening, cleaning, home repairs, childcare, and so on, significantly increases the flow of commodities (i.e. goods and services) that are available to family members, else it would certainly not be done. Many scholars have estimated the dollar value of home production time and found it to be substantial (Bryant et al., 1992; Gauger & Walker, 1980; Gronau, 1980; Murphy, 1982; Peskin, 1983; Zick & Bryant, 1983; 1990). To illustrate, one particular study reports that in 1973 the value of the commodities produced in the typical married-couple household exceeded two-thirds of the family's after-tax money income (Gronau, 1980). In another study using more recent data, it was estimated that in 1988, the median total monetary value of the time wives and husbands, aged 25 to 65 years, together spent in household work was $16,216 annually (Bryant et al., 1992), which is indeed considerable. Hence, given the potential contribution of home labor to households' well-being, it is not surprising that, for many years, home and family economists have been concerned with the issue of how to parsimoniously value time spent in household work.

Although the motivation for this type of research has emerged from a wide variety of sources[2], the most frequently cited reasons for wanting to assess the value of home production time are to improve on current measures of household economic well-being,

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[2] For an in-depth exposition of the various research applications regarding the "home-wage" statistic, see Hawrylyshyn & Woroby, 1982.

and/or to record its economic value in National Income and Product Accounts (NIPA). Additionally, measures of the value of home production time are also of great importance in both the legal and political arenas. For the purposes of settling claims involving a homemaker's wrongful death or injury, and also in cases in which property must be divided upon divorce, the valuation of a homemaker's time has become indispensable inasmuch as, in such cases, household production is often the single or principal source of economic value to the plaintiff or estate. For instance, in cases in which the housewife is permanently disabled and no longer can perform her household tasks, insurance benefits and/or legal compensations will depend on the lost value of the person's time in household work. Likewise, divorce settlements may depend on the relative contributions of the spouses to the household and, consequently, their contributions would depend on their respective values of time and how much each worked in the market as well as in the home. In the political arena, it is often suggested that the Social Security benefits of married women who have never participated in the paid labor force should be linked to the value of their household production time.

Without doubt, empirical measures of the value of home production time have come to represent some of the most sought after figures in all of economics and, to meet this end, two general approaches have been used by researchers over the years: the market replacement cost and the opportunity cost of time approaches.

CHAPTER 2

HOME PRODUCTION TIME AND ITS VALUATION

The Market Replacement Cost Approach

By far, most of the work on valuing household production time has been done using the market replacement cost approach (Zick & Bryant, 1983). As its name implies, the market replacement cost approach measures the value of home production time in terms of how much it would cost the household to replace the home labor in the market (Rosen, 1974). Basically, there exist two variants of the market replacement cost approach. One variant, the "equivalent housekeeper" method, takes the net (i.e. after-tax) hourly market wage of a typical hired housekeeper who supposedly provides for a *similar* package of household tasks to derive the value of time the unpaid homemaker spends in home production activities (Chiswick, 1982). A more popular variant of the market replacement cost approach, the "individual function costs" method, breaks down household production into specific tasks and assigns to each of them the appropriate hourly wage, net of taxes, that would have to be paid by the household in order to hire market workers to carry out each of these particular home tasks (Gauger & Walker, 1980; Hawrylyshyn, 1976; Peskin, 1983). Thus, while the first variant of the market replacement cost approach equates the hourly value of time of the homemaker to the net wage rate of a typical hired housekeeper, the second variant equates the homemaker's hourly value of time to a net wage representing the weighted average cost of hiring market workers for each separate and particular home task.

Limitations of the Market Replacement Cost Approach

Although the market replacement cost, and more specifically, the individual function costs variant, represents the approach that has been most often used in studies attempting to assess the monetary value of home production time, several serious limitations inherent in this approach have been pointed out over the years (see Bryant et al., 1992; Chiswick, 1982; Ferber & Birnbaum, 1980; Hefferan, 1982; Murphy, 1978; 1982; Peskin, 1983; Zick & Bryant, 1983; 1990).

First, the simple fact that no specific theory of household behavior underlies the market replacement cost approach makes it theoretically unfounded when researchers are interested in assessing a homemaker's value of time from her/his household's perspective. Indeed, for this approach to be sound, it is necessary to postulate that households are totally indifferent between producing commodities (i.e. goods and services) at home and purchasing their market alternatives. However, the fact that households still perform a wide range of tasks in the home, rather than delegating them to the market sector, suggests that they are not indifferent between the two modes of production. More precisely, this suggests that many households perceive they can produce certain commodities themselves either at lower costs than what the market alternatives offer, and/or the market alternatives are just "imperfect" substitutes (Becker, 1981) of the commodities usually produced in the home. Moreover, according to the home production activity model developed by Beutler and Owen (1980), certain production activities might simply be "*inseparable*" from the home inasmuch as the integrity of the processes and the setting around which these productive activities take place might convey by themselves the very essence that gives rise to utility. This is to say that households often resist delegating their productive tasks to the market sector because they perceive that the "*time utility*" normally gathered through the productive processes would be lost if they were left only with the market output per se. Accordingly, those home-produced commodities from which household members' satisfaction is derived mainly through the production processes could be difficult or even impossible to duplicate via the market sector. As a consequence, the market alternatives may not offer any viable substitute at all for many of the usual commodities households voluntarily elect to produce at home.

Second, the market replacement approach completely ignores the critical managerial components of home production inasmuch as, although the household with the necessary economic resources could presumably find and hire satisfactory market replacements for some of the time its members spend producing in the home, the management function of home production has still to be performed effectively. For example, market "substitutes" have to be hired and supervised, budgeting has to be done, decisions regarding what, when, and how to produce have to be suitably taken, and so on.

Third, many homemaking activities are either performed simultaneously or result in joint products. Obviously, very few homemakers place the laundry in the washing machine and just wait for it to move through the whole series of cycles. Similarly, the cooking of that tasteful Thanksgiving's or Christmas's turkey hardly portrays the idea of a homemaker standing by the oven patiently contemplating the sacred bird. In fact, most homemakers engage in two, three, or even more productive activities simultaneously, and that especially in households where childcare is a constant responsibility which accompanies all other household activities. Consequently, when people are asked to report the time they spend in household production—be it either by the recall or time diary method—to which of the many productive activities performed simultaneously do they assign their time? Further, even when individuals are able to provide highly meticulous accounts for their home production time, how do researchers weight the relative importance of each (simultaneous) task? Indeed, the way these questions are handled directly influences the value placed on home production time. For example, given that researchers tend to use the most popular variant of the market replacement cost approach—the individual function costs method—to value home production time, if standby care of children (or any other care-dependent household members) is measured and subsequently valued in addition to the other household work performed during the period of care, estimates of the value of home production time would be much higher than if only primary home production activities were measured and valued. Yet, if only primary home production activities were included, the derived value of home production time may represent an underestimate of its true value. In the same order of ideas, home production activities that have joint products also pose important problems to the market replacement cost methodology. For instance, a homemaker may prepare a meal with the help of a child and, obviously, the final product of this productive process may not only be the meal itself, but also the training of the child in food preparation and healthy nutrition. While measurement of joint production may not be of direct concern to time-allocation researchers, it may however greatly distort the time-use patterns of certain households and reduce the meaningfulness of time as a measure of homemaking. Hence, homemakers who maximize their efficiency through joint production may appear to do less household work than those who do not use this means of production. Thus, the empirical hardship faced by researchers in dealing with both simultaneous and joint household production renders the market replacement cost approach to valuing home production time hardly applicable, particularly when the individual function costs variant of it is used. This is so because the measurement of time spent in household production activities as the basis for valuing homemaking may lead to an *overestimation* of its economic worth in inefficient households and to an *underestimation* of its value in efficient ones.

Finally, and perhaps most importantly, the market replacement cost concept is totally silent regarding any potential differential in utility value derived by household members engaging in home work. This comes from the fact that this approach takes the hourly market wage of a typical housekeeper (i.e. the equivalent housekeeper variant), or a wage representing the average cost for hiring market replacements for each different household task (i.e. the individual function costs variant), to be the *universal* value of home production time for any individual engaging in such household production activities. However, it seems more than plausible that individuals do not enjoy all household tasks equally nor that all households derive the same amount of satisfaction from similar commodities produced at home. For example, taking the average wage of childcare workers as representing a homemaker's monetary value of time when she/he engages in childcare could simply underestimate the true value of this time if the homemaker derived a large amount of utility performing the necessary childcare. Conversely, homemakers who get little utility, or even disutility producing childcare services may perceive the wage rate of the market replacement (i.e. the childcare worker) as an overestimate of the true economic value of their time when performing this particular household duty. More formally, it suffices to recall and agree with the rationale underlying the theory of compensating differences in the paid market sector (Rosen, 1986) to realize how this theory may actually also apply to the non-market, home production, sector. Clearly, recognizing that the equilibrium value of time to the utility-maximizing individual (or household) needs not to be the same as the value society—via the market mechanism—places on that time poses serious conceptual problems to researchers who opt to use the market replacement cost approach to value home production time from a homemaker's or household's perspective.

Thus, it is clear that, taken together, the important conceptual and practical limitations of the market replacement cost methodology render this approach useless when the analytical effort is geared toward the purpose of valuing the overall economic contribution of home production time to the well-being of families, or examining the antecedents of household time-allocation behavior. At best, it can easily be argued that the market replacement cost methodology may be more appropriate for the purpose of adding the value of home production to national accounts. Besides, since the GNP is first and foremost a measure of economic output as valued from a societal (i.e. market) perspective rather than being a welfare indicator for a particular society, it is natural that this approach is more promising for the purpose of national product accounting. Legitimately, the market replacement cost approach is preferred by many macro-economists interested in adding production-oriented measures of household work to national accounts (for instance, see Eisner, 1978; Kendrick, 1979; Murphy, 1982).

The Opportunity Cost of Time Approach

The most frequently proposed alternative to the market replacement cost approach to value household production time is the opportunity cost of time approach (Zick & Bryant, 1983). The basic premise of this approach flows directly out of Becker's allocation of time theory (1965) and is solidly rooted in the neoclassical economic theory. A simple but suitable model of this allocation of time theory for the case of a single-individual household assumes that during any time period under analysis, say a typical day, the individual derives utility (i.e. satisfaction) from three competing composite commodities: goods and services purchased in the market, called *market commodities* and denoted by C; goods and services produced at home and consumed by the individual, called *home-produced commodities* and denoted by Z; and *leisure-oriented activities*, denoted by L. Algebraically, the individual's preferences vis-à-vis these three competing and utility-increasing composite commodities can be expressed via the following utility function:

$$U = u(C, Z, L). \qquad (2.1)$$

Although these preferences could be illustrated geometrically on a three-dimensional graph with C, Z, and L measured along the three axes, such a graph would be quite arduous to draw and, most importantly, to comprehend. Inasmuch as graphs are generally utilized to facilitate understanding, a very practical simplification is to assume that the individual regards market-purchased commodities (C) and home-produced commodities (Z) as perfect substitutes[1], and thus reformulate the utility function as

$$U = u(C + Z, L). \tag{2.2}$$

Hence, the complex three-dimensional diagram of the individual's preferences one would normally obtain with (2.1) collapses into two dimensions when the utility function is simplified and expressed as in (2.2), that is, with one dimension representing commodities (i.e. C+Z), and the other representing leisure time, L.

Further, this simple model of the allocation of time theory assumes that the individual maximizes her/his utility [i.e. equation (2.2)] subject to her/his time-endowment constraint, available home technology, and income constraint. For instance, if one denotes paid market work by M, household work by H, leisure-oriented activities by L, and the total endowment of time available within the specific period under analysis by T, then the time constraint may be simply written as

$$T = H + M + L\ . \tag{2.3}$$

---

[1] Although this assumption of perfect substitutability between market-purchased and home-produced commodities is patently false, its falsity bears very little impact on the conclusions that may be drawn from this simple model. More specifically, that is, so long as one keeps this simplifying assumption firmly in mind, she/he may adjust her/his conclusions by relaxing this assumption of perfect substitutability between C and Z commodities.

Indeed, not only is the individual physically bound by the time constraint, she/he is also bound by the technology of her/his household production function. Because home commodities such as cooked and served meals; clean and pressed clothes; clean and maintained houses, lawns, cars and other durables; clean, fed, healthy, and developing children, are 'produced' by combining the individual's labor in specific ways with other inputs (i.e. market-purchased commodities that are used, in turn, as inputs into home production processes), it is clear that the home production function specifies the technological constraint involved in these productive processes. Letting the quantity of market inputs that the individual combines with her/his home time to produce household commodities be represented by X, the home production function may be expressed algebraically as

$$Z = z(H; X). \tag{2.4}$$

This home production function simply describes the fact that given the individual (or household) has a *fixed* quantity X of market inputs on hand, if H hours of labor are devoted to home production activities per day, Z units of home commodities will be produced. The semicolon separating H from X in equation (2.4) just indicates that the typical individual (or household) may alter the amount of time (i.e. labor) allocated to home production, H, but not the quantity of market inputs, X, with which household labor is combined to produce the home commodities, Z. Therefore, the focus is directly put on the individual's (household's) time allocation decisions and not on her/his decisions about the quantity of market inputs to demand. Here the easiest way to think about the fixed quantity of market inputs, X, is to link it with the home technology available to the individual (or household)—that is, the array of appliances, equipment, and housing characteristics—which, unquestionably, tends to be relatively fixed for any typical individual or household in the short run[2]. A typical home production function is illustrated in Figure 2.1.

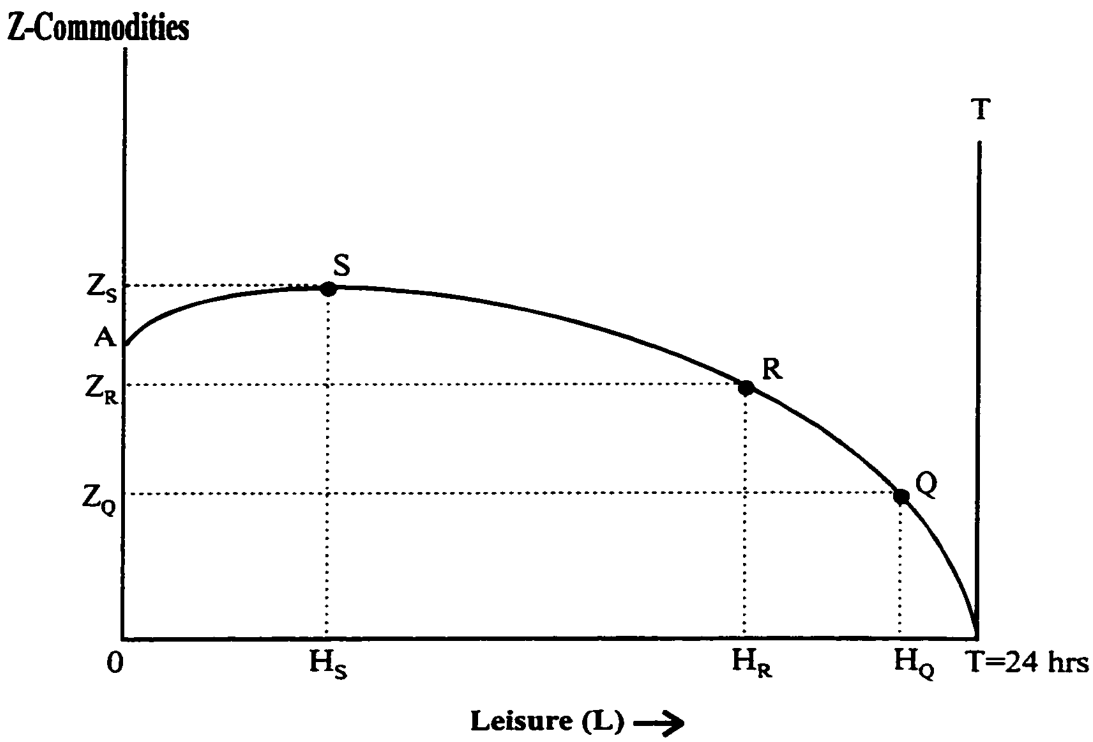

Figure 2.1 The Typical Home Production Function: $Z = z(H; X)$

The horizontal axis of Figure 2.1 represents hours per day. Measuring from left to right along the horizontal axis are hours per day of leisure, L. The vertical line TT depicts the reality that no more than 24 hours per day are available for any activity (i.e. TT simply

[2] That market inputs, X, are considered fixed in the short run does not imply that potential differentials in home technology across households or individuals under analysis are ruled out from the model.

represents the time-endowment constraint faced by the individual). Measuring from right to left along the horizontal axis beginning at T are hours per day devoted to home production activities, H. The vertical axis shows quantity levels of home commodities (i.e. Z-commodities) produced by the individual as more and more hours per day are devoted to household production activities. Hence, line TA represents the home production function of a typical individual (or household). Clearly, if TH_Q hours per day are devoted to household work, then a quantity $0Z_Q$ of home commodities is produced per day. If more time is spent, say TH_R hours per day, then more commodities, $0Z_R$, are produced. Note that the slope of the home production function, TA, is positive (i.e. $\partial Z/\partial H > 0$, or simply $Z_H > 0$) until point S is reached—reading the graph from right to left—being steeper for few hours spent and shallower as more and more time per day is devoted to household production activities. After point S the home production function becomes negatively sloped (i.e. $Z_H < 0$). That it becomes negatively sloped after point S indicates that the rational person would never be observed allocating more time than TH_S hours per day to household production activities, since doing so would simply deplete the stock of previously produced home commodities. As such, hours of household work beyond point S would be detrimental to the individual (or to her/his household).

The fact that the home production function (i.e. line TA) is drawn as a line concave to the hours axis simply represents Turgot's principle of *diminishing marginal productivity*[3]

[3] The law of variable proportions, commonly referred to as the principle of diminishing marginal productivity, was first articulated in 1767 by Turgot, a French physiocratic economist who served as Louis XVI's Controller General of Finances, Trades, and Public Works for a year until dismissed in 1776 for enacting free-market reforms against the wishes of the King. Although Turgot applied the principle strictly to physical capital, he realized that it holds for any variable input including labor.

(and hence, diminishing marginal returns to the individual) of home labor. More particularly, this principle states that when the time input (i.e. labor) in a production process is increased, holding all other inputs (i.e. X) constant, the marginal product of that time input declines. That is, as more home production time is used, *ceteris paribus*, the input's productivity decreases. Thus, the more time that is devoted to home production, the less productive—and hence valuable to the individual (or household)—yet another hour will be. Algebraically, this principle comes to say that, within its *productive range* (i.e. the TS segment of the home production function), the typical home production function must obey the two following simple conditions:

$$\frac{\partial Z(H;X)}{\partial H} \equiv Z_H > 0 \qquad \text{and} \qquad \frac{\partial^2 Z(H;X)}{\partial H^2} \equiv Z_{HH} < 0.$$

In practice, the principle of diminishing marginal productivity of home production time (i.e. $Z_{HH} < 0$) may be seen as resulting from the natural phenomenon of fatigue. That is, as more and more hours are continuously allocated to the process of homemaking, the individual becomes increasingly tired and, consequently, it follows that less and less valuable outputs (i.e. home commodities) are produced at the margin. Moreover, after a certain lengthy period of time has been devoted to the production of home commodities, the individual may become so exhausted that further hours of household labor may, under some circumstances, even destroy previously produced outputs. Indeed, in Figure 2.1, this situation is depicted by the SA segment of the home production function where, after point S, $Z_H < 0$ and $Z_{HH} > 0$.

Still another important constraint which is considered by the typical individual (or household) who seeks to fully optimize her/his allocation of time so as to maximize utility is the income constraint, or more precisely, the *full income constraint* (Becker, 1965). For the individual, disposable daily money income—defined as Y dollars—is made of after-tax earnings and/or net profits from paid market work, E, and real unearned (i.e. nonlabor) income, V. Algebraically, that is,

$$Y = E + V. \tag{2.5}$$

Unearned income, V, includes such things as rent received from real estate property, interest on savings, dividends and capital appreciation from stocks, monetary gifts received, alimonies, cash benefits received from welfare and/or social security programs, etc.; that is, any income that is not earned directly through either paid market employment or self-employment.

Since this simple model assumes expenditures to exhaust disposable income, if the individual's (or household's) expenditures on market goods and services are represented by pC—where p is the price index of those market-purchased commodities, C, which could be normalized to equal one—then

$$pC = Y = E + V. \tag{2.6}$$

Recognizing that earnings depend on how much time is allocated per day to paid market work, if the individual can command a real (i.e. after-tax) hourly wage of \$w, then *net* daily earnings are just

$$E = wM\,. \tag{2.7}$$

Substituting equation (2.7) into (2.6) yields

$$pC = wM + V\,. \tag{2.8}$$

Making use of the individual's time constraint described in equation (2.3), one may substitute the latter into equation (2.8) to get the income constraint that follows:

$$wT + V = pC + wH + wL\,. \tag{2.9}$$

While the left-hand side of equation (2.9) represents the *full income* available to the individual, and thus denotes the maximum income she/he could have if she/he worked *every* available hour of the day (i.e. T) in the labor market at the real hourly wage \$w, the expression on the right-hand side shows how this full income is spent: pC on purchased commodities, wH on home-produced commodities, and wL on leisure-oriented activities.

With the constraints identified above on hand, the typical individual's (or household's) problem is to allocate her/his scarce time in such a way that the maximum amount of utility is achieved. Algebraically, this problem is as follows:

$$\underset{C+Z,\ L}{\mathrm{MAX}} \quad U = u\big[C + z(H;X), L\big] \quad \text{s.t.} \quad wT + V = pC + wH + wL\,. \tag{2.10}$$

Setting the lagrangean function, $\mathcal{L}$, for this utility maximization problem, one gets

$$\mathcal{L}(C+Z, L, \lambda) = u\big[C + z(H;X), L\big] + \lambda\big[wT + V - pC - wH - wL\big]\,. \tag{2.11}$$

The first order conditions necessary for utility maximization are simply

$$U_C - \lambda p = 0 \qquad (2.12)$$

$$U_Z \cdot Z_H - \lambda w = 0 \qquad (2.13)$$

$$U_L - \lambda w = 0 \qquad (2.14)$$

and $$wT + V - pC - wH - wL = 0\,, \qquad (2.15)$$

where U_C and U_Z are equivalent under the simplifying assumption of perfect substitutability between C and Z, and represent the marginal utility of commodities (i.e. either market-purchased or home-produced commodities) ;

U_L is the marginal utility of leisure time ;

Z_H is the marginal product (i.e. value) of home production time ;

and λ is the lagrangean multiplier, which equals the marginal utility of income .

Solving (2.13) and (2.14) each for λw and equating yields

$$MRS_{LZ} \equiv U_L/U_Z \equiv U_L/U_C \equiv \mathbf{MRS_{LC} = Z_H} \qquad (2.16)$$

which states that, in equilibrium, the marginal rate of substitution of leisure time for commodities (MRS_{LC}) is equal to the marginal product of home production time (Z_H).

Similarly, solving (2.12) and (2.13) for λ and equating yields

$$Z_H = w/p \qquad (2.17)$$

which states that, if the price index of market commodities (p) is normalized to unity, the marginal product of home production time (Z_H) is equal to the real, after-tax, hourly market wage (w) in equilibrium.

Thus, from (2.16) and (2.17) comes the equilibrium condition

$$MRS_{LC} = Z_H = w/p \; (\equiv w) \tag{2.18}$$

for the individual participating in the paid labor market. Further, the equilibrium condition for the person voluntarily nonemployed in the labor market can be written as

$$MRS_{LC} = Z_H > w/p \; (> w) \,, \tag{2.19}$$

and the equilibrium condition for the person who is voluntarily not working at home is just

$$MRS_{LC} = w/p \; (\equiv w) > Z_H \,. \tag{2.20}$$

Here it is important to note that, since the typical individual always engages in some home production—even if it is just showering, dressing, and brushing her/his teeth each morning before going to work—the last equilibrium condition depicted in (2.20) is hardly observable in practice. For this reason, the latter state of equilibrium is ruled out of any further discussion.

Indeed, the typical equilibrium conditions (2.18) and (2.19) algebraically derived from the simple household work - market work - leisure model presented so far may be effectively illustrated with the help of two-dimensional diagrams. Accordingly, Figure 2.2 depicts geometrically the two typical equilibrium conditions algebraically derived above.

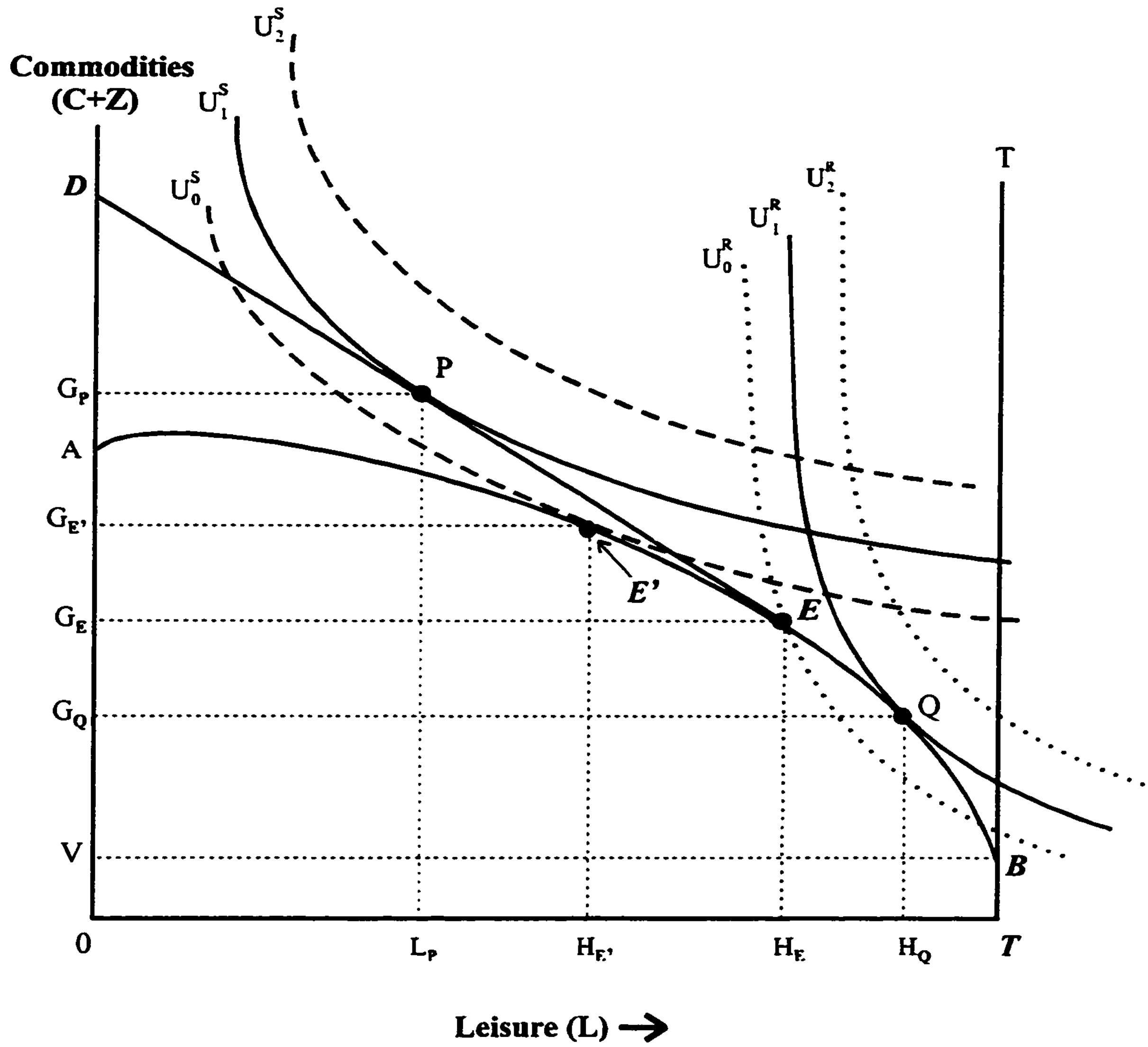

Figure 2.2 Two Typical Equilibrium Positions

Figure 2.2 illustrates the optimal time-allocation behavior of two individuals given their preference maps[4] and their total budget lines. Although these two individuals are shown to have different preferences, both happen to face the same total budget line. More precisely, individuals R and S face the same budget line, *TBED*. Individual S's

[4] Preferences are assumed to be well-behaved (i.e. monotonic and convex) and homothetic for this graphical analysis.

preferences are represented by the indifference curves U^S_0, U^S_1, and U^S_2, while individual R's preferences are depicted by indifference curves U^R_0, U^R_1, and U^R_2. Notice that the preferences of these two individuals are between commodities (C+Z) and leisure (L), in accordance with the simplifying assumption that market-purchased commodities (C) and home-produced commodities (Z) are regarded as perfect substitutes for each other, and that market work (M) and household work (H) yield satisfaction (i.e. utility) only through the commodities produced at home and/or purchased via paid market production.

Recognize also that the so-called "total" budget line, *TBED*, is made up of three distinct segments. Segment *TB* represents how much real unearned income, V, is available to the individual under analysis. Segment *BE* of the total budget line represents the portion of the household production function for which the marginal product (or value) of home production time, Z_H, is greater than or equal to the real offered market wage, w. Finally, segment *ED* simply represents the potential market work portion and, consequently, has a slope equal to the real hourly market wage.

From Figure 2.2, it is shown that individual R maximizes her satisfaction at the equilibrium point Q, where her highest attainable indifference curve, U^R_1, touches her total budget line, *TBED*. At point Q, individual R's marginal rate of substitution of leisure time for commodities equals her marginal productivity in household work activities. Therefore, for individual R at the equilibrium point Q, it is seen that $MRS_{LC}|_Q \equiv (U_L/U_Z)|_Q = Z_H|_Q$. That is, at the equilibrium point Q, the rate at which person R is willing to trade leisure time for commodities is exactly equal to the rate at which she *can* *exchange* leisure for commodities by engaging in household production activities. Consequently, individual R spends $0H_Q$ hours of leisure per typical day, and consumes $0G_Q$ quantity of goods and services per day. She also spends TH_Q hours per day in home production activities in which she produces VG_Q units of household commodities. In addition, she purchases 0V quantity of goods and services in the market with her daily unearned income.

Therefore, in equilibrium, individual R is voluntarily nonemployed. She is voluntarily nonemployed because, in equilibrium, the marginal product (i.e. value) of her home production time exceeds the real hourly wage she can potentially command in the paid labor market. That is, $Z_H > w/p$ at point Q. The real wage rate she can command in the labor market is represented by the slope of the line segment *ED*, which is w/p (or simply w if the price index p is normalized to unity). The slope of *BE* at point Q is $Z_H|_Q$ and is greater than at point *E*, where it equals the slope of *ED* (i.e. w/p). Further, that individual R prefers to do no market work at all is evident from Figure 2.2 since the slope of her indifference curve U^R_0 through point *E*—the point at which it would be efficient for her to cease any additional household production and work the first hour in the paid labor market instead—is greater than the slope of *ED*. That it has greater slope than w/p indicates that the price she is willing to pay for an added hour of leisure at *E* is greater than what she must actually pay. As a normal consequence, she takes more than $0H_E$ hours of leisure by sacrificing G_QG_E units of commodities and allocating TH_Q hours per day, rather than TH_E hours, to household production. For her to enter the paid labor market at all, the real offered hourly wage would have to be *at least* equal to the slope of her equilibrium indifference curve, U^R_1, at point Q. Conceptually speaking, the slope of this equilibrium indifference curve at point Q represents individual R's *shadow price of time* in non-market activities such as leisure and home production. Further, because this shadow price of time in home activities is valued at *full non-market time* (i.e. at zero hours of paid market work), it is conceptually referred to as individual R's *reservation wage*[5], and it simply reflects the *lowest* real wage the labor market would have to offer individual R—a typical nonemployed person—in order to make her totally indifferent between entering the labor force for a first hour of paid work and allocating her last hour to non-market activities. Here it is of critical importance to emphasize that the slope of this equilibrium indifference curve, U^R_1, at point Q coincides with the slope of the home production function at this particular point, and the latter slope turns out to represent the *marginal* value of household production time to individual R at *full non-market time* (i.e. at zero hours of market work)—that is, the economic value individual R, *herself*, places on her very last hour of household labor, H_Q, or, more specifically, her reservation wage.

Therefore, from Figure 2.2, it is found that the utility-maximizing equilibrium condition for individual R—a voluntarily nonemployed person (i.e. a typical full-time homemaker)—is just $MRS_{LC}|_Q \equiv (U_L/U_Z)|_Q = Z_H|_Q > w$, which is indeed fully consistent with the equilibrium condition previously found through the algebraic derivation of equation (2.19). Also, notice carefully that, in addition to its capacity of graphically reproducing the equilibrium condition found in equation (2.19), Figure 2.2 permits the

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[5] This concept goes back at least as far as Mincer, "Market Prices, Opportunity Costs, and Income Effects." In C. Christ (ed.). ***Measurement in Economics***, Stanford, California: Stanford University Press, 1963.

establishment of a very important corollary which characterizes the typical voluntarily nonemployed individual. This important corollary can be adequately summarized in the following simple and clarifying inequality: $MRS_{LC}|_Q = Z_H|_Q = r|_Q > w$, where 'r' represents the reservation wage of the nonemployed individual at a typical equilibrium position such as point Q.

From this inequality, it appears that, for the person who voluntarily elects not to participate in the paid labor market, it must be the case that her/his reservation wage is greater than the real hourly wage she/he can potentially command in the paid labor market (i.e. $r > w$). On one hand, the real wage rate she/he can secure in the labor market reflects the *opportunity cost of non-market time* to this nonemployed person (i.e. the cost of devoting time to non-market activities such as leisure and home production activities) which, unquestionably, is set by the labor market mechanism. On the other hand, while the shadow price of home time represents the *opportunity cost of market time* (i.e. the cost of spending time in paid market work), the reservation wage—being the shadow price of home time at full non-market time—conceptually denotes the *opportunity cost of labor market entry* (i.e. the cost of extending a very first hour to the paid labor force) to this nonemployed individual, and is directly conditioned by the individual's preferences between leisure and commodities, which latter also coincides with the economic value the typical nonemployed individual generates from her/his last hour of home labor at her/his equilibrium time allocation position (i.e. $MRS_{LC}|_Q = Z_H|_Q = r|_Q$). With this crucial distinction in mind, it becomes evident that, for the typical nonemployed person, the reservation wage must be a concept of choice when it comes to assess the economic value of home production time from this individual's perspective. This is so because the equilibrium allocation of time characterizing the nonemployed individual depicts a situation where the opportunity cost of labor market entry (i.e. r) simply outweighs the opportunity cost of non-market time (i.e. w), and the former is shown to coincide exactly with the marginal value of household production time to this individual.

Now, consider individual S who is satisfactorily employed in the paid labor market. Figure 2.2 shows that she maximizes utility at the equilibrium point P, where she consumes a total of $0G_P$ quantity of commodities (market-purchased and home-produced goods and services) and $0L_P$ hours of leisure per typical day. Individual S spends TL_P hours per day working—TH_E of them in the home and H_EL_P in the paid labor market. The $0G_P$ quantity of commodities she typically consumes each day is composed of 0V goods and services purchased in the market with her real daily unearned (i.e. nonlabor) income, VG_E home-produced commodities, and G_EG_P market goods and services purchased with her after-tax earnings from paid employment. For individual S at the equilibrium point P, it is found that $MRS_{LC}|_P \equiv (U_L/U_Z)|_P = Z_H|_E = w$, which is indeed consistent with the equilibrium condition previously derived and contained in equation (2.18). That is, individual S's marginal rate of substitution of leisure for commodities at the equilibrium point P (i.e. the slope of indifference curve $U^S{}_1$ at point P) equals the real hourly wage she is currently facing (i.e. the slope of *ED*), which also equals the *marginal* product of her home labor (i.e. the slope of *BE* at point *E*). Thus, in equilibrium, the rate at which individual S is *willing* to trade her last hour of leisure for commodities coincides exactly with the rates at which she is currently *able* to exchange this last hour of leisure for commodities (i.e. w via the labor and purchased-good markets, and $Z_H|_E$ via home production). In other words, at the equilibrium point P, individual S's shadow price for her last hour of household production, H_E, is simply given by $(U_L/U_Z)|_P$ (i.e. the slope of her highest attainable indifference curve, $U^S{}_1$, at point P), which also corresponds with the value of the real market wage she is facing in the labor market (i.e. w). Conversely to the case of the voluntarily nonemployed individual, this shadow price of individual S's last hour of household work does not represent her reservation wage, however. More precisely, because reservation wages can only be valued at *full non-market time* (i.e. at zero hours of market work), this shadow price must simply represent the economic value individual S places on her very last hour of household production, H_E, *after having allocated H_EL_P hours per day in the paid labor market*. Indeed, at the equilibrium point P, person S is left with only $0T - H_EL_P$ hours per typical day to allocate between leisure and home production activities. That fewer hours per day are left to her for non-market activities such as leisure and home production after having spent H_EL_P hours in paid employment must necessarily increase the marginal value individual S places on her time in both leisure and household production activities. As a normal consequence, one would expect individual S's reservation wage to be relatively lower than the shadow price of home time given by the slope of indifference curve $U^S{}_1$ at equilibrium point P.

In fact, under the assumption of well-behaved and homothetic preferences, individual S's reservation wage is given by the slope of indifference curve $U^S{}_0$ at point *E'* where, in absence of market work, her last hour of home production would be represented by $H_{E'}$.

rather than H_E. Although point *E'* does not portray individual S's current time-allocation equilibrium behavior, it accurately depicts what *would be* her time-allocation equilibrium behavior *at full non-market time*. Specifically, at point *E'*, person S would be spending $TH_{E'}$ hours per day in home production, $0H_{E'}$ hours in leisure-oriented activities, and no hours in paid market work. Note that at full non-market time individual S would not only devote more hours per day in leisure, but also more hours in household production activities. At point *E'*, individual S's marginal rate of substitution of leisure for commodities (i.e. the slope of $U^S{}_0$ through point *E'*) would exactly coincide with the economic value individual S places on *what would be* her last hour of home production time, $H_{E'}$, at full home time. Indeed, to be indifferent between working this last hour at home and *entering* the market for a first hour of paid work, individual S would have to be compensated by a real hourly wage at least equal to the slope of her indifference curve $U^S{}_0$ at point *E'*. As such, this *lowest* real market wage that would have to be offered to person S to make her indifferent between entering the market for a very first hour of paid work and working her last hour in the home rightfully denotes individual S's reservation wage.

Comparing individual S's time allocation position at full non-market time (i.e. at point *E'* where M=0)—the time allocation position utilized to graphically illustrate her reservation wage—with her current utility-maximizing position located at equilibrium point P, one notes that $MRS_{LC}|_{E'} \equiv (U_L/U_Z)|_{E'} = Z_H|_{E'} = r < MRS_{LC}|_P \equiv (U_L/U_Z)|_P = Z_H|_E = w$, where 'r', as before, simply represents individual S's reservation wage evaluated at full home time as its conceptual nature requires. That is, *at full non-market time*, individual S's marginal rate of substitution of leisure for commodities coincides with the marginal value of her last hour of household labor which, in turn, equals her reservation wage, but is less than her equilibrium marginal rate of substitution of leisure for commodities *after she has allocated $H_E L_P$ hours of her scarce time in the paid labor market*, which latter corresponds with the marginal value of her currently observed last hour of home labor and her current real hourly market wage. Indeed, this simple contrast conveys crucial conceptual implications for time allocation researchers interested in assessing the true economic value of household production time from the individual's perspective. It not only illustrates how individuals who choose to participate in the paid labor market make their decision, but it also permits to establish a clear distinction between what truly defines the reservation wage of a typical market worker versus what is often mistakenly considered by researchers as being the reservation wage of such a market worker[6]. For instance, the inequality formulated above reflects the fact that for any typical employed individual—such as person S in Figure 2.2—the real offered market wage must *always* be greater than the individual's reservation wage (i.e. $M > 0$ if and only if $w > r$). Further, it is seen that, for the typical worker—and as it is necessarily the case for the typical nonemployed person—the reservation wage can only be derived at full non-market time (i.e. at $M=0$) inasmuch as it conceptually denotes the shadow price required by the individual for *labor market entry* given her/his particular preferences between commodities and leisure, which, unquestionably, is very different from the shadow price

[6] As a single example, see Zick & Bryant (1983), p.137, third paragraph, to realize how the market wage of the typical worker, which market wage necessarily corresponds to the shadow price of the last hour of home time *after* a certain amount of time has been allocated by the individual to the paid market sector, could easily be mistaken for the individual's reservation wage.

of an extra hour of paid market work once the equilibrium hours-of-work decision has taken place.

As was established earlier in the discussion of the case of the voluntarily nonemployed person, the real market wage the employed individual commands in the labor force mirrors the *opportunity cost of non-market time* to this employed person (i.e. the cost of allocating time to leisure and home production activities), which, undoubtedly, is fixed through the labor market mechanism. Conversely, the reservation wage represents the *opportunity cost of labor market entry* to this employed person (i.e. the opportunity cost of extending a very first hour to the market), and is strictly relevant of the individual's preferences between leisure and commodities, which latter concurs with the value of the commodities the typical employed person would generate from her/his last hour of home labor *at a full non-market time allocation position* (i.e. $MRS_{LC}|_{E^{\cdot}} = Z_H|_{E^{\cdot}} = r$).

With the reiteration of this important distinction, it should be clear that the reservation wage of a typical employed individual is different from her/his real offered market wage. In fact, to the employed person the decision to participate in the paid labor market must necessarily portray a situation in which the real offered market wage is greater than the reservation wage (i.e. $w > r$), or else, if it were less (i.e. if $w < r$), the rational person would simply refuse to enter the labor market and hence, would not be employed. Unfortunately, it seems that a clear understanding of this basic, but so critical distinction between the nature of reservation and market wages is something that many of today's home and family economists have yet to perfect. Blindly equating the real offered market wage of the employed individual to her/his reservation wage represents a very naive transgression of the fundamental economic rudiments upon which is orchestrated the allocation of time theory[7]. Indeed, although to the employed person the offered market wage does actually correspond to the shadow price of her/his last *observed* hour of household production *at her/his current working equilibrium*, since this shadow price of home time is not valued at full home time (i.e. at zero hours of market work) it cannot rationally denote the lowest real wage necessary to draw the individual *at her/his non-working equilibrium* into the labor force or, more precisely, her/his reservation wage. The case of individual S in Figure 2.2, a typical employed person, could not be more illustrative of this last assertion.

Clearly, Figure 2.2 delineates the utility-maximizing equilibrium allocation of time among household production, paid market work, and leisure activities for the individual being analyzed[8]. The individual's preferences between leisure and commodities, her/his productivity in household work, and the real (i.e. after-tax) hourly wage she/he can

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[7] Given the nature of the reservation wage concept, it follows that the only instance in which the market wage could possibly equal the reservation wage is when the former makes the individual totally indifferent between trading her/his last hour of home time for a first hour of market work. Only if this occurs then the market wage would exactly coincide with the reservation wage (i.e. $w = r$); however, it should be clear that, under these circumstances, the individual would not be observed participating in the paid labor force.

[8] Although the simple model presented has been interpreted as a single-individual's time allocation model, it may easily be extended to the analysis of multiple-individual households. For example, it may be defined to represent the time-allocation behavior of either spouse in families in which both may be employed in the market. If the latter interpretation is adopted, unearned income (V) could be made to include the earnings of the spouse whose time allocation is not under analysis; however, inasmuch as both cross-substitution and income effects are usually of interest in time allocation studies, it would be advisable to keep the household's unearned income separated from the spouse's earnings—or more precisely, from the spouse's hourly market wage. With few additional modifications, the model may also be extended to the analysis of both spouses taken together as a single unit of analysis. Hence, whatever the analytical unit of interest, it is clear that this simple model is capable of being interpreted in a much wider context than it has been thus far.

command in the labor market represent the driving forces which dictate this equilibrium allocation of time. On one hand, for the person who works in the paid labor market, in equilibrium, the value of her/his *last* hour of household production is simply equal to the value of the real market wage she/he commands which, in turn, coincides with her/his *willingness* to trade her/his last hour of leisure for commodities (i.e. $MRS_{LC} = Z_H = w$). Hence, in equilibrium, it follows that this person's shadow price for her/his last hour of home labor is exactly equal to the real hourly wage she/he commands in the paid labor market, given the particular number of hours already allocated to the labor force. However, as was demonstrated above, this shadow price for her/his last hour of household work must not be confused with the individual's reservation wage. In fact, for any individual supplying a positive, non-zero, number of hours to the labor market (i.e. for the person whose labor supply is $M > 0$), the reservation wage must necessarily be lower than the real market wage offered to this individual, otherwise she/he would be not be observed working in the market (i.e. $M = 0$ if $w \leq r$). Thus, while the algebraic derivation of the utility-maximizing equilibrium condition that portrays the satisfactorily employed individual [i.e. equation (2.18)] can equivalently be replicated through a graphical presentation, the beauty of the graphical approach is that it possesses the useful advantage of allowing for the introduction of an important concept in time allocation and valuation studies: the reservation wage concept. By bringing the reservation wage concept into focus it becomes possible to see an important reality which generally characterizes the typical employed individual. That is, for the working person at her/his time-allocation equilibrium point, although the marginal rate of substitution of leisure for commodities coincides with both the marginal value of home production time and the real wage faced by the individual, this marginal rate of substitution of leisure for commodities is always greater than the individual's reservation wage (i.e. $MRS_{LC} = Z_H = w > r$ for the working individual at her/his time-allocation equilibrium point). In other words, compared to the opportunity cost of the last observed hour of home time at a working equilibrium (i.e. w), the opportunity cost of the first hour of market time (i.e. r) is, at the margin, always less to the employed person. This is precisely why, in equilibrium, such an individual is observed participating in the labor market. Accordingly, that person S in Figure 2.2 is observed working in the market is not surprising given that the slope of her indifference curve U^S_0 through point *E'* (i.e. r) is much less than the slope of her budget line segment *ED* (i.e. w).

On the other hand, for the person who opts to fully specialize in home production activities—and thus does not participate in the paid labor force—in equilibrium, the value of her/his last hour of household labor coincides with her/his *willingness* to exchange leisure for goods and services, but not with the real wage rate she/he could possibly receive in the labor market (i.e. $MRS_{LC} = Z_H > w$). Consequently, in equilibrium, this person's reservation wage is simply equal to a higher real market wage that would make her/him indifferent between working the *last* hour at home and entering the labor market. Here an important peculiarity that typifies the voluntarily nonemployed individual (i.e. the full-time homemaker) emerges from the fact that, in equilibrium, the marginal rate of substitution of leisure for commodities coincides with both the marginal value of home production time and the reservation wage, but is greater than the real hourly wage such an individual can potentially secure in the market (i.e. $MRS_{LC} = Z_H = r > w$ for the voluntarily nonemployed person at her/his time-allocation equilibrium position). Stated differently, in equilibrium, the opportunity cost of the first hour of market time (i.e. r) is always greater than the opportunity cost of non-market time (i.e. w) to the voluntarily nonemployed individual, and this is why she/he chooses not to supply any time at all in the market. A unique exception to this rule arises when, at the margin, the opportunity cost of both non-market and market time are equal (i.e. $w = r$), indicating that, although the person is still 'nonemployed', she/he faces a situation of perfect indifference between trading her/his last hour of home time for a first hour of market work.

Thus, for any individual, the decision of working in the labor market or not really depends on the relationship existing between the opportunity cost of home time (i.e. the real offered market wage, w) and the opportunity cost of labor market entry (i.e. the reservation wage, r, which is simply the shadow price of household time at full home time) at the margin. For the person who chooses to be nonemployed, it must be the case that the real offered market wage is less than, or equal to, the individual's reservation wage (i.e. $w \leq r$). Conversely, for the person who chooses to be employed, the offered market wage must simply be greater than her/his reservation wage (i.e. $w > r$), and the magnitude of the discrepancy between market and reservation wages must necessarily dictate the particular amount of time ultimately allocated to the labor market.

At a conceptual level, the above contrast is extremely meaningful because it allows the analyst to recognize that the labor supply decision faced by any individual entails in fact two distinct decisions: the *participation decision* and the *hours-of-work decision*, both directly resulting from the divergence existing between the real offered market wage and the reservation wage. Specifically, the labor-force participation decision—also referred to as the "extensive margin" of the labor supply function (Heckman, 1993)—is shown to arise from a direct comparison between the individual's reservation wage and her/his offered market wage. On one hand, when the offered wage is less than, or equal to, her/his reservation wage, the individual chooses not to participate in the paid labor market (i.e. the person chooses to 'extend' no hours to the market), and the hours-of-work decision—also referred to as the "intensive margin" of the labor supply function (Heckman, 1993)—is automatically defined at zero hours of market work. On the other hand, when the real offered wage is greater than her/his reservation wage, the individual rationally chooses to participate in the paid labor force (i.e. the person chooses to 'extend' hours to the market), and her/his hours of market work (i.e. the "intensive margin" of her/his labor supply decision) are determined according to the magnitude of the discrepancy existing between her/his market and reservation wages.

The Determination of the Opportunity Cost of Household Production Time and the Missing Wage Problem for Full-time Homemakers

Simply put, proponents of the opportunity cost approach derive a monetary value for home production time by examining the value of the individual's alternative activities that are precluded by doing household work. Since this approach is based upon the conception that the cost of any choice made by the individual should be measured in terms of the value of the *best* (i.e. most valuable) *foregone activity*, the opportunity cost of time approach has become increasingly appealing to researchers desiring to gauge the monetary value of home production time from the individual's (or household's) perspective. Specifically, the crucial economic assumption underlying this approach is that, in equilibrium, household members *freely* allocate their time across market and non-market activities so as to equate their marginal productivity in each activity. Given that one possible use of time is paid market work, in equilibrium, the marginal value of an hour of household labor to the individual must be at least equal to the foregone return of an hour of paid market work. Hence, as a practical matter, the real hourly market wage—or, more precisely, the net hourly return to paid employment—is deemed to be the appropriate measure for the opportunity cost of home time (Cogan, 1980; Murphy, 1978; 1982; Zick & Bryant, 1983; 1990). Thus, provided the monetary value of someone's time in paid employment is known, one may easily determine the marginal value of her/his time in any non-market activities (i.e. home production or leisure activities)[9]. However, since market wages are only observed for individuals who participate in the labor force, a true empirical dilemma related to the opportunity cost methodology is how to value the time of household members who fully specialize in unpaid home activities, and thus for whom the monetary value of time in the labor market (i.e. the individual's opportunity cost of non-market time, w) is missing.

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[9] Once and for all, it should be clear that whether this marginal value represents the opportunity cost of leisure time or the opportunity cost of home production time is not a relevant issue here since the opportunity cost methodology originates from a rationale which acknowledges the fact that, in equilibrium, the marginal value of time to the individual is equal in all activities she/he is observed participating in. That is, for the voluntarily nonemployed individual, the value of her/his last hour of leisure is equal to the value of her/his last hour of household labor in equilibrium. Similarly, for the satisfactorily employed individual, the value of her/his last hour of leisure is equal to the value of her/his last hour of home work, which also equals the value of her/his net market wage.

Until the mid-1980s the usual practice in empirical work was to estimate market wage functions limited to samples of working individuals exclusively. The problem of a missing wage was alleviated if only those reporting hours in the paid labor market, and thus a wage rate, were included in the analysis. Indeed, in the light that women are generally those on whom fall most of the household chores[10], and since married women have traditionally been less likely—relative to married men—to engage in paid market work, this practice has been subject to much justified criticism. A different but still imperfect procedure was to impute a potential wage to nonemployed individuals from a market wage equation estimated on employed individuals with "similar" observable personal and demographic characteristics such as education, gender, work experience, age, race, area of residence, etc. (Ferber & Birnbaum, 1980; Ferber & Green, 1985; Murphy, 1978; 1982; Sirageldin, 1969). Again, this was necessary because of the missing data on the monetary value of time for individuals fully specialized in non-market activities (i.e. full-time homemakers).

It is now recognized that if one estimates a market wage equation using a sample of working individuals to derive the monetary of time for nonemployed individuals, bias results. This is so because the same set of variables that determine wages enter as a criterion for sample eligibility. As such, the estimated wage function then confounds the true wage function with the rules for inclusion in the sample (Gronau, 1974; Heckman, 1974; 1976; 1979; 1980; 1993; Olsen, 1980; Smith, 1980; Zick & Bryant, 1990).

[10] According to Bergen (1991) and Ferree (1991), women generally report performing over 70 percent of the total household work, even if they are employed in the market.

Specifically, the problem with such a wage imputation is that apparently similar individuals are not similar in reality simply by the fact that one chooses to work in the labor market and the other does not. Indeed, provided that employment status is a choice the individual makes, although certain information believed to affect an individual's labor-force participation decision may be readily available—and hence observable—other determining factors, unknown or simply unobservable by the analyst, are nevertheless often present (Ferber & Green, 1985; Gronau, 1974; Heckman, 1974; 1976; 1979; 1980; 1993). For instance, studies by Heckman (1980) and Hanoch (1980) indicate that ordinary least squares (OLS) imputed wages for nonemployed women overestimate the true wage offer for these women by as much as 20 percent, which is indeed a considerable bias. In contrast, Ferber & Birnbaum (1980) suggest that at best OLS imputed wages can only provide for lower-limit estimates of the true value nonemployed individuals place on their home production time.

As seen previously, in the neoclassical economic framework of time allocation the relevant opportunity cost of time for the voluntarily nonemployed person turns out to be the value she/he places on her/his *last* hour of home time. This marginal value of non-market time—rightfully referred to as the reservation wage—essentially represents the lowest real market wage which would make the full-time homemaker indifferent between extending a very first hour to the paid labor force and working the *last* hour at home. As such, and as was demonstrated earlier, the reservation wage of the nonemployed individual necessarily outweighs her/his potential real offered market wage. Notice that, from a purely conceptual point of view, it must be the case that the individual's reservation wage mirrors the marginal value of home production time from this person's perspective inasmuch as it implicitly captures the personal inclination to perform such activities—the latter presumably being conditioned by the utility, or disutility, associated with the accomplishment of the particular productive home tasks, and/or the outputs (i.e. home commodities) generated from them. Thus, from the two procedures succinctly described above it follows that, in general, reservation wages as true opportunity costs of time to nonemployed individuals have often been ignored or poorly estimated by imputed market wages. Fortunately, pioneering work by Mincer (1963), Gronau (1973 and 1974) and, more particularly, by Heckman (1974, 1976, 1977, 1979, and 1980) has led to substantial econometric advances on which rests the by now standard statistical procedure for estimating reservation wages of nonemployed individuals. The main merit of this procedure is that it allows researchers to avoid the bias associated with using imputed potential market wages for nonemployed persons—a bias commonly referred to as *sample selection bias*—and thus, provides for consistent parameter estimates (Heckman, 1974, 1976, 1977, 1979, and 1980).

The next two sections of this chapter shall present an overview of the general estimation model originally proposed by Heckman (1976)[11] and later used by home and family economists (for instance, see Bryant et al., 1992; Pappalardo, 1987; Puang & Metzen, 1993; Peck, 1983; Zick & Bryant, 1983; 1990) in order to derive the monetary value of home production time in line with the opportunity cost of time methodology.

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[11] Prior to the work of Heckman (1976), the vast majority of researchers relied on computationally costly and complicated maximum-likelihood estimators (MLE) to derive parameter estimates free of sample selection bias. [For a good exposition of how this was done, see Heckman (1974).]

A Standard Recurrent System of Equations to Derive the Monetary Value of Household Production Time

Heckman was one of the first to propose the use of a 'recurrent' system of equations to get at the reservation wage. In fact, under the assumption that individuals are *fully free* to choose their hours of paid market work, Heckman came to recognize that only two functions fully characterize the labor supply decisions faced by any individual. The first function of his original system specifies a market wage equation and the second is a *shadow price of non-market time* equation[12] which records the marginal value an individual places on her/his home time. Following the common practice in labor supply studies, both equations are expressed in semi-logarithm (i.e. log-lin) forms[13]. According to Chiswick (1970) and Mincer (1972), the log-lin specification for these two functions is theoretically sound because the transformation of the dependent variables to their natural logarithms offers the additional desirable feature that derived labor supply functions have an uncompensated substitution effect which varies depending on hours of work and wages. More precisely, the market wage and the shadow price of non-market time

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[12] Although most of the literature reviewed seems to consider this second equation as a reservation wage function, conceptually speaking it is clear that this latter can only provide the individual's reservation wage at zero hours of market work (i.e. at full non-market time). In fact, to be fully consistent with the definition of the reservation wage, this must be the case. Otherwise, this equation provides the marginal value of the time left to the individual for non-market activities such as leisure and household work after having worked $M_i > 0$ hours in the market. More precisely, when $M_i > 0$ the shadow price of an extra hour of market work should always be greater than the reservation wage. This is so because δ in equation (2.22) is expected to be positive (i.e. $\delta \equiv \partial \ln S_i / \partial M_i > 0$) given the commonly assumed normality of home time relative to market time. Recall that the earlier discussion of Figure 2.2 has led to the same important conclusion. Thus, to avoid any potential conceptual confusion, this second equation shall be strictly referred to as a *shadow price of non-market or home time* function rather than a reservation wage function. It is imperative that this critical distinction be made because it seems that much of the confusion encountered in the literature originates from a misunderstanding of the nature of this particular function.

[13] For a good exposition regarding the properties of the semilog (log-lin) specification, see Gujarati, 1988, pp. 147-150, 154).

equations may be written, respectively, as

$$\ln W_i = X_{Wi}\beta_W + U_{Wi} \tag{2.21}$$

$$\ln S_i = X_{Si}\beta_S + M_i\delta + U_{Si} \tag{2.22}$$

where

$\ln W_i$ = the natural logarithm of the net hourly market wage for individual i ;

X_{Wi} = a (1 x K_W) row vector of exogenous variables affecting the market productivity of individual i ;

β_W = a (K_W x 1) column vector of parameters corresponding to the regressors included in X_{Wi}, plus an intercept ;

U_{Wi} = the disturbance term for the market wage equation ;

$\ln S_i$ = the natural logarithm of the shadow price of home time for individual i at $M_i \geq 0$ hours of market work which, by definition, is the natural log of her/his ***reservation wage*** only when $M_i = 0$ hours of market work (i.e. at full non-market time) ;

X_{Si} = a (1 x K_S) row vector of exogenous variables affecting the home productivity of individual i ;

β_S = a (K_S x 1) column vector of parameters corresponding to the regressors included in X_{Si}, plus an intercept ;

M_i = the number of hours worked in the paid labor market for individual i (i.e. the ***intensive*** margin of individual i's labor supply decision) ;

δ = the respective parameter of M_i ;

U_{Si} = the disturbance term for the shadow price of home time equation .

The disturbances U_{Wi} and U_{Si} in equations (2.21) and (2.22) are assumed to be jointly normally distributed, each with mean zero, and correlations between these disturbances are allowed although the disturbances are uncorrelated with the regressors in their respective equations. Further, and critical to this model, it is assumed that, while the value of market time [i.e. equation (2.21)] is constant, and thus invariant to the number of hours worked in the labor market by the individual, the shadow value of home time [i.e. equation (2.22)] explicitly varies with the number of hours supplied in the market, M_i.

From the economic theory, and as was illustrated in Figure 2.2, it is clear that if the market wage exceeds the reservation wage (i.e. if $\ln W_i > \ln S_i|_{M=0}$), the individual participates (i.e. she/he extends a positive, non-zero, amount of hours in the paid labor force), and her/his hours of market work (i.e. the intensity of her/his labor supply), M_i, adjust so that, in equilibrium, the marginal value or shadow price of her/his home time equals her/his net market wage. Thus, in equilibrium, $\ln W_i \equiv \ln S_i|_{M>0}$ for the working individual, and hence

$$\ln W_i - \ln S_i|_{M>0} \equiv X_{Wi}\beta_W - X_{Si}\beta_S - M_i\delta + U_{Wi} - U_{Si} \equiv 0 .$$

From the above representation of the equilibrium condition characterizing the typical employed individual, one finds the hours-of-work equation to be

$$M_i = \frac{1}{\delta}\left[X_{Wi}\beta_W - X_{Si}\beta_S + U_{Wi} - U_{Si}\right] = X_{Mi}\beta_M + U_{Mi}, \qquad (2.23a)$$

in reduced form, where

$$X_{Mi}\beta_M = \frac{1}{\delta}(X_{Wi}\beta_W - X_{Si}\beta_S),\ X_{Mi} = (X_{Wi}\ X_{Si}),\ \beta_M = \frac{1}{\delta}(\beta_W - \beta_S), \text{ and } U_{Mi} = \frac{1}{\delta}(U_{Wi} - U_{Si}),$$

or, equivalently,

$$M_i = \frac{1}{\delta}\left[\ln W_i - \ln S_i|_{M=0}\right] = \frac{1}{\delta}\left[\ln W_i - X_{Si}\beta_S - U_{Si}\right]. \tag{2.23b}$$

The first equality in equation (2.23b) clearly shows that, in equilibrium, hours of paid market work, M_i, are proportional to the difference between real offered market wages and reservation wages (i.e. shadow prices of home time at full non-market time). In fact, $1/\delta$ represents the equilibrium factor of proportionality between $(\ln W_i - \ln S_i|_{M=0})$ and M_i. Obviously, equations (2.21) and (2.22) become what could be reasonably qualified as a *recurrent* system of equations determining the *intensive margin* of the labor supply decision, M_i, and the particular adjustment of hours of market work is shown, in equation (2.23a), to partly depend on the magnitude of the discrepancy $(U_{Wi} - U_{Si})/\delta$.

Indeed, equation (2.22) cannot be directly estimated since the analyst possesses no *a priori* information on individuals' reservation wages. However, because the market wage equation (2.21) and the hours-of-work equation (2.23a or b) are both directly estimable, it is easy to see that—given the recurrent nature of the system described above—one may retrieve the shadow price of home time function and, hence, individuals' reservation wages, once both (2.21) and (2.23a or b) have been properly estimated. Specifically, once equations (2.21) and (2.23a or b) are estimated, retrieval of the coefficients of $\ln S_i$ is possible provided at least one element of X_{Wi} is not contained in X_{Si}. In other words, the coefficients of the shadow price of home time function (2.22) may be retrieved only if the market wage equation (2.21) is either exactly identified or overidentified[14].

[14] In the overidentified case, equation (2.23b)—rather than (2.23a)—must be used in conjunction with (2.21) to derive (2.22).

The Heckman Correction Procedure for Sample Selection Bias

Prior the 1980's, ordinary least squares regression (OLS) appeared to be the statistical technique of choice to estimate the market wage and hours-of-work equations. However, Heckman (1974, 1976, 1979, and 1980) argues that, because of the censoring of typical samples of observations in labor supply studies, least squares estimators are usually not optimal when generalized to random samples of the population. In other words, using OLS, equations (2.21) and (2.23a or b) may be estimated using only the subsample of working individuals (since no market wages are observed for the nonemployed), and thus the results emerging from least squares estimation would not normally be generalizable to the entire population of individuals (i.e. nonemployed as well as employed individuals).

To realize this, consider a *random* sample of T observations for the estimation model contained in equations (2.21)-(2.23), where the U_{ji} (j = W,S,M) disturbances are assumed to obey the following statistical restrictions:

$$\begin{aligned} &E[U_{ji}] = 0\,, && i = 1,2,\ldots,T\,, \\ &E[U_{ji}\, U_{j'i}] = \sigma_{jj'}\,, && j' \neq j\,, \\ &E[U_{ji}\, U_{j'i'}] = 0\,, && i' \neq i\,, \end{aligned} \tag{2.24a}$$

which implies that the disturbances have zero mean and are not correlated across individuals; however, there is a correlation for a given individual i between U_W and U_S, U_W and U_M, and U_S and U_M (i.e. $\sigma_{WS} \neq 0$, $\sigma_{WM} \neq 0$, and $\sigma_{SM} \neq 0$). Particularly, note that

$$E[U_{Wi}\,U_{Wi}] = \sigma_{WW}\,,$$

$$E[U_{Wi}\,U_{Mi}] = \sigma_{WM} = (\sigma_{WW} - \sigma_{WS}) / \delta\,, \text{ and} \tag{2.24b}$$

$$E[U_{ji}\,U_{Si}] = \sigma_{jS}\,, \qquad j = W,S,M \text{ and } i = 1,2,\ldots,T\,.$$

Denoting the joint distribution of U_{Wi} and U_{Si} by $m(U_{Wi}, U_{Si})$, which is assumed to be a bivariate normal density also permitted to be singular as in the Tobit model, $m(U_{Wi}, U_{Si})$ is fully characterized by the restrictions stated in (2.24a) and (2.24b). Hence, since the regressor matrix is assumed to be of full rank, if data on the market wages (i.e. $\ln W$) and hours of market work (i.e. M) were available for all T observations, unbiased estimators of the parameters of each equation could be achieved by simple least squares, and all parameters would be consistently identified.

However, suppose that one seeks to estimate equations (2.21) and (2.23a) but that, as it is usually the case, data are missing on the hourly market wage ($\ln W$) for some observations. While the population regression functions for the random sample are

$$E[\ln W_i \mid X_{Wi}] = X_{Wi}\beta_W \tag{2.25}$$

$$E[M_i \mid X_{Wi}, X_{Si}] = E[M_i \mid X_{Mi}] = \frac{1}{\delta}(X_{Wi}\beta_W - X_{Si}\beta_S) = X_{Mi}\beta_M \tag{2.26}$$

$$i = 1,2,\ldots,T\,,$$

the regression functions for the subsample of available data (i.e. the censored sample) are

$$E[\ln W_i \mid X_{Wi}, SSR] = X_{Wi}\beta_W + E[U_{Wi} \mid SSR] \tag{2.27}$$

$$\begin{aligned} E[M_i \mid X_{Wi}, X_{Si}, SSR] &= E[M_i \mid X_{Mi}, SSR] \\ &= \frac{1}{\delta}(X_{Wi}\beta_W - X_{Si}\beta_S) + \frac{1}{\delta}E[U_{Wi} - U_{Si} \mid SSR] \qquad (2.28) \\ &= X_{Mi}\beta_M + E[U_{Mi} \mid SSR] \qquad i = 1,2,\ldots,T_1 , \end{aligned}$$

where *SSR* simply means "Sample Selection Rule", and $T_1 < T$.

Clearly, if the conditional expectation of U_{Wi} is zero, then the selected subsample regression for the market wage function is the same as the population regression for the market wage function, and thus least squares may be applied to the subsample of the available data (i.e. the censored sample) to consistently estimate the population regression function. Here the only cost of estimating the population regression function via the censored sample would be a loss of efficiency. Similarly, if the conditional expectation of U_{Mi} [i.e. $(U_{Wi} - U_{Si})/\delta$] is zero, then the selected subsample regression for the hours-of-work function is the same as the population regression for the hours-of-work function and least squares estimators of the hours-of-work function computed on the selected subsample of data are indeed consistent estimators of the true population function.

In the case on hand, the sample selection rule (i.e. *SSR*) which determines the availability of the data has more serious consequences, however. More precisely, in the censored sample T_1, data on hourly market wages are available only for those individuals who participate in the paid labor market, while they are not for those who do not engage in market work. That is, data on lnW are available only if

$$M_i > 0 \left[\text{i.e. if } \frac{1}{\delta}(\ln W_i - \ln S_i|_{M=0}) \equiv \left\{\frac{1}{\delta}(X_{Wi}\beta_W - X_{Si}\beta_S) + \frac{1}{\delta}(U_{Wi} - U_{Si})\right\} > 0\right],$$

while if (2.29)

$$M_i = 0 \left[\text{i.e. if } \frac{1}{\delta}(\ln W_i - \ln S_i|_{M=0}) \equiv \left\{\frac{1}{\delta}(X_{Wi}\beta_W - X_{Si}\beta_S) + \frac{1}{\delta}(U_{Wi} - U_{Si})\right\} \leq 0\right],$$

the analyst does not observe the individual's hourly market wage.

Using representation (2.29) to denote the selection rule characterizing the selected sample of observations, one may write the last term of (2.27) and (2.28) respectively, as

$$E\left[U_{Wi} \mid M_i > 0\right] = E\left[U_{Wi} \mid \frac{1}{\delta}(U_{Wi} - U_{Si}) > \frac{1}{\delta}(X_{Si}\beta_S - X_{Wi}\beta_W)\right]$$

$$= E\left[U_{Wi} \mid U_{Mi} > -X_{Mi}\beta_M\right], \tag{2.30}$$

and

$$E\left[U_{Mi} \mid M_i > 0\right] = E\left[\frac{1}{\delta}(U_{Wi} - U_{Si}) \mid \frac{1}{\delta}(U_{Wi} - U_{Si}) > \frac{1}{\delta}(X_{Si}\beta_S - X_{Wi}\beta_W)\right]$$

$$= \frac{1}{\delta} E\left[(U_{Wi} - U_{Si}) \mid (U_{Wi} - U_{Si}) > (X_{Si}\beta_S - X_{Wi}\beta_W)\right]$$

$$= E\left[U_{Mi} \mid U_{Mi} > -X_{Mi}\beta_M\right]. \tag{2.31}$$

Accordingly, the selected sample regression for the market wage and the hours-of-work functions may be written as

$$E[\ln W_i \mid X_{Wi}, M_i > 0] = X_{Wi}\beta_W + E[U_{Wi} \mid \frac{1}{\delta}(U_{Wi} - U_{Si}) > \frac{1}{\delta}(X_{Si}\beta_S - X_{Wi}\beta_W)]$$

$$= X_{Wi}\beta_W + E[U_{Wi} \mid U_{Mi} > -X_{Mi}\beta_M] , \qquad (2.32)$$

and

$$E[M_i \mid X_{Wi}, X_{Si}, M_i > 0] = \frac{1}{\delta}(X_{Wi}\beta_W - X_{Si}\beta_S)$$

$$+ \frac{1}{\delta} E[(U_{Wi} - U_{Si}) \mid (U_{Wi} - U_{Si}) > (X_{Si}\beta_S - X_{Wi}\beta_W)]$$

$$= X_{Mi}\beta_M + E[U_{Mi} \mid U_{Mi} > -X_{Mi}\beta_M] . \qquad (2.33)$$

Notice from equation (2.32) that the selected sample regression for the market wage function depends on both X_{Wi} and X_{Mi}. Clearly, there would be no bias if X_{Mi} and X_{Wi} were independent (except for the constant term). However, recall that according to the model under analysis X_{Mi} depends on both X_{Wi} and X_{Si} and, consequently, X_{Mi} cannot be independent of X_{Wi}. Similarly, if U_{Wi} and U_{Mi} were independent (i.e. if $\sigma_{WM} = 0$), there would be no bias since the conditional expectation of U_{Wi} would drop out of the selected sample regression function. However, since U_{Mi} depends on both U_{Wi} and U_{Si}, U_{Mi} cannot be independent of U_{Wi}. In fact, it is clear that $\sigma_{WM} \equiv (\sigma_{WW} - \sigma_{WS})/\delta \neq 0$. Thus, because of the special characteristics of the model on hand, the discussion above supports the fact that standard least squares estimates of β_W are affected by sample selection bias. In the same order of ideas, notice that the last allegation also applies to standard least squares estimates of β_M [i.e. $(\beta_W - \beta_S)/\delta$] in equation (2.33).

Hence, from equations (2.32) and (2.33), it appears that the problem of sample selection bias, initially viewed as a missing *dependent* variable problem resulting in the non-observability of $\ln W_i$ for those sampled observations that do not participate in the paid labor force, may be reformulated as an ordinary omitted explanatory variable problem. In fact, this is so because regression estimators of the market wage and hours-of-work equations computed on the selected subsample "omit" the final term of equations (2.32) and (2.33), respectively.

Utilizing results well known in the econometric literature (for instance, see Johnson & Kotz, 1972, pp. 112-113), one may rewrite the omitted part of (2.32) and (2.33) as

$$E\left[U_{Wi} \mid \frac{1}{\delta}(U_{Wi} - U_{Si}) > \frac{1}{\delta}(X_{Si}\beta_S - X_{Wi}\beta_W)\right] = \frac{(\sigma_{WW} - \sigma_{WS})/\delta}{\left[(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})/\delta^2\right]^{1/2}}\,\lambda(Z_i)$$

$$= \frac{(\sigma_{WW} - \sigma_{WS})/\delta}{(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}/\delta}\,\lambda(Z_i),$$

or simply,

$$E\left[U_{Wi} \mid U_{Mi} > -X_{Mi}\beta_M\right] = \frac{\sigma_{WM}}{(\sigma_{MM})^{1/2}}\,\lambda(Z_i), \tag{2.34}$$

and

$$\frac{1}{\delta}E\left[(U_{Wi} - U_{Si}) \mid (U_{Wi} - U_{Si}) > (X_{Si}\beta_S - X_{Wi}\beta_W)\right] = \frac{1}{\delta}\,\frac{\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS}}{(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}}\,\lambda(Z_i)$$

$$= \frac{(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}}{\delta}\,\lambda(Z_i),$$

or just,

$$E\left[U_{Mi} \mid U_{Mi} > -X_{Mi}\beta_M\right] = (\sigma_{MM})^{1/2}\,\lambda(Z_i), \tag{2.35}$$

where

$$\sigma_{WM} \equiv \text{cov}(U_{Wi}, U_{Mi}) = (\sigma_{WW} - \sigma_{WS}) / \delta ,$$

$$\sigma_{SM} \equiv \text{cov}(U_{Si}, U_{Mi}) = (\sigma_{SS} - \sigma_{WS}) / \delta ,$$

$$\sigma_{MM} \equiv \text{var}(U_{Mi}) = (\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS}) / \delta^2 ,$$

$$\lambda(Z_i) = \frac{\phi(Z_i)}{1-\Phi(Z_i)} = \frac{\phi(Z_i)}{\Phi(-Z_i)} ,$$

$$\phi(Z_i) = \frac{1}{\sqrt{2\pi}}.e^{-Z_i^2/2}$$ (i.e. the probability density function, p.d.f., for the standard normal variable Z_i),

$$\Phi(Z_i) = \int_{-\infty}^{Z_i} \frac{1}{\sqrt{2\pi}}.e^{-t^2/2}dt$$ (i.e. the cumulative distribution function, c.d.f., for the standard normal variable Z_i),

and

$$Z_i = \frac{-X_{Mi}\beta_M}{(\sigma_{MM})^{1/2}} = \frac{(X_{Si}\beta_S - X_{Wi}\beta_W)/\delta}{(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}/\delta} .$$

Lambda, $\lambda(Z_i)$, is the inverse Mills ratio (also referred to as the hazard ratio), and simply represents the ratio of the ordinate of a standard normal to the tail area of the distribution. Indeed, note that the denominator of lambda [i.e. $1-\Phi(Z_i)$, or simply $\Phi(-Z_i)$] is just the probability that a population observation with characteristics X_{Mi} be selected in the subsample of T_1 observations for which market wages are observed, and therefore for which $M_i > 0$. Furthermore, lambda is a monotonic increasing function of Z_i , and thus a monotonic decreasing function of the probability of sample selection. Particularly,

$$\lim_{Z_i \to -\infty} \lambda(Z_i) \to 0 , \quad \lim_{Z_i \to \infty} \lambda(Z_i) \to \infty , \quad \text{and} \quad \frac{\partial \lambda(Z_i)}{\partial Z_i} > 0 .$$

Hence, for samples in which the selection rule guarantees that all population observations have the same chance of being sampled, $\lambda(Z_i)$ is equal to zero and least squares estimators of equations (2.21) and (2.23a) have their optimal properties. Indeed, whether or not all population observations have the same chance of being sampled is an empirical matter.

Making use of equations (2.34) and (2.35), equations (2.32) and (2.33) become

$$E[\ln W_i \mid X_{Wi}, M_i > 0] = X_{Wi}\beta_W + \frac{(\sigma_{WW} - \sigma_{WS})/\delta}{(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}/\delta}\lambda(Z_i)$$

$$= X_{Wi}\beta_W + \frac{\sigma_{WM}}{(\sigma_{MM})^{1/2}}\lambda(Z_i), \qquad (2.36)$$

and

$$E[M_i \mid X_{Wi}, X_{Si}, M_i > 0] = \frac{(X_{Wi}\beta_W - X_{Si}\beta_S)}{\delta} + \frac{(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}}{\delta}\lambda(Z_i)$$

$$= X_{Mi}\beta_M + (\sigma_{MM})^{1/2}\lambda(Z_i) \qquad (2.37a)$$

or, equivalently,

$$E[M_i \mid X_{Wi}, X_{Si}, M_i > 0] = \frac{1}{\delta}\{E[\ln W_i \mid X_{Wi}, M_i > 0] - X_{Si}\beta_S\}$$

$$- \frac{1}{\delta}\frac{\sigma_{SS} - \sigma_{WS}}{(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}}\lambda(Z_i). \qquad (2.37b)$$

Obviously, if one could estimate Z_i and hence $\lambda(Z_i)$, the simple inclusion of the latter variable as a regressor in equation (2.36) would permit a direct estimation of β_W and $\sigma_{WM}/(\sigma_{MM})^{1/2}$ by simple least squares. Similarly, if one could measure M_i when $M_i > 0$, as in the Tobit model, knowledge of M_i and $\lambda(Z_i)$ would permit direct least squares estimation of β_M [i.e. $(\beta_W - \beta_S)/\delta$] and $(\sigma_{MM})^{1/2}$ [i.e. $(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}/\delta$].

Adding disturbances to (2.36), (2.37a), and (2.37b), the statistical model proposed by Heckman becomes:

$$E\left[\ln W_i \mid X_{Wi}, M_i > 0\right] = X_{Wi}\beta_W + \frac{(\sigma_{WW} - \sigma_{WS})/\delta}{(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}/\delta}\lambda(Z_i) + V_{Wi}$$

$$= X_{Wi}\beta_W + \frac{\sigma_{WM}}{(\sigma_{MM})^{1/2}}\lambda(Z_i) + V_{Wi}$$

$$= X_{Wi}\beta_W + \lambda(Z_i)\xi_W + V_{Wi}\,, \tag{2.38}$$

and

$$E\left[M_i \mid X_{Wi}, X_{Si}, M_i > 0\right] = \frac{(X_{Wi}\beta_W - X_{Si}\beta_S)}{\delta} + \frac{(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}}{\delta}\lambda(Z_i) + \frac{(V_{Wi} - V_{Si})}{\delta}$$

$$= X_{Mi}\beta_M + (\sigma_{MM})^{1/2}\lambda(Z_i) + V_{Mi}$$

$$= X_{Mi}\beta_M + \lambda(Z_i)\xi_M + V_{Mi} \tag{2.39a}$$

or, equivalently,

$$E\left[M_i \mid X_{Wi}, X_{Si}, M_i > 0\right] = \frac{1}{\delta}\left\{E\left[\ln W_i \mid X_{Wi}, M_i > 0\right] - X_{Si}\beta_S\right\} + \frac{1}{\delta}\frac{\sigma_{WS} - \sigma_{SS}}{(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}}\lambda(Z_i) + \frac{1}{\delta}(V_{Wi} - V_{Si}) \tag{2.39b}$$

where V_{ji} are the new, and now truly stochastic disturbances with zero mean and unconstrained covariance structure.

In particular, note that

$$E\left[V_{Wi} \mid X_{Wi}, \lambda(Z_i), U_{Mi} > -X_{Mi}\beta_M\right] = 0 \,,$$

$$E\left[V_{Mi} \mid X_{Wi}, X_{Si}, \lambda(Z_i), U_{Mi} > -X_{Mi}\beta_M\right] = 0 \,, \qquad i = 1,2,\ldots,T_I \,,$$

$$E\left[V_{ji}\, V_{j'i} \mid X_{Wi}, X_{Mi}, \lambda(Z_i), U_{Mi} > -X_{Mi}\beta_M\right] = \sigma_{WM}\left[1 + Z_i\lambda(Z_i) - \lambda^2(Z_i)\right] \qquad (2.40)$$

$$= \frac{(\sigma_{WW} - \sigma_{WS})}{\delta}\left[1 + Z_i\lambda(Z_i) - \lambda^2(Z_i)\right],$$

$$E\left[V_{ji}\, V_{j'i'} \mid X_{Wi}, X_{Mi}, \lambda(Z_i), U_{Mi} > -X_{Mi}\beta_M\right] = 0 \,, \qquad j = W, M \;,\quad j' = W, M \;,$$

$$j' \neq j \,, \quad \text{and} \quad i' \neq i \;.$$

Indeed, if one knew $\lambda(Z_i)$, one could enter it as a normal regressor in equations (2.38) and (2.39a or b) and directly estimate these equations using simple least squares techniques. From (2.40), it is clear that least squares estimators of β_W, β_M, ξ_W [i.e. $\sigma_{WM}/(\sigma_{MM})^{1/2}$], and ξ_M [i.e. $(\sigma_{MM})^{1/2}$] would be unbiased and hence fully consistent[15].

Unfortunately, in practice, the analyst does not know Z_i [i.e. $-X_{Mi}\beta_M / (\sigma_{MM})^{1/2}$] and $\lambda(Z_i)$ and, consequently, cannot directly estimate equations (2.38) and (2.39a or b). However, in the case of censored samples, it is possible to estimate the probability that an observation i has missing data on $\ln W_i$ and hence, the probability that this observation is working in the paid labor force. As a result, Heckman (1976, 1979, and 1980) suggests

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[15] Although these least squares estimators would be unbiased and consistent, they would nonetheless be inefficient due to the heteroskedasticity problem created by the nontrivial regressors contained in X_{Mi} and hence Z_i.

the use of Probit analysis over the entire sample of T observations in order to estimate Z_i [or, more precisely, $\beta_M/(\sigma_{MM})^{1/2}$] and hence $\lambda(Z_i)$. Accordingly, the maximum-likelihood Probit function for the censored sample may be written as

$$L = \prod_{i=1}^{T} [\Phi(Z_i)]^{P_i} [1 - \Phi(Z_i)]^{1 - P_i} , \qquad (2.41)$$

where P_i is defined as a dummy random variable with the value of one denoting the event 'observation of individual i working in the paid labor force' (or, alternatively, 'observation of $\ln W_i$'). As such, this Probit function implies the regression on a dichotomous dependent variable; namely, the labor-force participation decision—also labeled the extensive margin of the labor supply decision. Formally, this limited-dependent variable regression equation which is translated in (2.41) can be written as follows:

$$P_i = X_{Pi}\beta_P + U_{Pi} , \qquad (2.42)$$

where

P_i = the labor-force participation choice of individual i which takes the value of one if she/he is observed participating in the paid labor market (i.e. if $M_i > 0$), and zero if not (i.e. if $M_i = 0$) ;

X_{Pi} = a (1 x K_P) row vector of exogenous variables affecting the labor-force participation choice of individual i, and which contains the same set of regressors included in the hours-of-work equation [i.e. $X_{Pi} = X_{Mi}$][16] ;

β_P = a (K_P x 1) column vector of parameters corresponding to the regressors included in X_{Pi} (and hence X_{Mi}), plus an intercept ;

[16] Here it is critical to notice that the same regressors included in the hours-of-work equation [i.e. equation (2.23a)] must also appear in the Probit equation of the labor-force participation decision [i.e. equation (2.42)]. This is so because both extensive and intensive margins of the labor supply decision are basically assumed to be explained by the very same set of regressors in Heckman's model. Thus, as a particular requirement in Heckman's model, $X_{Pi} = X_{Mi}$.

and

U_{Pi} = the stochastic error term (i.e. $E[U_{Pi} | X_{Pi}] = 0$) of the labor-force participation decision equation, with customary assumed unitary variance [i.e. $var(U_{Pi}) = 1$] .

Under the standard conditions for convergence in Probit analysis (for instance, see Nerlove & Press, 1973), consistent estimates of $\lambda(Z_i)$ may be obtained. Once the likelihood Probit function (2.41) is fully optimized, the resulting consistent estimates of $\lambda(Z_i)$ may then be substituted for the true values of $\lambda(Z_i)$ in equations (2.38) and (2.39a), and OLS regression may be performed over the selected sample of T_1 observations (i.e. only those observations for which $M_i > 0$). Ordinary least squares estimators of β_W, β_M, ξ_W [i.e. $\sigma_{WM}/(\sigma_{MM})^{1/2}$], and ξ_M [i.e. $(\sigma_{MM})^{1/2}$] will then be unbiased and thus consistent. Alternatively, the hours-of-work equation may be estimated from (2.39b) [instead of (2.39a)] using the predicted values from the *corrected* market wage function given by (2.38) as regressor. As Heckman (1976; 1980) points out, the main advantage of this alternative procedure is that it allows for the estimation of a unique value of $1/\delta$ whereas, in the event that the model is overidentified, equation (2.39a)—that is, the reduced-form *corrected* equation for hours of market work—leads to multiple estimates of $1/\delta$. In other words, this alternative procedure, which follows conventions in simultaneous equations theory, allows the analyst to avoid the multiplicity of estimates for δ generally arising when the model is overidentified. Thus, since the usual rank and order restrictions apply for the identification of $1/\delta$ (and hence δ), if X_{Wi} contains at least one regressor that is not included in X_{Si} , then δ and thus β_{Si} are all estimable parameters. Also, notice that because the stochastic structure is heteroskedastic [i.e. X_{Mi} (and hence Z_i) contains regressors different from '1'], generalized least squares (GLS) could be applied to the system of equations (2.38) and (2.39a or b) in order to improve the precision of least squares estimates. Finally, at a conceptual level, it should be emphasized that the Probit function used to derive lambda [i.e. equation (2.41)] simply models the labor-force participation decision or, more exactly, the extensive margin of the labor supply decision as expressed in equation (2.42), which simultaneously determines the observability of market wages and hours of market work (i.e. the intensive margin of the labor supply decision) for the random sample of observations.

Therefore, the standard estimation model suggested by Heckman (1976) can be rightfully viewed as a two-stage estimation procedure. In the first stage, the probability of being in the paid labor force is estimated over the entire sample of individuals (i.e. both working and non-working individuals) using Probit analysis. The results of this Probit analysis are then used to compute the inverse Mills ratio [i.e. $\lambda(Z_i)$], labeled lambda, which, ultimately, contributes to capture important unobserved differences with regard to the personal characteristics that distinguish individuals who choose to participate in the labor market from those who choose not to participate. Hence, the first stage of the estimation procedure exploits the *extensive* margin of the labor supply decision, modeled into a Probit analysis of the probability of labor force participation, in order to derive a pseudo instrument, lambda, which is subsequently used to correct for the censoring of the sample (i.e. sample selection bias). In the second stage of the procedure simple least squares regression techniques are used strictly on the selected sample (i.e. only those individuals participating in the paid labor force) to estimate the parameters of the market wage and the hours-of-work functions, including lambda as an explanatory variable. Specifically, market wages and hours of market work are regressed on various labor market and personal characteristics that are proper to the selected sample, plus the inverse Mills ratio derived from the first stage of the estimation procedure. The inclusion of the inverse Mills ratio in those two equations allows the analyst to correct for sample selection bias. As such, the estimated parameters of the selection bias-corrected market wage and hours-of-work functions may then be utilized to impute potential market wages for the nonemployed individuals by substituting their particular labor market and personal characteristics into the corrected equations. Likewise, and perhaps of greater interest to home and family economists, because of the recurrent nature of the estimation model, the selection bias-corrected market wage and hours-of-work equations may be used in tandem in order to derive the selection bias-corrected shadow price of home time function from which the reservation wage of any sampled individual, working or not, may then be properly estimated.

Surely, the standard estimation procedure developed by Heckman presents a very significant advance over most of what was done until recently with respect to the valuation of non-market time (i.e. the opportunity cost of engaging in activities other than paid market work). For home and family economists as well as other applied researchers sharing similar research interests, the greatest merit of Heckman's work rests on the solidly rooted methodology it suggests to alleviate the difficulties usually encountered with 'corner' solutions (i.e. $M_i = 0$) in labor supply studies as well as in home-time valuation studies based upon the opportunity cost of time approach. This is especially true with studies targeted to married women since, as mentioned earlier, these women seem to represent an important segment of the population for whom corner solutions are, by tradition, most likely to be observed, and thus for whom the use of an imputed potential market wage stained by selectivity bias as a measure of the opportunity cost of their home time is totally inappropriate.

Thus, provided that the behavioral assumptions underlying the opportunity cost of time approach are fully met, shadow prices of non-market time—as opportunity cost of time measures used to value the *last* hour of home production time—derived via the two-stage estimation procedure explicated above are thought to be *free* of bias and to accurately reflect the true value of household production time from an individual's (or household's) perspective. Here, however, some important qualifications are in order, and the exposition of these is the primary focus of the following chapter.

CHAPTER 3

THE SHADOW PRICE OF NON-MARKET TIME AND THE TRUE VALUE OF HOUSEHOLD PRODUCTION TIME

This chapter identifies and discusses three important issues that may very likely introduce substantial biases and/or unexplained variations in the valuation of household production time when the standard assumptions underlying the opportunity cost approach are used to derive the monetary value of home labor from the individual's (household's) perspective. Further, simple corrective solutions are presented for each potential source of bias.

The Implicit Assumption of Linearly Homogeneous Home Production Functions

The first issue is related to the standard and implicit assumption of *linearly homogeneous* home production functions. In fact, as pointed out earlier, opportunity cost estimates measure the shadow price of non-market time only at the margin. For the voluntarily nonemployed individual, inasmuch as it is valued at full non-market time (i.e. $\ln S_i|_{M=0}$), this shadow price of home time represents the individual's reservation wage—the lowest real hourly wage that would make the nonemployed individual indifferent between allocating her/his last hour to unpaid home production activities and entering the labor market for a very first hour of paid work. For the satisfactorily employed person, the estimated shadow price of home time gives the economic value of the last hour of household production to this individual, *after* she/he has already spent a certain number of hours in the labor market (i.e. $\ln S_i|_{M>0}$), which shadow price of home time happens to corroborate with her/his real hourly market wage. Hence, provided the shadow price of non-market time (i.e. $\ln S_i|_{M>0}$ for the working individual and $\ln S_i|_{M=0}$ for the voluntarily nonemployed person) represents the monetary value the individual confers to her/his *last* hour of home production time in equilibrium, one may infer that it is the true economic value for each hour of someone's household production time *if and only if* home production functions are characterized by constant returns to scale of time (i.e. hours) input. In this case, since the individual would be equally productive during the last hour spent in household work as during the first hours, then one could derive the total daily (weekly, monthly, or yearly) value of an individual's home production time by simply multiplying her/his estimated shadow price of non-market time by the number of hours she/he typically spends in a day (week, month, or year) doing household work. Indeed, this is what is normally done in studies based on the opportunity cost approach to derive the monetary value of household production time [for instance, see Bryant et al. (1992), Murphy (1982), and Zick & Bryant (1990)]. However, in the very likely event that home production time exhibits, as deliberately depicted in both Figure 2.1 and 2.2, decreasing marginal productivity (i.e. $\partial^2 Z/\partial H^2 \equiv Z_{HH} < 0$), then intramarginal hours devoted to household production—that is, those hours spent in home production that are not the very last hour—should necessarily be worth more to the individual (and hence to her/his household) than the estimated shadow price for her/his *last hour* of home labor. In fact, the more accentuated the curvature of the household production function (i.e. the smaller Z_{HH}) and the larger the amount of time spent in home production by a particular individual during a given period of time, the more considerable should be the discrepancy between the estimated shadow price of non-market time and the true value (i.e.

opportunity cost) of home production time to this individual. Therefore, if the principle of diminishing marginal productivity truly characterizes home production time, the estimated shadow price of non-market time could be a valid opportunity cost measure only for a person's *last* hour of household labor and, hence, a *lower-bound estimate* in terms of the real value of home production time from the individual's (household's) perspective. Consequently, substantial biases may result if researchers erroneously postulate linearly homogeneous home production functions. Here, simply due to the natural phenomenon of fatigue which characterizes labor time input, it seems more than reasonable to believe that the implicit assumption of linearly homogeneous home production functions is totally incongruent with reality. Yet, even though such a potential problem has been rightfully acknowledged in some studies (see Murphy, 1982; Zick & Bryant, 1983; 1990), at the time of this writing no single piece of work had seriously attempted to deal with this important issue.

Indeed, an obvious solution to this problem would be to relax the assumption of linearly homogeneous home production functions and fully use the flexibility of the shadow price of home time equation described earlier in Chapter 2. Recognizing that every single hour allocated to paid market production represents one less hour of non-market time to the individual, if one knew how many hours a particular individual spends in household work during a given period of time, then one could simply utilize this individual's reservation wage (i.e. $S_i|_{M=0}$) as the initial value to derive shadow prices for each intramarginal hour of home production in her/his typical day (week, month, or year), and then take the simple arithmetic mean of these shadow price values as the *average* opportunity cost value of home production time to this individual. Essentially, what is suggested here is that the estimated shadow price of home time function [i.e. equation (2.22), corrected for sample selection bias via the inclusion of lambda, $\lambda(Z_i)$, in both market wage and hours-of-work equations respectively] be used to compute how the individual values each of her/his intramarginal hours of home labor, starting from a full home time allocation position (i.e. $M_i = 0$) and until hours of paid market work perfectly match the number of hours the individual currently works in the home (i.e. until $M_i = H_i$). Doing so, a total number of $H_i + 1$ shadow price values would be derived for any person i. Taking the sum of these computed shadow price values and dividing by $H_i + 1$, one would get an average shadow price of home production time to the individual. Indeed, to justify the use of this averaging procedure, one must naturally assume that leisure time remains constant as the individual is 'forced' to take any incremental hour of market work starting from a full home time allocation position. Thus, the averaging procedure proposed above can be adequately summarized via the following formula:

$$\overline{S_i} = \frac{\sum_{j=0}^{H_i} S_i|_{M_i=j}}{H_i + 1} \quad . \qquad (3.1)$$

Notice carefully here that the arithmetic mean of these shadow prices should provide the analyst with an estimated average opportunity cost value of household production time as perceived by the individual under analysis rather than a conventional shadow price which only provides for the opportunity cost value of home production time at the margin (i.e. the value of the last hour spent by the individual in household work). In the unlikely event that home production time is characterized by constant returns to scale, then average and marginal values of home production time would have to be the same. However, remembering the fundamental economic law of variable proportions which applies to any production process (Turgot, 1767), and looking back to the shadow price of home time function [i.e. equation (2.22)], one realizes that the inclusion of market hours of work, M_i, in this equation guarantees that average and marginal values of household production time would not coincide. More precisely, because the amount of time spent in the paid labor market is expected to increase the value an individual places on his/her remaining home time (i.e. $\delta > 0$), it follows that the average opportunity cost value of home production time to the individual should always be greater than the marginal value provided by the estimated shadow price of home time at full home time (i.e. the individual's reservation wage). Of course, the main idea behind this averaging of intramarginal shadow prices procedure is to somewhat achieve a *linearization* of the home production function and, by itself, this 'linearization' constitutes an important extension of the standard opportunity cost methodology to valuing home production time.

At first glance, the procedure suggested above might appear tedious to apply with large samples of observations, but today's computer programming capabilities render this type of repetitive operation easily manageable. Moreover, if home labor obeys the principle of diminishing marginal product as believed, a 'linearization' of home production functions according to the averaging procedure discussed above presents a relatively simple way of getting at the true average opportunity cost value of home production time as perceived from the household side. Finally, a last important advantage of this procedure resides at the conceptual level. In fact, the suggested procedure is fully consistent with the limiting nature of the reservation wage concept as well as how this latter should be applied in any study that proposes to assess the economic value of home production time per se. Fundamentally, the reservation wage reflects the marginal value of home time to the individual in complete absence of market work; thus it would be a conceptual adulteration to take the reservation wage as representing anything else than the value of the *last hour of home time* to the individual *at full non-market time*.

The Continuity Assumption with respect to Individuals' Labor Supply

A second potentially important problem which could presumably impair shadow price of home time estimates as opportunity costs of the last hour of home production arises from the standard continuity assumption vis-à-vis individuals' labor supply decisions (Murphy, 1982). More specifically, the opportunity cost of time approach explicitly assumes individuals to *freely* allocate their time between market and non-market activities so that any possible institutional constraint from the demand side of the labor market is ignored in the estimation procedure. Indeed, the standard opportunity cost approach to estimating the value of household production time takes the number of hours of paid market work reported by individuals as being their *desired* hours of work. As such, this implies that involuntarily unemployed, underemployed, or overemployed individuals simply become indistinguishable from the voluntarily nonemployed and employed individuals who are content working short or long hours in the paid labor force. While perfectly continuous 'budget' lines is perhaps not an unreasonable assumption for long run labor supply behavior[1], it simply cannot be rationally supported for the short run. In fact, since the static economic model of the allocation of time does not warrant the type of equilibrium (i.e. short- or long-run equilibrium) observed from cross-sectional data, allowing for potentially constrained equilibria appears much more in line with studies such as those by Altonji & Paxson (1988), Blank (1988), Ham (1982), and Kahn & Lang (1992), which all provide concrete evidence that many individuals are importantly constrained with respect to their labor supply behavior, hence indicating that labor supply decisions—whether at the extensive and/or intensive margins—are not, as customarily implied, fully endogenous to the individual. Basically, the recognition of potentially constrained 'equilibria' reflects the analyst's awareness that some sampled individuals might be observed optimizing utility in their long-run time-allocation equilibria, while others might be observed in their non-optimizing (i.e. constrained) short-run time allocation positions.

In view of the fact that part-time and contingent employment represent a growing share of market jobs in this country, and that although women (especially married women) are more likely to opt for such types of jobs relative to men, they are also more likely to be confined to them against their will[2], it is extremely surprising that the opportunity cost methodology to valuing home production time—along with most policy implications

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[1] In the long run, *underemployed* individuals may take a second or even a third job so as to meet their desired hours of labor supply; *overemployed* individuals may either find another job more in line with their own time availability, or keep the same job but deliberately lengthen coffee breaks or systematically arrive late at work and/or leave earlier than stipulated in their contracts. Further, in the long run, *unemployed* individuals may find a job elsewhere by migrating to areas where job prospects are growing; they may also get further training or schooling which could possibly increase their employability.

[2] For instance, according to Tilly (1992), the rate of involuntary part-time employment is 44 percent higher among married women than among married men.

stemming from it—has constantly been based upon the assumption that all individuals freely choose to allocate as many or as few hours as they want to the paid labor market.

On one hand, it is clear that any individual who would prefer to work more hours at her/his actual or potential offered market wage than the number of hours currently allowed by the market is confined to underemployment and, under similar circumstances, unemployment may be seen as an extreme case of underemployment. Here one should recognize that if firms substitute work-sharing and reduced hours of work (i.e. rationing) for layoffs, then underemployment may be caused by the same factors that lead to unemployment. On the other hand, the existence of an institutionally fixed work-day (or work-week) may also lead to workers being overemployed in the sense that some may have to work longer hours (weeks) than they would otherwise be choosing[3].

Therefore, the problem of imperfect continuity in budget lines may be due in large part to institutional upper-bound limits (i.e. involuntary unemployment or underemployment) as well as lower-bound constraints (i.e. overemployment) on the number of hours individuals may work or have to work in the labor force[4]. Hence, postulating continuous budget lines can often be very misleading, especially when one is interested in deriving

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[3] For instance, see Lewis's (undated) paper on employer interests in employee hours of work for the circumstances under which employers may require their employees to work longer hours than they would normally want.

[4] This analysis does not consider other factors such as fixed money or time costs of employment, which also create a break in the continuity of 'budget' lines [for instance, see Cogan (1980) and Moffit (1982) for a good exposition on these issues]. However, although not considered in this study, both money and time costs of employment may be easily accounted for if one adjusts market wages and/or nonlabor income accordingly.

the true value of home production time for married women. Further, since hours of paid market work directly enter the shadow price of home time function [i.e. equation (2.22) in the recurrent estimation system introduced in the previous chapter], it is evident that taking *observed* hours of market work to be the individual's *desired* (i.e. freely chosen) hours of labor supply in the market could lead to significant biases in the shadow price of home time estimates, no matter if marginal or average shadow prices are used to value the opportunity cost of household production time. More precisely, our economic model of the allocation of time theory tells us that reservation wage estimates, as shadow prices of the last hour of home time prior to labor market entry, may be upward biased for underemployed (and thus involuntarily unemployed) individuals, while they may be downward biased for those who are overemployed. Although the reservation wage does not constitute the opportunity cost of household production time to the employed person (recall that the net hourly market wage, which coincides with the shadow price of home time after the individual has allocated $M_i > 0$ hours to the labor market, is the opportunity cost of household production time for the working person), it is obvious that estimating a labor supply function [i.e. equations (2.23a or b) corrected for selection bias as in equations (2.39a or b)] on a sample of individuals constrained with respect to the number of hours they can possibly allocate to the labor market would lead to different parameter estimates than if those sampled individuals were truly allowed to allocate their desired hours of work to the market. In fact, provided that the retrieval of the coefficients for the shadow price of home time function [i.e. equation (2.22)] is only possible after the estimation of a market wage and a labor supply function, it follows that any discrepancy between observed and desired hours of work resulting from labor market constraints and affecting the coefficients of the labor supply function must necessarily contaminate the retrieved coefficients of the shadow price of home time function. Consequently, even in samples in which only few individuals are affected by institutional constraints, taking observed hours of market work as being the desired hours these constrained (but undifferentiated) individuals would normally supply to the market should not only impede reservation wage estimates, but also any particular opportunity cost value derived from the shadow price of home time function. Likewise, taking observed labor market participation as being the individual's desired participation choice should necessarily distort the results obtained from the Probit analysis used to derive the sample-selection-correction variable, lambda, which directly impacts on the equations utilized to derive the shadow price of home time function. Hence, even if only a small proportion of constrained individuals are present in a particular sample of observations, it should be clear that, under the assumption of perfectly continuous budget lines, the retrieved coefficients of the shadow price of home time function would be biased. Under such circumstances, because the coefficients of the shadow price of home time function are biased, it follows that any reservation wage figure (or any other shadow price figure) derived from this function—whether it is derived for constrained or unconstrained sampled individuals—would be inaccurate.

The next three sections present the most common cases of institutional labor market constraints, and illustrate how the resulting break of continuity in budget lines potentially biases reservation wages estimated under the usual (i.e. standard) assumption that all individuals freely allocate their time in both market and non-market activities.

The Case of the Involuntarily Unemployed Individual

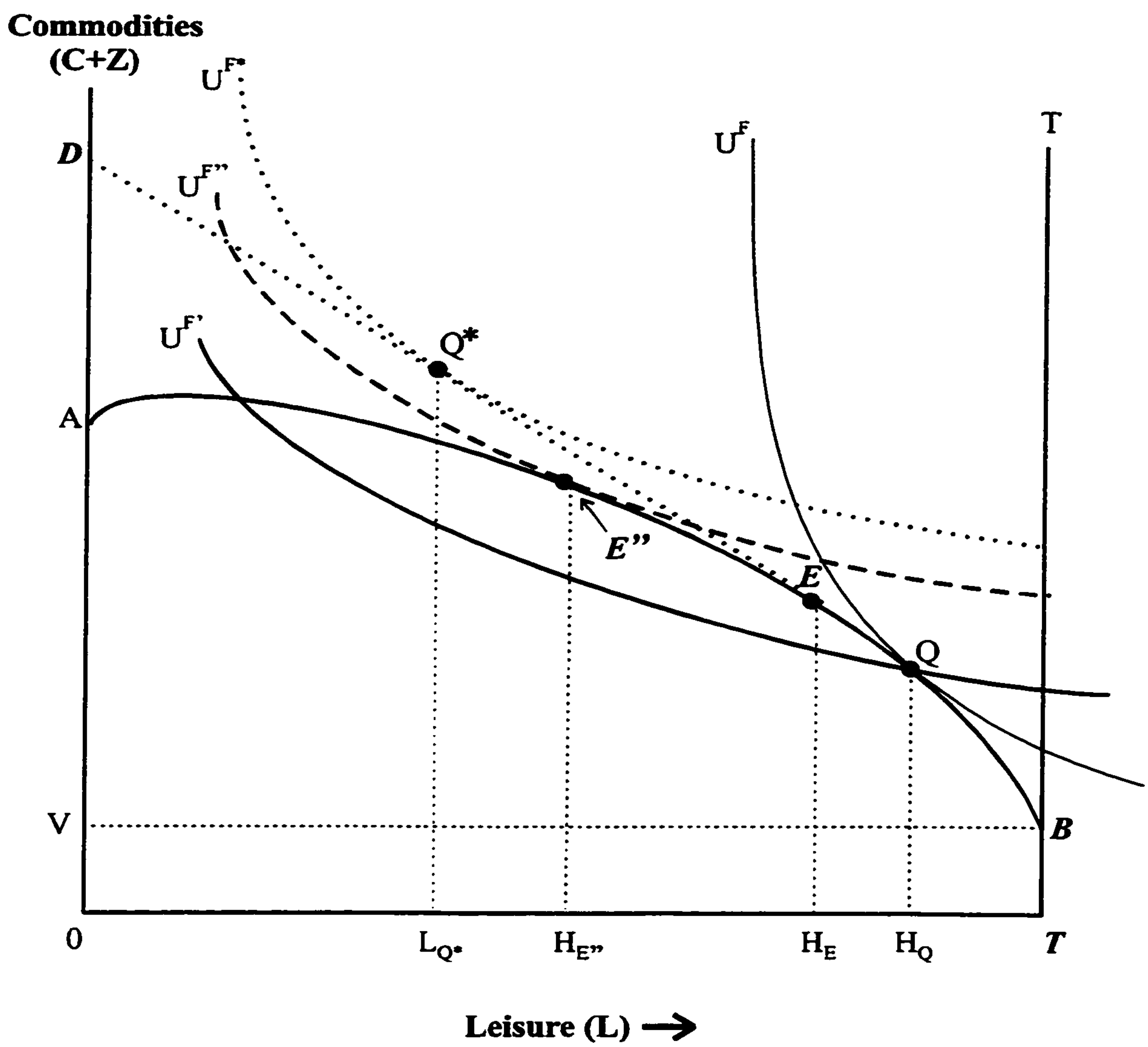

Figure 3.1 Bias Created by Institutional Constraints: The Involuntarily Unemployed

Figure 3.1 illustrates how, under the standard assumption of perfectly continuous budget lines, reservation wage estimates (and thus, estimated shadow price of home time functions) might be biased when involuntarily unemployed individuals are left indistinguishable from the voluntarily nonemployed. For instance, individual F, represented in the graph above, is thought to freely allocate her scarce time among home production, market work, and leisure activities so as to unrestrictedly maximize her overall utility which, in turn, is derived from commodities [i.e. (C+Z)] and leisure time (i.e. L). Indeed, individual F is observed supposedly doing so at the equilibrium point Q, where she is working TH_Q hours per day in the home and spending $0H_Q$ hours in leisure activities per typical day. Therefore, point Q is seen as being the time-allocation equilibrium position for individual F, where she appears to be voluntarily nonemployed and, presumably, fully satisfied with this situation. Yet, the latter assertion is only true if individual F *freely* allocates her time in *all* three domains of activities under analysis (i.e. home production, market work, and leisure activities). More exactly, the total budget line, *TBED*, faced by individual F must be perfectly continuous in all its segments in order to allow this individual to reach her highest attainable indifference curve, and thus fully maximize her satisfaction. Indeed, if the analyst possesses supporting empirical evidence that individual F is unconstrained in the way she could potentially allocate her time in all competing activities—including paid market work—then it may legitimately be concluded that point Q is truly the equilibrium position at which person F maximizes utility by fully specializing in home activities. In this case, the indifference curve U^F passing through point Q would define an unconstrained equilibrium in the sense that it would have to be on the highest attainable indifference curve individual F could reach given her unconstrained feasible budget set. Individual F's reservation wage would thus be represented by the slope of this U^F equilibrium indifference curve at Q and, given that $MRS_{LC}|_Q = Z_H|_Q = r|_Q > w|_E$, the analyst would rightfully be led to identify person F as a *voluntarily nonemployed* individual. Here it is critical to understand that, under these circumstances, individual F's reservation wage would simply correspond to the shadow price of her currently observed *last hour* of home production time, H_Q, evaluated at *full non-market time*. More precisely, that is the lowest price the labor market would have to pay individual F to make her indifferent between entering the market for a first hour of work and spending her last hour in home production (i.e. H_Q), given that she spends $0H_Q$ hours per typical day in leisure-oriented activities.

Notice that, in the case at hand, the total budget line, *TBED*, is not continuous in all of its segments, however. In fact, its market work segment is non-existent in reality (which situation is depicted by the dots between points *E* and *D*), indicating that even if person F wanted to participate in the labor force at the hourly wage she can normally command, there would be no market job currently available to her. As such, individual F is potentially restrained with regard to both the extensive and intensive margins of her labor supply decision. Hence, person F is facing an upper-bound institutional labor market constraint and thus, cannot be regarded as *free* to allocate her time in all three competing domains of activities.

On one hand, if the analyst knew that individual F would not be inclined to participate in the labor force at the real market wage she can normally command, then the current non-availability of a market job would become an irrelevant (i.e. non-binding) constraint inasmuch as person F's higher reservation wage would simply prevent her from entering the labor force given the lower offered market wage (i.e. $MRS_{LC}|_Q = Z_H|_Q = r|_Q > w|_E$). Indeed, under such circumstances, individual F would still be maximizing utility at the equilibrium point Q, where her reservation wage would be given by the slope of her equilibrium indifference curve U^F at point Q.

On the other hand, if the analyst realized that individual F's absence of market work is incongruent with her desired employment status (i.e. her choice with respect to the extensive margin of her labor supply decision) and, consequently, with the amount of time she would normally be willing to supply in the labor force at her potential offered market wage (i.e. her choice with respect to the intensive margin of her labor supply decision), then this would strongly suggest that the current non-availability of a market job is indeed a relevant (i.e. binding) constraint faced by this individual. Further, since this market constraint would make it impossible for the concerned person to enter the labor market at all, while she would normally do so if a job were available, then it follows that point Q cannot be considered as an equilibrium position any more; neither can the indifference curve U^F exist under these constraining circumstances. In fact, given her currently constrained allocation of time, individual F's indifference curve would have to look much more like the one portrayed by U^{F^*}. Here it is imperative to emphasize that although indifference curve U^{F^*} still passes through point Q—as it was with U^F—it cannot possibly represent individual F's equilibrium indifference curve since U^{F^*} does not constitute the highest attainable indifference curve she could reach had a market job been currently available to her. Consequently, point Q could only be considered as an *accommodating* point—or, at best, a *short-run* transitory position—at which person F is temporarily compelled to be. Obviously, individual F is involuntarily unemployed and point Q is a transitory position for her since she is searching for a market job opening in order to adjust her overall allocation of time in a way that would fully maximize utility.

Letting the market wage individual F could normally command be represented by the slope of the dotted line segment *ED*, point Q*, through which passes her highest attainable indifference curve, U^{F*}, truly defines her utility-maximizing allocation of time. Hence, point Q* represents individual F's *long-run* (i.e. desired) equilibrium position where she would normally be working TH_E hours in the home[5] and H_EL_{Q*} hours in the market per typical day. Her remaining time, $0L_{Q*}$, would be allocated to leisure-oriented activities. At this long-run equilibrium position, individual F's shadow price for what would normally be her last hour of home production (i.e. H_E) would be given by the slope of indifference curve U^{F*} at point Q*, where individual F's marginal rate of substitution of leisure for commodities coincides with both the value of her last hour of home production at point *E* and her real hourly market wage (i.e. $MRS_{LC}|_{Q*} = Z_H|_E = w|_E$). Indeed, this long-run equilibrium point depicted by Q* represents individual F's unconstrained allocation of time position. Here the slope of indifference curve U^{F*} at point Q* represents the shadow value individual F places on her last hour of home production, H_E , after she has allocated H_EL_{Q*} hours of her precious time to the labor

[5] The reader might be surprised to notice that when individual F is allowed to reach her long-run (i.e. unconstrained) equilibrium position at point Q*, she appears to devote longer hours in home production activities (i.e. $TH_E > TH_Q$). A very simple but logical explanation for this apparent increase in home production time is linked to the fact that, for F to qualify as an *involuntarily unemployed* person, she would have had to be actively searching for a market job before ultimately finding one. Although this 'search time' might have been relatively intensive, given the exclusive nature of home production activities, it could not have possibly been accounted for as such. Instead, this productive search time would have been mistakenly confounded with leisure time. However, since at point Q* individual F is fully satisfied with her employment situation, she naturally stops her job-searching activities. As a consequence, it follows that at Q* individual F is just substituting job-search hours for home production hours, which substitution process appears to inflate the time she devotes to home production activities.

market. Indeed, because this shadow price coincides exactly with the real hourly wage she would normally command at her long-run equilibrium position, it is referred to as individual F's opportunity cost for what would normally be her last hour of home production time at Q*. Of course, individual F's reservation wage would have to be lower than her net hourly market wage, otherwise she would not be observed supplying hours to the labor market at her long-run equilibrium position. In fact, individual F's reservation wage is given by the slope of her indifference curve $U^{F''}$ at point *E''*, which is indeed less than the real hourly wage she commands at her long-run equilibrium position. In accordance with the reservation wage concept, at point *E''* individual F would be totally indifferent between working her last hour, $H_{E''}$, in the home and *entering* the labor market for a first hour of paid work. Carefully note that at point *E''* individual F allocates much more time to home production activities than she currently does when constrained at point Q (i.e. $TH_{E''} > TH_Q$). But how could this be possible given that both points depict individual F's time-allocation behavior in absence of market work? The reason for this divergence is linked to the concept of unemployment itself. While at point *E''* individual F is placed in a *non-employment* situation (i.e. the full non-market time requirement necessary to derive her reservation wage), point Q—where intersects her indifference curve $U^{F'}$—depicts the current *unemployment* situation faced by person F. Hence, since unemployed individuals are, by definition, actively searching for employment opportunities (while the nonemployed are not), it turns out that the existing difference between $TH_{E''}$ and TH_Q—which difference is depicted by $H_QH_{E''}$—must simply reflect the amount of time person F is currently investing per day in her job-search process.

Thus, under the standard assumption of perfectly continuous budget lines, person F would be seen as totally free to allocate her time in both market and non-market activities. Being currently observed doing no market work at all, she would naturally be qualified as *voluntarily nonemployed*, and her reservation wage would simply be the slope of indifference curve U^F at point Q. However, if the analyst could empirically verify whether or not sampled individuals are really free to allocate their time in both market and non-market activities, then constrained individuals such as F would become distinguishable from the truly unconstrained individuals and, with this important distinction on hand, the analyst would notice that unemployed individuals' true reservation wages may be quite different from those derived under the misleading assumption of perfectly continuous budget lines. For instance, and as shown above, person F's true reservation wage is given by the slope of indifference curve $U^{F''}$ at point *E''*, which is much less than the one that would be given by the slope of indifference curve U^F at point Q under the false assumption of perfectly continuous budget lines.

Therefore, it is manifest from Figure 3.1 that, under the usual assumption of perfectly continuous budget lines, reservation wage estimates for unemployed individuals are upward biased, and thus inadequate as opportunity cost measures for valuing the time allocated to household production activities by these individuals. Clearly, it is so because unemployed individuals cannot be readily distinguished from the voluntarily nonemployed, unless the analyst relaxes the standard continuity assumption in budget lines by fully accounting for the existence of potentially interfering labor market constraints.

The Case of the Involuntarily Underemployed Individual

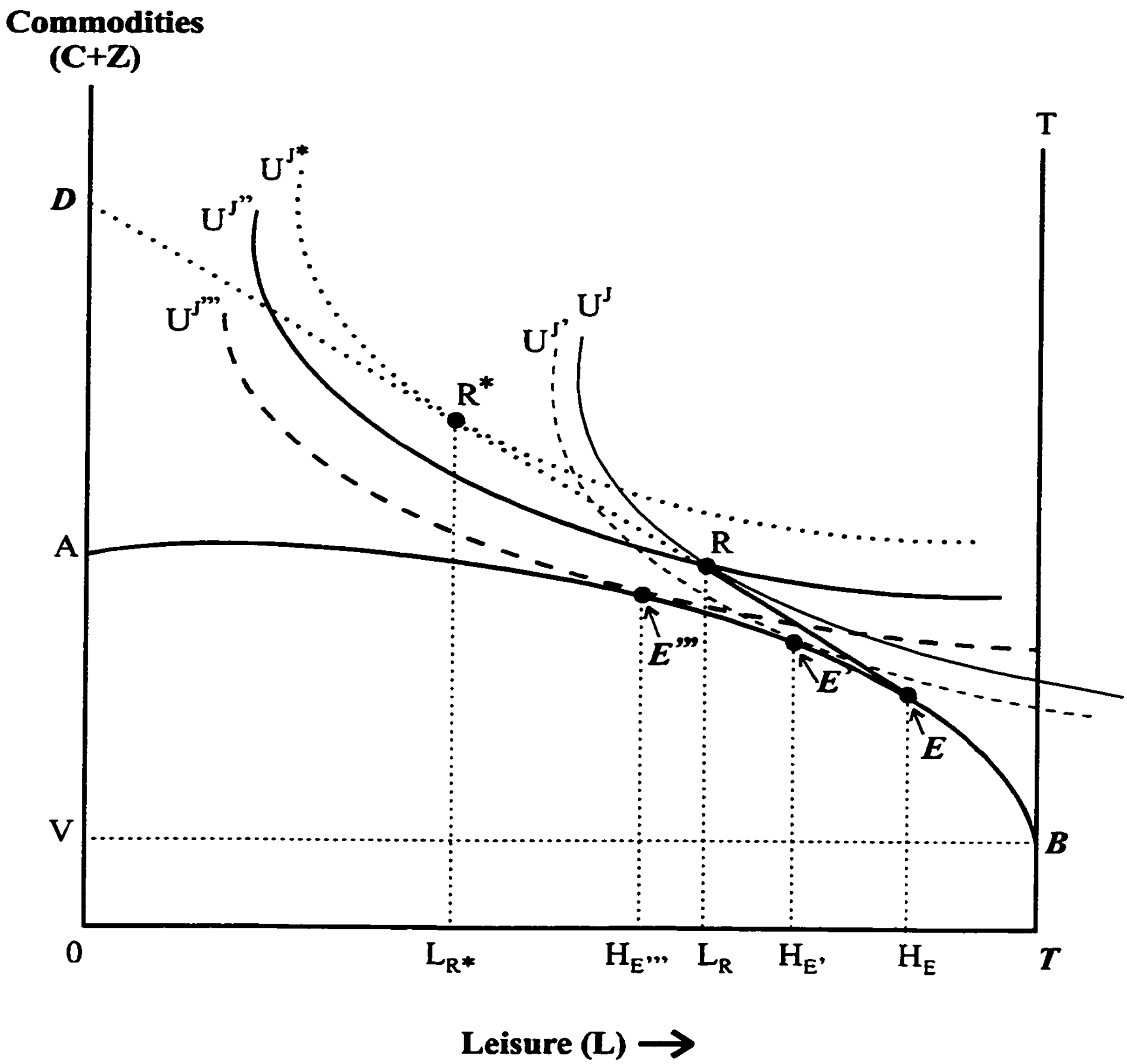

Figure 3.2 Bias Created by Institutional Constraints: The Involuntarily Underemployed

Using the very same graphical approach as in the previous analysis, Figure 3.2 illustrates geometrically how reservation wages derived under the standard assumption of perfectly continuous budget lines might be inaccurate when this assumption makes involuntarily underemployed individuals indistinguishable from those who are content working short hours in the paid labor market. Although the reservation wage concept is used throughout this simple graphical demonstration, it is obvious that any bias in reservation wage estimates introduced by upper-bound market constraints is replicated in the shadow price of home time function (i.e. recall that reservation wages are just shadow prices of home time when M_i is set to zero). As shall be seen, the case of underemployed individuals shares many similarities with the case of involuntarily unemployed individuals. This should not be very surprising since, as mentioned earlier, both cases reflect an institutional upper-bound limit interfering with the amount of time individuals would normally desire to allocate to the paid labor sector.

For instance, when individual J represented in Figure 3.2 is believed to freely allocate her time among home production, market work, and leisure in a way that maximizes her utility, she is observed on her indifference curve U^J at equilibrium point R. At this unconstrained equilibrium point, individual J is seen working TH_E hours in the home, H_EL_R hours in the paid market, while her remaining time, $0L_R$, is spent engaging in leisure activities. Given the few hours she spends in the paid labor market, individual J must be working part-time at point R. Nevertheless, because she is assumed to be entirely free to allocate as many or as few hours of her scarce time in any of the three competing domains of activities, individual J is assumed to be fully satisfied working short hours in the market, inasmuch as these short hours presumably convey the result of her own personal choice. Under these particular circumstances, individual J's shadow price for her currently observed last hour of home production, H_E, is defined by the slope of her equilibrium indifference curve U^J at point R, and incontestably reflects individual

J's opportunity cost of household time given by her real hourly market wage (i.e. $MRS_{LC}|_R = Z_H|_E = w|_E$). To individual J, this shadow price is an appropriate opportunity cost of time only for her last hour of home labor, H_E, and it certainly does not represent her reservation wage since the latter must be valued in absence of paid market work. Still assuming that individual J is fully maximizing utility at point R, her reservation wage would have to be given by the slope of her indifference curve $U^{J'}$ at point *E'* where, at full home time, she would be totally indifferent between trading her last hour of home labor, $H_{E'}$, for a first hour of market work. Indeed, this last allegation is only valid if person J is not restrained in any way with respect to her time allocation possibilities.

As Figure 3.2 shows, individual J's total budget line, *TBED*, is not perfectly continuous in all its segments, however. More precisely, segment *ED* shows a break of continuity after point R (which is represented by the series of dots between points R and *D*). This indicates that, even if she wanted to, for the time being individual J could not work more hours in the labor market than what she is currently working (i.e. H_EL_R). Consequently, individual J is facing an upper-bound constraint on the amount of time she could currently work in the paid labor force, and thus cannot be assumed to freely allocate as many hours in the market as she could possibly want. As such, although person J is not constrained with respect to the extensive margin of her labor supply decision, she is potentially constrained with regard to the intensive margin of her labor supply decision.

Whether or not this upper-bound institutional market constraint has an impact on individual J's estimated reservation wage depends on the relationship existing between the number of hours she currently works in the market and the number of hours she would normally want to work at her current offered wage. In the event that individual J's desired hours of market work exactly correspond with the hours she currently supplies, then the actual upper-bound constraint would not be binding, and individual J's reservation wage would be accurately given by the slope of her indifference curve $U^{J'}$ at point *E'*. Conversely, if it is the case that individual J's current labor supply is less than the number of hours she would normally choose to devote to the paid labor market at her current market wage, then the upper-bound market restraint would indeed be binding, and the slope of indifference curve $U^{J'}$ through point *E'* would not be an appropriate measure for individual J's reservation wage. This is so because, under such circumstances, indifference curves U^{J} and $U^{J'}$ themselves would simply not belong in person J's utility map. In fact, in order to depict the current constraining situation, individual J's indifference curve would have to closely resemble to the one labeled $U^{J''}$. Accordingly, since $U^{J''}$ could not be considered as person J's highest attainable indifference curve, point R through which crosses $U^{J''}$ would have to be defined as an *accommodating* position, at which she is temporarily held against her will. Hence, it would be unambiguous that person J is underemployed, and that point R denotes a transitory position until longer hours of market work become available to her. When longer hours would be available (say, when her employer would give her the possibility of working full-time instead of part-time), then person J's highest attainable indifference curve, U^{J*}, would be reached, and point R* would define her utility-maximizing equilibrium point. At this *long-run* equilibrium point, person J would maximize utility working TH_E hours per day in the home and H_EL_{R*} (rather than H_EL_R) hours per day in the market. Also, she would be spending $0L_{R^*}$ (rather than $0L_R$) hours in leisure activities per typical day.

From the graph above, it is important to note that at equilibrium point R* individual J's opportunity cost for her last hour of household work (i.e. H_E) is similar to the one that would have been derived under the false assumption that she was free to work as many hours as she wants in the paid labor market. That is, graphically, it is found that person J's opportunity cost for her last observed hour of home work (i.e. H_E) at her desired equilibrium position, R*, is simply her real market wage (i.e. $MRS_{LC}|_{R^*} = Z_H|_E = w|_E$), and this real hourly wage also corresponds to the opportunity cost that would have been found for this same last hour of household work under the false assumption that she was fully maximizing utility at point R (i.e. $MRS_{LC}|_R = Z_H|_E = w|_E$). This should indeed be the case. After all, recall that, to the typical employed individual, the opportunity cost of home time—regardless whether this home time is allocated to household production or leisure activities—is the individual's real hourly market wage. However, as was insisted upon in an earlier section, market wages are conceptually very different from reservation wages. Consequently, although the graphical approach shows that, at the margin, the opportunity cost of home time to individual J is the same whether or not the analyst accounts for the upper-bound market constraint affecting her time-allocation behavior, it is obvious that the true reservation wage of individual J is quite different from the one that would normally be derived under the standard assumption of perfectly continuous budget lines. For instance, accounting for the upper-bound market constraint, individual J's true reservation wage would be given by the slope of her indifference curve $U^{J'''}$ at point *E'''* where, at full home time, she would be indifferent between trading her last hour of home work (i.e. $H_{E''}$) for a first hour of market work. Undoubtedly, individual J's true reservation wage is not equal to the one given by the slope $U^{J'}$ at point *E'*. Precisely, and as should be expected, Figure 3.2 shows that person J's true reservation wage is less than the reservation wage that would be derived under the standard assumption of perfectly continuous budget lines.

Therefore, from the preceding discussion it is clear that, under the standard assumption of perfectly continuous budget lines, reservation wage estimates for underemployed individuals are—as with the case of involuntarily unemployed individuals—upward biased. Consequently, although it is demonstrated that, at the margin, the opportunity cost of home production time to the employed person would always be equal to her/his market wage and that, whether she/he is satisfactorily employed or not, it is evident that any extension of the opportunity cost approach using the reservation wage as the starting point to derive an average (rather than a marginal) monetary value for the individual's home production time would be adversely affected from not distinguishing between constrained and unconstrained individuals. This is so because, at the estimation level, the discrepancies between observed and truly desired hours of market work would not only generate bias in the labor supply equation, but also in the retrieved coefficients of the shadow price of home time function. Hence, unless the standard continuity assumption in budget lines is relaxed by fully recognizing the potential existence of upper-bound market constraints, biases in shadow price of home production time estimates would be present because involuntarily underemployed individuals would not be distinguishable from those who are fully satisfied working short hours in the labor market.

The Case of the Involuntarily Overemployed Individual

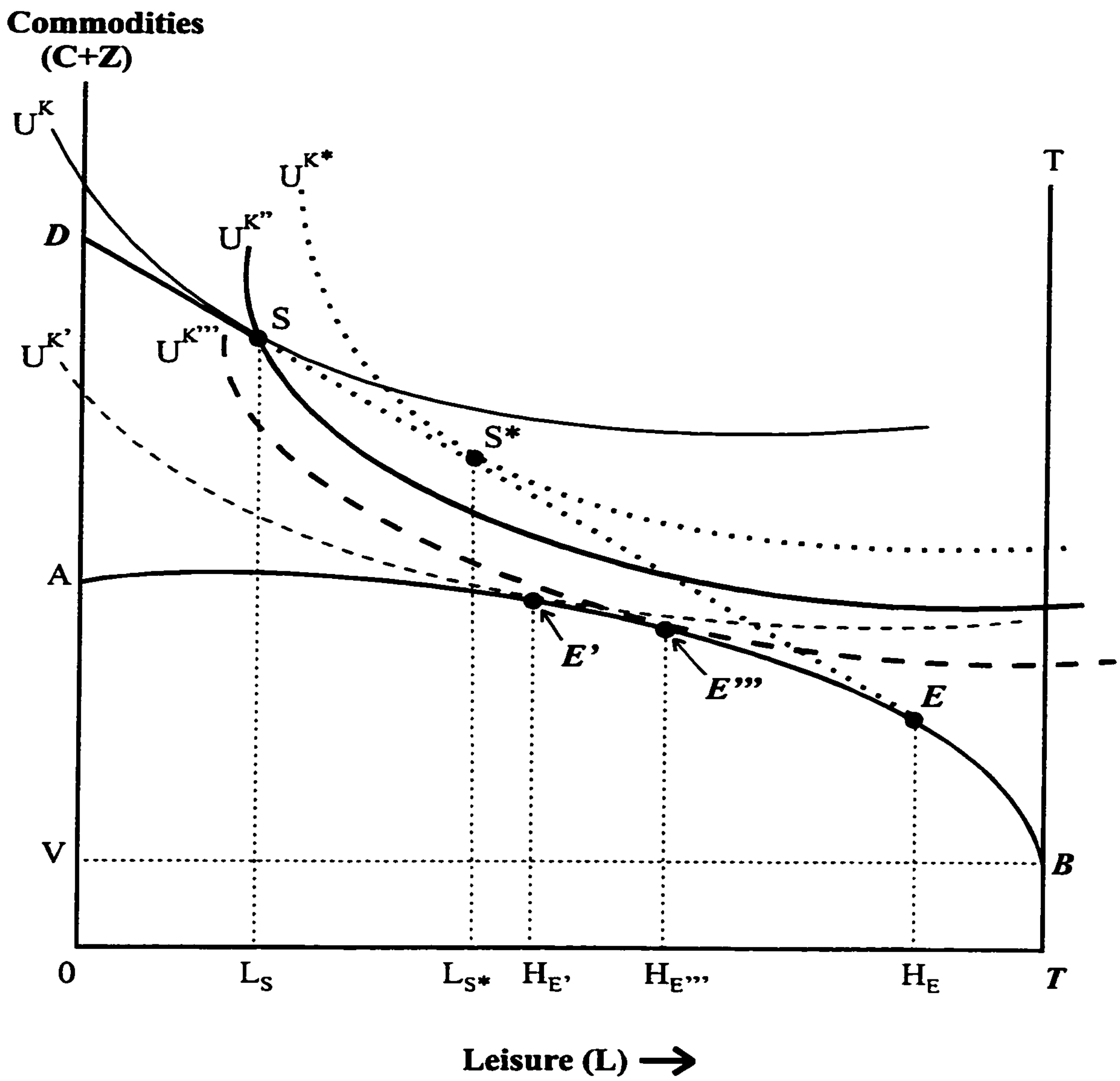

Figure 3.3 Bias Created by Institutional Constraints: The Involuntarily Overemployed

Figure 3.3 presents the last of the three most common types of institutional labor market constraints. It illustrates how reservation wage estimates (and, hence, the shadow price of home time functions from which these reservation wage estimates are derived) based upon the perfectly continuous budget lines assumption might be biased in situations where this assumption renders involuntarily overemployed individuals indistinguishable from those who are fully satisfied working long hours in the paid labor market.

For instance, individual K portrayed in the graph above represents a typical overemployed person. This individual would appear to be fully satisfied working long hours in the labor force if the standard assumption of perfectly continuous budget lines were in effect. Being supposedly free to allocate as few or as many hours of her scarce time in any of the three competing domains of activities at stake, individual K would be thought to maximize utility at point S, where what is considered to be her highest reachable indifference curve, U^K, coincides with the real hourly wage she currently receives in the paid labor market (i.e. $MRS_{LC}|_S = Z_H|_E = w|_E$). At this point, individual K would seem to maximize utility by allocating TH_E hours per day in household work, H_EL_S hours in market work, and $0L_S$ hours in leisure activities. Further, without being aware that individual K is involuntarily overemployed, and thus faces a lower-bound institutional constraint as to the hours she might in fact work in the paid labor market, her reservation wage would be erroneously estimated by the slope of indifference curve $U^{K'}$ at point *E'*.

However, because she is overemployed, it is obvious that neither U^K nor $U^{K'}$ are relevant indifference curves in individual K's utility map. In fact, although she is currently observed allocating her time at point S, her true indifference curve would have to look much more like the one labeled $U^{K''}$. To individual K, point S represents an *accommodating* position at which she is currently constrained to be. Even though she would prefer the shorter hours of market work offered by point S*, the non-continuity of her budget line between points *E* and S makes it currently impossible to fulfill her wants and, therefore, to reach what would normally be her highest attainable indifference curve, U^{K*}, were it not for the lower-bound labor market constraint. As such, person K is constrained with respect to the intensive margin of her labor supply decision. Indeed, if the market constraint were to fall, individual K would naturally change her overall time allocation in order to access her *long-run* (i.e. unconstrained) utility-maximizing equilibrium point, S*, and her reservation wage would be given by the slope of her indifference curve $U^{K'''}$ at point *E'''*. Without the glimpse of a doubt, individual K's true reservation wage corroborates the earlier proposition of our economic model stating that, under the standard assumption of perfectly continuous budget lines, reservation wages estimated for overemployed individuals are downward biased.

Again, unless the standard continuity assumption in budget lines is effectively relaxed via the full recognition of potential labor market constraints, biases in reservation wage estimates for involuntarily overemployed workers would be unavoidable, inasmuch as these constrained individuals would simply remain indistinguishable from those who are satisfied working long hours in the labor market. Furthermore, as with underemployed individuals, although the opportunity cost of home time to the employed individual is the real hourly market wage, regardless whether the individual is facing an institutional labor market constraint or not, it is clear that any extension of the opportunity cost approach using the reservation wage concept as the basis to derive average rather than marginal values for home production time would be adversely affected by not accounting for the reality of institutional market constraints.

Drawing from the presentation of the three graphs above, one simple way to distinguish between constrained and unconstrained observations would be to know if individuals' current labor supply behavior truly corresponds with their *desired* labor supply. As such, if information were available on desired hours of market work—that is, on the desired intensity of the labor supply decision—for each individual, one could simply replace 'observed' by 'desired' hours of market work in the hours-of-work function [i.e. equation (2.39a or b)], and thus correct for the biases resulting from discontinuous budget lines[6]. Otherwise, in cases where only observed hours of market work for each individual are available—which is usually the case with studies using currently available national data sets—it would be advisable that the analyst develop a multiple selection rule procedure which could be used in conjunction with the current estimation model [for instance, see Catsiapis & Robinson (1982)]. However, the former procedure would allow for a direct control of the potential biases introduced by institutional labor market constraints in both labor supply and reservation wage estimates in a much more suitable fashion than the indirect control resulting from a multiple selection rule approach.

In view of the fact that all studies reviewed have either simply ignored the issue of potentially constrained hours of market work, or unsatisfactorily adopted an indirect type of control to account for hours-of-work constraints (perhaps because the large majority of

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[6] Indeed, inasmuch as knowledge of the desired intensity of the labor supply decision necessarily dictates the desired employment status of the individual (i.e. the extensive margin of the labor supply decision), it follows that the Probit function expressed in equation (2.41), which is also translated into the labor-supply participation decision [i.e. equation (2.42)], also needs to be refined in terms of desired rather than observed labor force participation in order to fully account for labor market constraints. This is so because, in addition to being restrained with respect to the number of hours they can supply to the labor market, unemployed individuals are also constrained with respect to labor-market participation status.

these studies have principally dealt with less than perfect secondary sources of data such as the Panel Study of Income Dynamics (PSID), the Current Population Survey (CPS), the National Longitudinal Survey (NLS), the National Survey of Families and Households (NSFH), the Northeastern Regional Project data (NE-113), and so on, which usually do not contain the necessary information with respect to respondents' desired market work behavior), the impact of discontinuous budget lines on the value of home production time has yet to be empirically assessed. Hence, it becomes imperative that household production valuation studies exert an appropriate control of institutional hours-of-work restraints, especially when such studies purport to value the true economic contribution of home production time of married women who, presumably, may be more likely to experience such market constraints.

The Problem of Unobserved Critical Labor Supply Determinants

A last potential problem which may also undermine reservation wage estimates as true shadow prices (i.e. opportunity costs) of the last hour of household labor at full home time is due to the omission of presumably critical regressors from the standard specification of the recurrent system of equations presented in Chapter 2. Although human capital theory (Ben Porath, 1970) provides sound guidance as to which important explanatory variables should be included in the market wage equation [i.e. equation (2.21)] and, similarly, although both time allocation theory (Becker, 1965)—and thus utility theory—and human capital theory permit a quite straightforward delineation with regard to the critical determinants of the shadow price of home time equation [i.e.

equation (2.22)], available secondary sources of data rarely enable researchers to include all the salient regressors in their analytical endeavor.

Not surprisingly, to a large extent the sample selection correction procedure developed by Heckman reflects the incapacity of the commonly used regressors to adequately differentiate individuals who choose to participate in market work from those who do not. Consequently, it is no coincidence that the problem of selection bias comes down to an "ordinary" omitted explanatory variable problem in the correction procedure suggested by Heckman. More precisely, his procedure explicitly recognizes the fact that the error structure of the recurrent system of equations [i.e. equations (2.21)-(2.23a or b)] is *non-random* (i.e. non-stochastic), inasmuch as it contains substantial unexplained variations which, alone, possibly determine most of the sample censoring resulting from the partial observability of market wages. Accordingly, Heckman's correction procedure resorts to sophisticated econometric techniques to somewhat 'explode' the error term of equations (2.21) and (2.23a or b) in an attempt to recover the *non-random* variations through the addition of a new regressor labeled 'lambda', $\lambda(Z_i)$, which is constructed from the results of a Probit analysis performed on the labor-force participation decision (i.e. on the extensive margin of the labor supply function) of all sampled individuals. The selection-corrected functions resulting from such a procedure are presented in equations (2.38) and (2.39a or b) derived earlier. Indeed, lambda, as a new regressor in the market wage and hours-of-work equations, can be seen as an attempt to make up for the important omitted explanatory variables and, by the same token, to correct for sample selection bias directly emerging from the omission of these critical explanatory variables.

Here it is very important to realize that, although the estimation procedure proposed by Heckman is capable of removing sample selection bias from reservation wage estimates (and hence from the shadow price of home time function), it does not provide the analyst with any kind of information regarding the nature of the critical determinants left out of the recurrent system of equations. That is, the sample selection correction procedure suggested by Heckman only indicates whether or not certain critical regressors have been omitted from the estimation model. For instance, when the estimated parameters of lambda, ξ_W [i.e. $\sigma_{WM}/(\sigma_{MM})^{1/2}$ in the market wage equation, (2.38)] and/or ξ_M [i.e. $(\sigma_{MM})^{1/2}$ in hours-of-work equation, (2.39a)], are found to be statistically significant, selection bias is said to be a relevant issue, hence indicating that the currently included regressors simply fail to adequately discriminate between individuals who choose to participate in paid market work and those who do not. Conversely, in cases where lambda is not statistically significant, sample selection bias does not appear to exist, hence supporting the fact that the currently included regressors are sufficient to distinguish between individuals who choose to be employed and those who do not. Thus, sample selection bias can be rightfully linked to the discriminatory power of the explanatory variables considered in the estimating system of equations used to derive shadow prices of home time. Specifically, this comes to say that, if the analyst could pinpoint all the relevant determinants with respect to individuals' labor supply—particularly the determinants of the participation decision that is modeled through the maximum-likelihood Probit function contained in equation (2.41), and which actually translates the extensive margin of the labor supply decision [i.e. equation (2.42)]—sample selection would become irrelevant as a bias resulting from the censoring of samples. This is so because the censoring itself would be fully explained by the regressors supposedly leading to it. A very simple way to see how this could be possible is to consider the following *corrected* hours-of-work equation

$$M_i = X_{Mi}\beta_M + (\sigma_{MM})^{1/2}\lambda(Z_i) + V_{Mi},$$

which could equivalently be written as

$$M_i = X_{Mi}\beta_M + \lambda(Z_i)\xi_M + V_{Mi},$$

as in equation (2.39a), where

X_{Mi} = a (1 x K_M) row vector of regressors affecting the hours-of-work decision of individual i ;

β_M = a (K_M x 1) column vector of parameters corresponding to the regressors contained in X_{Mi}, including an intercept ;

$\lambda(Z_i)$ = lambda, the new regressor constructed from the results of the Probit analysis on the probability of labor force participation performed over the entire sample of individuals, and representing the inverse Mills ratio ;

$\xi_M \equiv (\sigma_{MM})^{1/2}$ = the corresponding parameter of $\lambda(Z_i)$; and

V_{Mi} = the *now* stochastic (i.e. random) disturbance term for the corrected hours-of-work equation .

Notice carefully that the corresponding parameter of lambda, ξ_M, is just the square-root of the variance of the *non-stochastic* error for the hours-of-work equation *before* correction for sample selection bias. Hence, it is clear that if the independent variables contained in X_M were capable of explaining the censoring of the sample—that is, if they were powerful enough to discriminate between the individuals who choose to participate in the labor market and those who do not—then ξ_M [i.e. $(\sigma_{MM})^{1/2}$] would necessarily tend toward zero, indicating that sample selection bias would not be a relevant issue.

Of course, it would be hardly conceivable to suggest that *all* the critical determinants of the labor supply decision can be accounted for in the specification of even the best estimation model, inasmuch as some of them could simply be ***unknown*** to the analyst. Nevertheless, what is suggested here is that some critical regressors are consistently omitted from the standard specification of the recurrent estimation model proposed by Heckman simply because currently available secondary sources of data do not permit their proper inclusion. Under these circumstances, the problem of sample selection bias faced by the analyst may not be a problem arising from the 'non-observability' of certain salient regressors per se as claimed by Heckman (1979), but one possibly emerging from the 'non-availability' of these *observable* important determinants. Although rudimentary, this simple semantic distinction is essential[7].

For example, one such important and generally omitted regressor is believed to be of a psychological nature. Indeed, often because of the non-availability of the appropriate information, applied researchers wanting to value home production time are usually compelled to get along without even considering individuals' attitudes toward the objects of interest (i.e. market and non-market production activities). Inasmuch as shadow prices of home production time convey both economic and utilitarian values [for instance, recall that the reservation wage also captures, among other things, the individual's utility or

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[7] As such, while the expression "non-availability of observable important determinants" reflects the limitations that characterize the imperfect sets of data upon which the analyses are conducted and for which future improvements are possible and hoped for, the semantic entailed in the expression "non-observability of certain salient regressors" leaves no room at all for possible improvements with respect to the additional important regressors that should be accounted for in the estimation model since these are presumably unobservable.

disutility derived from engaging in household production activities], omitting such attitudinal variables from the shadow price of home time function [i.e. equation (2.22)] and, consequently, from the hours of market work function [i.e. equation 2.23a or b)], inevitably weakens the overall quality of the parameter estimates one might derive. Likewise, in the event that such attitudinal variables contribute to distinguishing between individuals who choose to be employed and those who do not, their omission from the Probit analysis of the labor-force participation decision [i.e. equation (2.42) upon which (2.41) is optimized] should necessarily impair the explanatory power of the Probit function and possibly contribute to sample selection bias. Indeed, the impact of this omission on the overall quality of the estimates and on whether or not sample selection is a relevant issue in the model (i.e. whether lambda is statistically significant or not in the market wage equation and/or the hours-of-work equation) will depend on the potential contribution of the omitted regressors in explaining the underlying dependent variables (i.e. $\ln S_i$, $\ln W_i$, M_i, and P_i for our purpose), as well as their inter-correlations with the other existing regressors included in the equations to be estimated. Simply put, the greater the predictive power of the omitted variables (i.e. the larger their contribution to the adjusted R-square in the least-squares estimated market wage and hours-of-work equations, and the larger their contribution to the pseudo R-square measures in the estimated Probit equation of the labor-force participation decision), the larger would be the bias in the estimates from having omitted them[8], and the more likely lambda is to be significant in the market wage and hours-of-work equations. Rightfully, the deterministic

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[8] For more details regarding the impact of omitting relevant regressors on the overall quality of the coefficients obtained from least squares regression, see Gujarati, 1988, pp. 403-404.

power of attitudinal variables with respect to the reservation wage, or any other shadow price of home time, is an empirical matter. However, in light of actual evidence from an abundant number of studies, it appears that certain attitudes, especially *gender-role attitudes*, represent very important determinants of the labor force decision—both at the extensive and intensive margins—particularly with respect to married women. More precisely, many studies which have attempted to explain the causes of women's paid employment have found gender-role attitudes to strongly predict employment behavior, whether it is current labor force participation (Dowdall, 1974; Ferber, 1982; Thornton et al., 1983; Thornton & Camburn, 1979), plans for future employment (Kim & Murphy, 1973; Stolzenberg & Waite, 1977; Waite & Stolzenberg, 1976), or intensity of recent employment (Edge & Meyer, 1970). Further, other studies have found that men's attitudes toward their wives' employment significantly affect both women's own attitudes toward labor force participation (Spitze & Waite, 1981) and their current labor market behavior (Astin, 1968; Folk et al., 1989; Spitze & Spaeth, 1979).

Hence, given these substantial findings on the relationships between gender-role attitudes and the labor supply function of married women, it seems very likely that important biases may result from omitting such important attitudinal variables from the shadow price of home time function [equation (2.22)]. In other words, it must be the case that the reservation wages of married women and hence, their labor supply decisions—both their labor-force participation decision [i.e. equation (2.42)] and hours of market work decision [i.e. equation (2.23a or b)]—are directly conditioned by their gender-role attitudes. Further, it is also reasonable to think that the proper inclusion of gender-role attitudes as regressors in the recurrent system of equations may permit a better understanding of the sample-censoring process resulting from labor-supply participation decisions of married women. To this date, no study has attempted to examine the influence of these gender-role attitudes on the value of home production time of married women and/or on the issue of sample selection bias itself. Therefore, it seems that an appropriate investigation of these issues remains to be conducted.

In the same order of ideas, other potentially important regressors such as the individual's potential health impairment, available household technology, and perception with respect to the overall adequacy of household's income are usually missing from the system of equations used to derive the shadow price of home time function. Given their particular nature, these regressors are believed to be consequential in explaining labor supply decisions, and hence reservation wages. As for gender-role attitudes, their omission from the recurrent estimation model, notably from the shadow price of home time function [i.e. equation (2.22)], the hours-of-work function [i.e. equation (2.23a or b)], and the Probit analysis of the labor-force participation decision [i.e. equation (2.42)] appears to be mainly attributable to the non-availability of the necessary information in existing secondary sources of data. Therefore, proper measurement and inclusion of such generally omitted regressors in the relevant functions should add to the overall robustness of the estimation model and, consequently, provide for better opportunity cost estimates of the true value of home production time.

CHAPTER 4

THE PRESENT STUDY

Primary Purpose of this Study

From the preceding discussions, it is clear that although the methodological contribution of Heckman provides a useful avenue for handling sample selection bias, other important sources of bias emanate from certain oversimplifying assumptions upon which the standard opportunity cost of time methodology generally relies to derive the monetary value of home production time.

Specifically, the implicit assumption of linearly homogeneous home production functions (i.e. the assumption that home production functions are of constant returns to scale in home labor input) and the perfectly continuous budget lines assumption (i.e. the assumption that individuals are totally free to allocate as little or as much of their time to both market and non-market activities—or, more precisely, that there are no institutional labor market constraints possibly affecting individuals' time-allocation behavior) portray very strong premises believed to be incongruent with reality. In the very likely event these assumptions fail to depict the real circumstances surrounding household members' time allocation, economic values of home production time derived via the standard opportunity cost methodology could be importantly distorted from the true opportunity cost values individuals and their households actually place on this non-remunerated productive time.

Additionally, the omission of potentially critical labor supply regressors from the usual specification of the shadow price of home time function—notably the individual's and her/his spouse's gender-role attitudes, her/his available home technology, health considerations, and perception with respect to the adequacy of her/his household's income in meeting the wants of her/his household—may further bias estimates of the true opportunity cost value of home labor time. As such, in the eventuality that some of these commonly omitted regressors importantly contribute to explain individuals' labor-force participation decision, it might even be possible that the sample-selection correction procedure developed by Heckman becomes unnecessary when such regressors are properly included in the specification of the shadow price of home time function.

Clearly, it becomes imperative to empirically verify the validity of the speculations formulated above, and this represents the primary purpose of this study. Also, inasmuch as wives still accomplish most of the home production in married-couple households (Bergen, 1991; Ferree, 1991), and since they seem to represent a segment of the population potentially more likely to be affected by labor market constraints (Tilly, 1992), this study focuses exclusively on the valuation of home production time of married women. Indeed, compared to what has been done in prior research, it is argued that the application of the opportunity cost of time methodology in line with the conceptual and empirical refinements discussed above should not only provide for a more accurate and reliable assessment of the authentic opportunity cost value of married women's home labor time, but also for a better understanding of the antecedents at the basis of their time-allocation behavior with respect to both market and non-market productive activities.

Data Used to Conduct the Study

Given both the very nature of the information necessary to implement the proposed methodological refinements and the various limitations of secondary sources of data currently available, it was decided to employ primary data to conduct the present study. Specifically, a sample of 5,000 married men and women, aged 20 or more, but less than 65 years of age, and living together in intact families were randomly drawn from the Midwestern state of Missouri. The decision to use the state of Missouri as the sampling population rested mainly on practical and economic considerations. A proportional sampling scheme was elaborated by *Best Mailing Lists, Inc.* in order to ensure that every Missouri family unit conforming to the above criteria had an equal chance of being sampled[1]. Given the size and demographic characteristics of the sample requested, of the 117 Missouri counties, 114 could be retained through the sampling frame[2].

Also for practical and economic reasons, mailed, self-administered questionnaires were used to gather all the needed information. The first version of these questionnaires was elaborated during the Winter of 1996 and piloted with a small random sample of 50

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[1] Although *Best Mailing Lists, Inc.* guaranteed that its proportional sampling technique provided for a representative sample of the population of married Missouri households conforming to the sampling criteria that were decided upon, a word of caution must be expressed regarding this 'representativity' of the sample. In fact, inasmuch as mailing list companies compete among each other on the basis of the accuracy of their lists, and because homeowners are less likely to move (i.e. change their addresses) than renters in the short run, then it is very likely that these mailing list companies over-sample families which own their home. Hence, if this were to be the case as suspected, then the representativity of the sample would be impeded by this over-sampling of homeowners.

[2] The three counties that could not be retained through the proportional sampling frame were Mercer, Schuyler, and Worth. Each of these three counties had less than 4,347 of population at the time of the survey, and thus were not populated enough to be represented in the mailing sample.

Missouri households in April of 1996. The pilot phase was mainly to ensure that the questionnaires could be adequately adjusted in their contents, lengths, and forms so as to maximize the response rate from the sampled households. Specimens of the final version of the questionnaires used for the study are reproduced in Appendix A. For the study itself, a two-wave mailing scheme was adopted. During the first wave, which took place in the last week of May 1996, 4,950 pairs of questionnaires were mailed to the married couples randomly selected from the state. As a reminder for the completion of the survey, post cards were sent to those very same households two weeks after the initial mailing. The second wave of the mailing scheme was intended as a follow-up targeting only those sampled households that had not returned any completed questionnaire at all by the third week of June. This second wave took place in the last week of June 1996, and consisted of 4,120 pairs of questionnaires. As for the initial wave, post-card reminders were sent out exactly two weeks after this second mailing. Appendix B presents specimens of these post-card reminders.

In total, 1,243 of the sampled households returned survey instruments. Of these, 187 surveys could not be retained and processed, either because both questionnaires were not completed at all, because they were both improperly or poorly completed, because the marital status of the household had changed between the sampling phase and the sending of the questionnaires, or because one or both spouses were 65 years of age or over. Thus, from an original mailing sample of 4,950 households, 1,056 surveys could be processed. This represents a response rate of over 21 percent, more than twice the rate of response faced during the pilot phase of the survey[3]. Indeed, this is not to say that 1,056 *pairs* of *completed* questionnaires were returned. In fact, of these 1,056 returned surveys, 143 households only answered one questionnaire or, although they sent back both questionnaires, refused to disclose any kind of information on their personal earnings or family income. Inasmuch as family income and personal earnings figures represent indispensable information for the conduct of the present study, households which returned only one questionnaire as well as those for which income and earnings data could not be obtained from available information were simply excluded from the sample. Therefore, in total, 913 pairs of completed questionnaires were returned. Considering that both spouses were asked to participate in the survey by independently completing a questionnaire, a response rate of 18.44 percent in terms of completed pairs of survey instruments appears to be relatively fair. For all the various analyses to be conducted in this dissertation, only 857 pairs of questionnaires are utilized, however. In fact, 56 households were eliminated from the usable sample because the wives in those households were multiple job-holders. The removal from the study of those households in which the wives were multiple job-holders was largely motivated by the problem arising from the necessity of dealing with different market wage schedules for such individuals. Since the market wage mirrors, as explained in a previous section, the opportunity cost of non-market time (i.e. the cost of engaging in home activities such as household work or leisure instead of working in the labor market) at the margin to the employed individual, it should be obvious that the holding of more than one market job adds a great deal of complexity to the valuation of household production time. For

[3] Only five out of 50 households (i.e. 10 percent) returned survey instruments during the pilot phase.

instance, in cases in which the individual under analysis commands different wages from different market jobs, which wage rate should be considered and used to derive the value of home time? Should the analyst take the hourly wage rate netted on the primary job, the hourly wage on the job that was first taken by the individual, or just the weighted net hourly return to paid employment? Indeed, although the current literature is silent on this specific issue, one could reasonably argue that, at the conceptual level, the latter alternative would seem to be more appropriate. Yet, at the empirical level, since an hourly weighted wage would necessarily differ in values depending on the differences between the number of hours (say per week) worked on each market job, it is evident that the analyst who projects to use both observed and desired hours of work to identify labor market constraints and, ultimately, control for their adverse effects on the valuation of household production time would inevitably have to cope with the perplexity of different 'weighted' wage rates for the same individual[4]. Thus, mostly for this reason, and abstracting from the other mentioned requirements for sample inclusion, it was decided to limit the sample of this study only to those households in which the wives had no more than one market job at the time of the survey. Consequently, any particular analysis,

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[4] For example, assume an individual who holds two different market jobs and who is currently working 30 hours per week on her primary job and 20 hours per week on her second job. Also, suppose that on her primary job she earns a real hourly wage rate of $12, while on her second job she nets only $7 per hour. If a 'weighted' hourly wage rate were computed, it would be found that this individual's real return to paid market employment is $10 per hour [i.e. {(30 hours * $12)+(20 hours * $7)} / 50 hours = $10].

Now, if we knew that this person is currently facing an upper-bound labor market constraint with respect to the weekly hours she can possibly allocate to her primary job (i.e. she is underemployed in her primary job), inasmuch as she would normally be observed working, say, 40 hours per week on her primary job if she could and no hours on her second job, then this individual's real return to paid employment would simply be $12 per hour. Hence, from this simple example, it is clear that using 'observed' hours of work (i.e. not accounting for the upper-bound labor market constraint) yields a 'weighted' wage of $10 per hour, while using 'desired' hours of work (i.e. controlling for the constraint) would give a 'weighted' hourly wage rate of $12.

descriptive or inferential, that is reported in this study is based upon a total sample size of 857 households, unless otherwise specified. Naturally, the generalization of any result or conclusion emerging from this study would have to be adjusted accordingly.

Uniqueness of the Data Used in this Study

As it should be anticipated, the data used to conduct this study offer several unique and distinctive features which, until now, had hardly ever been compiled in a single data set. Not only do these data represent an abundance of information about the usual personal and socio-demographic characteristics of the sampled wives and their husbands, the composition of their families, the households in which they reside, and the nature and amount of unpaid household work they typically accomplish, but also they contain a great deal of details on both their actual (i.e. currently observed) and desired time-allocation behavior with respect to paid labor market employment. Specifically, information about whether the wives and husbands worked for pay in 1995, how much they actually worked, how much they earned respectively in terms of wages and salaries, and how much they would normally have chosen to work had they been fully allowed (i.e. 'free') to allocate their time to their paid market jobs, is crucial for the purposes of this study. As such, the availability of both 'observed' and 'desired' labor supply behavior for each sampled wife constitutes an important addition which makes this collection of data unique in its kind since, in contrast to any other currently available data set, the information on desired labor supply behavior—along with the actual (i.e. observed) labor market behavior—makes it at last possible to easily distinguish between constrained and truly unconstrained individuals, and thus control for the adverse (i.e. biasing) effects of institutional labor market constraints on the estimated opportunity cost value of household production time.

In addition to the conventional personal and socio-demographic data about the sampled wives and their husbands, the composition of their families, the characteristics of the households in which they live, their typical hours of household production and the nature of this production, their actual involvement and earnings in the labor market, and the new details it provides on their desired labor supply behavior, the data set utilized in this study also contains important information about the gender-role attitudinal orientations of these sampled individuals, their health-related restraints, and their perceptions regarding the adequacy of their home technology and household's overall money income. Furthermore, another notable feature of these data is that information about the retrospective paid labor market experience is available for all sampled individuals—whether they currently work or not. Hence, these additional pieces of information convey valuable improvements over most other available collections of data which, unfortunately, seldom provide any kind of insights with regard to these important personal characteristics.

Also of prime importance for this study, information about the spouses' gross combined income in 1995—including earnings from any remunerated market work activities and income derived from sources other than paid employment—the number of personal tax-exemptions for dependents claimed in 1995, and the dollar amount of expenditures related to childcare services in the same fiscal year, is also contained in the data set. As such, not only does this particular information make it possible to obtain nonlabor income figures for each sampled individual, but also it provides a workable basis for the derivation of an average income tax rate for each household, and thus for the imputation of Federal and State income taxes from both wages and nonlabor income figures.

Finally, it is appropriate to mention that the data used in this study were captured via the *Full Screen Product* provided by the SAS software (i.e. SAS/FSP®) on a personal micro-computer. Technically speaking, this special component of the SAS software offers a windowing environment which greatly facilitates the overall process of inputting the data through the replication and imaging of the original survey instrument. It also offers the analyst many useful programming utilities in order to control the accuracy of data entry. Additionally, for the sake of consistency all the data have been input in two distinct data sets which, subsequently, were meticulously compared and revised for any potential discrepancy. Consequently, although twice as time-consuming as a single data-pass, this double-input procedure guarantees a very high standard of accuracy with respect to the resulting collection of data exploited in this study.

CHAPTER 5

METHODOLOGY

The Analytical Framework of the Study

In order to empirically verify and control for each previously reviewed source of bias thought to result from the standard application of the opportunity cost methodology to valuing household production time, three different versions of the general recurrent estimation model proposed by Heckman (1976) are utilized and compared in terms of their empirical results with a sample of Missouri wives in this study. Further, through a simple averaging procedure based on the formula contained in equation (3.1), and which exploits the full flexibility of the shadow price of home time function, an extension of the opportunity cost approach is implemented to derive *average* shadow price values for home time devoted to household production activities.

As should be seen in the following sections of this chapter, while the first version of the estimation model only reproduces the usual and currently standard practice of deriving the opportunity cost of household production time, the two other estimation models improve on the usual model by refining its econometric formulation in ways that allow control of certain particular sources of bias simply ignored in the standard model and which, presumably, may lead to substantial discrepancies between estimated and true economic values of household production time. For instance, the second version of the estimation model incorporates regressors generally missing from the conventional specification of the standard model, but believed to be of critical importance in the determination of reservation wages—and thus, in the determination of the shadow price values of household production time—and on the very issue of sample selection bias as well. Likewise, in addition to the new important regressors considered in the second version of the estimation model, the third version makes use of desired (i.e. truly unconstrained) labor supply behavior in order to control for institutional labor market constraints also known to generate bias in reservation wage estimates and in any other estimate of the monetary value of household production time derived from the shadow price of non-market time function. Consequently, it is important to realize that only the third version of the estimation model guarantees that all sampled wives are 'observed' in their long-run time-allocation equilibria.

For every particular version of the estimation model utilized in this study the shadow price of home time function is retrieved upon ordinary least squares estimation of the sample selection-corrected market wage and hours of market work equations. As such, both the market wage and shadow price of home time equations are used to derive the monetary value of household production time for the sample of Missouri wives. Specifically, in a first analysis, reservation wages—as shadow price values of the last hour of home time prior to labor market entry—and market wages are derived from each of the three distinct models for both working and non-working wives. In conformity with the standard practice, opportunity cost values of household production time are computed directly from the shadow price of home time function for the subsample of full-time housewives (i.e. for the subsample of non-working wives), and from the market wage function for the subsample of wives participating in the paid labor market (i.e. for the subsample of working wives). Indeed, compared to the estimates obtained from the standard version of the model, while the opportunity cost values of home production time derived from the second version of the estimation model should offer better estimates of the monetary values sampled wives place on their household labor, opportunity cost values derived from the third and most refined version of the estimation model should be much more reflective of the true economic value sampled wives actually confer to that productive time.

As pointed out earlier, inasmuch as household production time—like any other input used in a production process—is believed to obey the principle of diminishing marginal returns (i.e. DRS), and because any single opportunity cost value derived from the market wage and shadow price of home time functions only provides for the monetary value of home production time *at the margin*, it follows that intramarginal hours of household production must be valued and averaged if one wants to derive an opportunity cost measure that is valid for all hours allocated to household production activities. Accordingly, in a second analysis, the standard implicit assumption of linearly homogeneous (i.e. CRS) home production functions is relaxed in order to account for the decreasing marginal productivity of home labor time, and a 'linearization' of home production functions is achieved for each different version of the estimation model from a simple computational procedure which permits derivation of average shadow price values of home labor time that are not impeded by the limiting marginal nature of market wages, reservation wages, or any other shadow price of home time derived under the standard assumption of linearly homogeneous home production functions. These average shadow price values of home labor time are contrasted to the standard opportunity cost measures—such as market and reservation wage figures—obtained under the implicit assumption of linearly homogeneous (i.e. CRS) home production functions, and then utilized to derive annual monetary value of household production time for the subsamples of employed and nonemployed Missouri wives. Here it shall be seen that the derivation of average shadow price values of home production time represents a substantial improvement over the *marginal* opportunity cost measures offered by the standard (i.e. usual) application of the opportunity cost of time approach to assessing the monetary value of household production time.

Before presenting and describing in detail each of the three particular versions of the estimation model used to conduct this study, it is appropriate to recall that the general econometric model developed by Heckman consists of two functions that are directly estimable via simple least squares regression techniques—a market wage function, equation (2.21), and an hours of market work function, equation (2.23a or b)—both corrected for sample selection bias as illustrated in equations (2.38) and (2.39a or b) respectively, and from which the estimated parameters of a shadow price of home time function, equation (2.22), are retrieved upon the statistical identification of the recurrent estimation model. Here recall also that this particular estimation model qualifies as 'recurrent' because it explicitly recognizes that labor supply decisions are strictly based on the existing discrepancies between market and reservation wages and that, although the shadow price of home time function can be properly defined and specified in the econometric model, its coefficients can only be retrieved after the estimation of the market wage and hours of market work functions. Furthermore, it is important to remember that the sample-selection correction procedure which ultimately resumes to the inclusion of lambda, $\lambda(Z_i)$, in equations (2.38) and (2.39a or b) is made possible through a Probit estimation of the labor-force participation decision—the extensive margin of the labor supply decision—over the entire sample of individuals [i.e. equation (2.41) which is optimized by the maximum-likelihood Probit estimation of equation (2.42)].

Thus, statistically speaking, the basic econometric model from which the results of this study are obtained follows Heckman's two-stage estimation procedure, which, as seen earlier, is consistent with the opportunity cost methodology to valuing home production time. Specifically, in the first stage of the estimation procedure the probability of working in the paid labor force is estimated for each sampled individual via Probit analysis of the labor-force participation decision, and the results of this Probit run are used to compute a selection-bias correction variable, lambda, for each observation. In the second stage of the estimation procedure, lambda is added to the set of regressors included in the market wage and hours-of-work functions, both of which are subsequently estimated over the selected sample of observations (i.e. only those sampled wives participating in the paid labor market) using ordinary least squares regression. Because of the inclusion of lambda as regressor in the market wage and hours-of-work equations, once estimated, the parameters of these equations may be used to predict the potential market wages for the non-selected sample of observations (i.e. the nonemployed wives) by substituting their particular personal characteristics into the corrected equation. As such, the predicted market wages for the nonemployed observations are free from selection bias. Most importantly, given the recurrent nature of Heckman's model, the equations obtained from the second stage of the estimation procedure are used in tandem to retrieve the coefficients of the selection bias-corrected shadow price of home time function from which the reservation wage of any sampled wife, employed or not, is derived.

Hence, as a practical matter, the general econometric model upon which is designed each of the three estimation models utilized in this study necessitates that four distinct functions be appropriately specified. Specifically, the labor-force participation decision function (i.e. the extensive margin of the labor supply decision) upon which the Probit analysis is performed in order to compute lambda, the market wage function, the shadow price of home time function, and the hours of market work function (i.e. the intensive margin of the labor supply decision) must all be specified.

With this reiteration of the basic estimation framework developed by Heckman, it is now possible to introduce each of the three versions of the estimation model used in this study. Accordingly, the remaining sections of this chapter present the three particular versions of the estimation model. More precisely, each specific version of the estimation model is described in terms of its particularities and primary expectations, the different functions to be estimated are fully specified, and the variables used in each version of the model are defined and justified.

The Standard Version of the Estimation Model

Because its specification closely duplicates the very particularities of the econometric model commonly implemented by home and family economists to derive the monetary value of household production time from an opportunity cost perspective, the first version of the estimation model used in this study shall be referred to as the 'standard version' of the estimation model.

As such, this first version of the recurrent equations system, along with its standard regressors, is estimated as it is usually done via Heckman's two-stage procedure—accounting for sample selection bias, but not for any other particular source of bias possibly affecting shadow price of home time values, and hence reservation wages. The coefficients of the shadow price of home time function for the sample of Missouri wives are then retrieved and, in line with existing empirical work, it is expected that sample selection bias will be present, although controlled for by the inclusion of lambda in both market wage and hours of market work equations. More precisely, lambda should be statistically different from zero in the market wage equation and/or in the hours-of-work equation, indicating that the particular socio-demographic and economic regressors generally utilized in the standard estimation model do not adequately explain the labor-supply participation decision (i.e. the decision of whether to participate in the paid labor force or not) of the sampled Missouri wives. Accordingly, the standard version of the estimation model should be relatively weak in terms of its explanatory power, especially with respect to its capacity to explain the censoring of the sample.

Empirical Specification of the Standard Version of the Estimation Model

For the standard version of the estimation model, the sample selection-corrected market wage equation and the shadow price of home time equation can be respectively expressed in terms of the commonly used regressors from the wives' data as:

$$\begin{aligned}\ln W_i = {} & \beta_{W0} + \beta_{W1}AGE_i + \beta_{W2}AGESQ_i + \beta_{W3}ED1_i + \beta_{W4}ED2_i + \beta_{W5}ED3_i + \beta_{W6}ED4_i + \\ & \beta_{W7}CRED_i + \beta_{W8}RACE_i + \beta_{W9}EXP_i + \beta_{W10}CNSIZE_i + \beta_{W11}UNEMP_i + \\ & \xi_W LAMBDA_i + V_{Wi} ,\end{aligned}$$

and

$$\begin{aligned}\ln S_i = {} & \beta_{S0} + \beta_{S1}AGE_i + \beta_{S2}AGESQ_i + \beta_{S3}ED1_i + \beta_{S4}ED2_i + \beta_{S5}ED3_i + \beta_{S6}ED4_i + \beta_{S7}CRED_i + \\ & \beta_{S8}RACE_i + \beta_{S9}CNSIZE_i + \beta_{S10}UNEMP_i + \beta_{S11}KDSLT6_i + \beta_{S12}KDS6{\sim}16_i + \\ & \beta_{S13}KDSGE16_i + \beta_{S14}OTHGE16_i + \beta_{S15}YMARRIED_i + \beta_{S16}OWN_i + \beta_{S17}BEDROOMS_i + \\ & \beta_{S18}SIZEYRD_i + \beta_{S19}SPWAGE_i + \beta_{S20}UNEARN_i + \delta M_i^{OBS} + V_{Si}\end{aligned}$$

where

$\ln W_i$ = the natural logarithm of the wife's after-tax hourly market wage. Considering both Federal and Missouri State income taxes, one minus the household's 1995 average income tax rate was used to convert gross market wages into after-tax market wage figures[1] ;

$\ln S_i$ = the natural logarithm of the wife's shadow price of home time ;

AGE_i = the age of the wife in years ;

$AGESQ_i$ = the age of the wife squared ;

$$ED1_i = \begin{cases} 1 \text{ if the wife's highest education level is a High School diploma,} \\ 0 \text{ if otherwise}^2 ; \end{cases}$$

[1] See Appendix C for the details on how the household's average income tax rate for 1995 was estimated.

[2] The reference category for the schooling achievement variables (i.e. ED1, ED2, ED3, and ED4) is 'less than a high school diploma', ED0, which category does not appear in the above equations.

$$ED2_i = \begin{cases} 1 \text{ if the wife's highest education level is a Technical School diploma,} \\ 0 \text{ if otherwise (see footnote 32) ;} \end{cases}$$

$$ED3_i = \begin{cases} 1 \text{ if the wife's highest education level is an Undergraduate College degree,} \\ 0 \text{ if otherwise (see footnote 32) ;} \end{cases}$$

$$ED4_i = \begin{cases} 1 \text{ if the wife's highest education level is a Graduate/Professional College degree,} \\ 0 \text{ if otherwise (see footnote 32) ;} \end{cases}$$

$$CRED_i = \begin{cases} 1 \text{ if the wife possesses any extra-curricular credential such as a special license, certification, etc.,} \\ 0 \text{ if otherwise ;} \end{cases}$$

$$RACE_i = \begin{cases} 1 \text{ if the wife is Caucasian (White),} \\ 0 \text{ if otherwise ;} \end{cases}$$

EXP_i = the wife's years of experience in paid market work since age 16[3] ;

$CNSIZE_i$ = the size of the population expressed in 100,000s of inhabitants in the wife's county of residence (as published by the U.S. Census Bureau on March 1996, series CB96-32) ;

$UNEMP_i$ = the unemployment rate for the second quarter of 1996 (i.e. April, May, June 1996) in the wife's county of residence (computed from the non-seasonally-adjusted unemployment data published by the Bureau of Labor Statistics) ;

$LAMBDA_i$ = the sample-selection correction variable representing the inverse Mills ratio computed from the results of the Probit analysis of the wife's labor-force participation decision ;

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[3] The market work experience variable, EXP, was generated from the wives' data by assigning a weight of :

a) 1.00 for each year in which the wife had worked *9 months or more* on a *full-time basis* (i.e. 35 hours or more most of the weeks) since age 16 ,

b) 0.50 for each year in which the wife had worked *9 months or more* on a *part-time basis* (i.e. less than 35 hours most of the weeks), or in which she had worked *less than 9 months* on a *full-time basis* since age 16 ,

c) 0.25 for each year in which the wife had worked *less than 9 months* on a *part-time basis* since age 16 ,

and by taking the sum of the figures generated in a), b), and c) .

$KDSLT6_i$ = the number of children under 6 years of age living in the wife's household ;

$KDS6\sim16_i$ = the number of children aged 6 and over, but less than 16 years old living in the wife's household ;

$KDSGE16_i$ = the number of children aged 16 and over living in the wife's household ;

$OTHGE16_i$ = the number of relatives (excluding immediate family members) and/or friends aged 16 and over living in the wife's household ;

$YMARRIED_i$ = the number of years the wife had been married with her current spouse at the time of the survey ;

$$OWN_i = \begin{cases} 1 & \text{if the wife's household owns or is buying its current residence,} \\ 0 & \text{if otherwise ;} \end{cases}$$

$BEDROOMS_i$ = the number of bedrooms in the wife's current residence ;

$SIZEYRD_i$ = the size of the yard the household must care for where the wife currently resides[4] ;

$SPWAGE_i$ = the after-tax market wage of the wife's spouse on his primary job. Considering both Federal and Missouri State income taxes, one minus the household's 1995 average income tax rate was used to convert the husband's gross market wage into an after-tax figure[5] ;

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[4] The household's yard size variable, SIZEYRD, was scaled as follows:

'1' if the household had *no yard* to care for or only a *modest yard* (i.e. less than 1/8 acre or 75 x 75 feet) to maintain at the time of the survey ;

'2' if the household had a *small yard* (i.e. 1/8 acre or more but less than 1/4 acre or 100 x 100 feet) to maintain at the time of the survey ;

'3' if the household had a *medium yard* (i.e. 1/4 acre or more but less than 1/2 acre or 150 x 150 feet) to maintain at the time of the survey ;

'4' if the household had a *large yard* (i.e. 1/2 acre or more but less than 1 acre or 200 x 200 feet) to maintain at the time of the survey ;

'5' if the household had a *very large yard* (i.e. 1 acre or more) to maintain at the time of the survey .

[5] See Appendix C for the details on how the household's average income tax rate for 1995 was estimated.

$UNEARN_i$ = the after-tax total household income for 1995 in thousands of dollars minus husband's and wife's earnings from paid employment. Taking into account both Federal and Missouri State income taxes, one minus the household's 1995 average income tax rate was used to convert the gross unearned income into an after-tax figure[6] ;

and

M_i^{OBS} = the wife's observed hours of paid market work per year (i.e. the intensive margin of her labor supply decision expressed in terms of observed behavior, on a yearly basis) .

From our economic theory of time allocation, and as was demonstrated earlier in Figure 2.2, it is clear that for the wives who work in the paid labor force, in equilibrium, the shadow price of non-market time is, at the margin, equal to the real market wage. Consequently, because $\ln W_i$ equals $\ln S_i|_{M>0}$ at the margin for the wives who work in the market, it follows that the market wage and the shadow price of home time equations can be equated and arithmetically solved to obtain the hours of market work equation (i.e. the intensive margin of the labor supply decision). Accordingly, equating the market wage and the shadow price of home time functions and solving for M_i^{OBS} yields:

$$\begin{aligned} M_i^{OBS} = \delta^{-1}\big[& (\beta_{W0}-\beta_{S0}) + (\beta_{W1}-\beta_{S1})AGE_i + (\beta_{W2}-\beta_{S2})AGESQ_i + (\beta_{W3}-\beta_{S3})ED1_i + \\ & (\beta_{W4}-\beta_{S4})ED2_i + (\beta_{W5}-\beta_{S5})ED3_i + (\beta_{W6}-\beta_{S6})ED4_i + (\beta_{W7}-\beta_{S7})CRED_i + \\ & (\beta_{W8}-\beta_{S8})RACE_i + \beta_{W9}EXP_i + (\beta_{W10}-\beta_{S9})CNSIZE_i + (\beta_{W11}-\beta_{S10})UNEMP_i + \\ & (-\beta_{S11})KDSLT6_i + (-\beta_{S12})KDS6\sim16_i + (-\beta_{S13})KDSGE16_i + (-\beta_{S14})OTHGE16_i + \\ & (-\beta_{S15})YMARRIED_i + (-\beta_{S16})OWN_i + (-\beta_{S17})BEDROOMS_i + (-\beta_{S18})SIZEYRD_i + \\ & (-\beta_{S19})SPWAGE_i + (-\beta_{S20})UNEARN_i + (\sigma_{WW}-2\sigma_{WS}+\sigma_{SS})^{1/2}LAMBDA_i + \\ & (V_{Wi}-V_{Si})\big] \end{aligned}$$

[6] See Appendix C for the details on how the household's average income tax rate for 1995 was estimated.

or simply,

$$M_i^{OBS} = \beta_{M0} + \beta_{M1}AGE_i + \beta_{M2}AGESQ_i + \beta_{M3}ED1_i + \beta_{M4}ED2_i + \beta_{M5}ED3_i + \beta_{M6}ED4_i + \beta_{M7}CRED_i + \beta_{M8}RACE_i + \beta_{M9}EXP_i + \beta_{M10}CNSIZE_i + \beta_{M11}UNEMP_i + \beta_{M12}KDSLT6_i + \beta_{M13}KDS6\sim16_i + \beta_{M14}KDSGE16_i + \beta_{M15}OTHGE16_i + \beta_{M16}YMARRIED_i + \beta_{M17}OWN_i + \beta_{M18}BEDROOMS_i + \beta_{M19}SIZEYRD_i + \beta_{M20}SPWAGE_i + \beta_{M21}UNEARN_i + \xi_M LAMBDA_i + V_{Mi}.$$

As pointed out earlier, the shadow price of home time function is not directly estimable. (Recall that reservation wages—as shadow price of home time at full non-market time—are not observable). However, since both sample selection-corrected market wage and hours-of-work equations are directly estimable via simple least squares regression techniques from the data on the wives who work, upon statistical identification of the recurrent system of equations the coefficients of the shadow price of home time equation can be retrieved[7] and utilized to derive shadow values of household production time for any sampled wife—whether she works in the labor market or not—including reservation wage values. Because of the inclusion of the inverse Mills ratio, LAMBDA, as a regressor in both market wage and hours-of-work equations, not only the coefficients of these equations, but also the retrieved coefficients of the shadow price of home time

[7] The identifier for the standard the model is EXP, and its corresponding parameters, β_{W9} and β_{M9} . In fact, since EXP represents the only regressor appearing in the market wage equation that is not contained in the shadow price of home time equation, one can easily identify δ , and hence retrieve the coefficients of the shadow price of home time function once both market wage and hours-of-work equations are estimated. Specifically, inasmuch as $\delta = \beta_{W9}/\beta_{M9}$, the coefficients of the shadow price of home time equation for the standard estimation model may be retrieved as illustrated below:

$b_{S0} = b_{W0} - b_{M0}*\delta$; $b_{S1} = b_{W1} - b_{M1}*\delta$; $b_{S2} = b_{W2} - b_{M2}*\delta$; $b_{S3} = b_{W3} - b_{M3}*\delta$; $b_{S4} = b_{W4} - b_{M4}*\delta$;
$b_{S5} = b_{W5} - b_{M5}*\delta$; $b_{S6} = b_{W6} - b_{M6}*\delta$; $b_{S7} = b_{W7} - b_{M7}*\delta$; $b_{S8} = b_{W8} - b_{M8}*\delta$; $b_{S9} = b_{W10} - b_{M10}*\delta$;
$b_{S10} = b_{W11} - b_{M11}*\delta$; $b_{S11} = -b_{M12}*\delta$; $b_{S12} = -b_{M13}*\delta$; $b_{S13} = -b_{M14}*\delta$; $b_{S14} = -b_{M15}*\delta$; $b_{S15} = -b_{M16}*\delta$;
$b_{S16} = -b_{M17}*\delta$; $b_{S17} = -b_{M18}*\delta$; $b_{S18} = -b_{M19}*\delta$; $b_{S19} = -b_{M20}*\delta$; $b_{S20} = -b_{M21}*\delta$.

function, are free from sample selection bias and hence fully consistent. Indeed, prior to the estimation of the market wage and hours-of-work equations, the sample-selection correction procedure proposed by Heckman requires the estimation of a Probit function of the probability of labor force participation (i.e. the extensive margin of the labor supply decision) using all observations in order to derive LAMBDA for each sampled wife. Accordingly, for the standard version of the estimation model this labor-force participation function upon which the Probit analysis is performed is specified as follows:

$$\begin{aligned} P_i^{OBS} = \phi(&\beta_{P0} + \beta_{P1}AGE_i + \beta_{P2}AGESQ_i + \beta_{P3}ED1_i + \beta_{P4}ED2_i + \beta_{P5}ED3_i + \beta_{P6}ED4_i + \beta_{P7}CRED_i + \\ &\beta_{P8}RACE_i + \beta_{P9}EXP_i + \beta_{P10}CNSIZE_i + \beta_{P11}UNEMP_i + \beta_{P12}KDSLT6_i + \beta_{P13}KDS6{\sim}16_i + \\ &\beta_{P14}KDSGE16_i + \beta_{P15}OTHGE16_i + \beta_{P16}YMARRIED_i + \beta_{P17}OWN_i + \beta_{P18}BEDROOMS_i + \\ &\beta_{P19}SIZEYRD_i + \beta_{P20}SPWAGE_i + \beta_{P21}UNEARN_i\ ) \end{aligned}$$

where

$$P_i^{OBS} = \begin{cases} 1 \text{ if the wife is \textit{observed} participating in the paid labor force (i.e. } M_i^{OBS} > 0\text{)} \\ 0 \text{ if the wife is out of the paid labor force (i.e. } M_i^{OBS} = 0\text{)} \end{cases}$$

and all independent variables are defined as before[8].

From the results of the Probit analysis, LAMBDA is computed for each sampled observation i as $\phi(Z_i)/[1-\Phi(Z_i)]$ {i.e. $\phi(Z_i)/\Phi(-Z_i)$}, where Z_i is simply the *standardized* predicted value obtained from the estimated Probit function of the labor-force

[8] Notice that, as required, the same regressors that appear in the hours-of-work equation are also contained in the labor-force participation equation. Indeed, since both extensive and intensive margins of the labor supply decision must necessarily be determined by the same set of regressors in Heckman's estimation model, all regressors contained in the hours-of-work equation must also be found in the labor-force participation equation.

participation decision {i.e. $Z_i = [-X_{Pi}\beta_P / (\sigma_{PP})^{1/2}]$}, $\phi(Z_i)$ is the probability density function for this standard normal variable, and $\Phi(Z_i)$ is its cumulative distribution function.

Theoretical Justifications and Statistical Expectations for the Variables Included in the Standard Version of the Estimation Model

The set of regressors considered in the market wage equation are factors that are commonly assumed to affect the market productivity of individuals, and hence the wage rate they can ultimately command in the paid labor force. In fact, following the standard human capital model (for instance, see Ben Porath, 1970), it is hypothesized that higher educational achievements (ED1, ED2, ED3, and ED4), extra-curricular credentials (CRED), years of market work experience (EXP), and age (AGE) will raise market productivity—with age doing so at a decreasing rate, however. Although detached from the productive capacity of individuals, the race of the wife (RACE) as regressor is entered in the wage equation as a precautionary measure to control for the possibility of ethnic segregation in labor markets. Evidence from past work on the direction of the influence of racial groups on the wage individuals can command in the labor force is mixed, and so no particular prediction is made with respect to the sign of this variable. The size of the population and the unemployment rate in the county of residence (CNSIZE and UNEMP respectively) also represent regressors that are common in the standard specification of the market wage function. As such, it is current practice to include these variables as an attempt to control for the particular demand conditions that characterize different geographical labor markets, and which are well known to affect market wages. Specifically, the rationale for including the size of the population in the wife's county of residence as regressor in the market wage equation is that highly populated geographical areas are often associated with those locations where job prospects are flourishing or simply better, and where households have migrated in response to more promising labor market conditions. Accordingly, based on this rationale, a positive relationship is hypothesized between the size of the population in the county of residence (CNSIZE) and the market wage of the wife[9]. In contrast, because unemployment per se reflects a situation in which there exists an excessive supply of workers for a limited demand, an inverse relationship is hypothesized between the county's unemployment rate (UNEMP) and the offered market wage[10]. Indeed, the rationale for this hypothesis flows out of the standard labor economic model which indicates that in the face of a surplus of available workers, the wage structure is normally driven down until a new state of equilibrium between supply and demand is reestablished. Here it is important to recognize that, as a way to control for the potential differences in the demand conditions of distinct geographical labor markets, the inclusion of the unemployment rate in the market wage equation directly conflicts with the standard assumption of perfectly continuous budget lines (i.e. the assumption that individuals are entirely free to allocate as many or as few hours of their time to paid market work as well as to unpaid home activities) usually maintained by home and family economists when implementing the opportunity cost of

[9] It is assumed that, in general, individuals who work normally do so within the geographical boundaries of their county of residence, although this might not necessarily be the case for all working individuals.

[10] See the previous footnote.

time methodology. This is so because if the standard assumption of perfectly continuous budget lines were to be valid, then unemployment—as a concept that depicts a situation in which certain individuals are restrained from accessing market employment—would not be conceivable. Obviously, under the assumption of perfectly continuous budget lines, which implicitly characterizes the standard version of the estimation model, the inclusion of the unemployment rate as regressor in the market wage equation, or in any other equation that defines the recurrent estimation model, is hardly justifiable. However, for the sake of consistency with the standard practice, even though such an incongruity is pointed out, the unemployment rate in the wife's county of residence is included in the specification of the wage equation.

Like the regressors in the market wage equation, the independent variables included in the shadow price of home time function for the standard version of the model represent factors that are commonly considered by home and family economists when specifying the estimation model. Conceptually speaking, these standard regressors are usually selected because they are hypothesized to affect the economic value individuals confer to their non-market time. Again, human capital-related variables such as educational achievements (ED1, ED2, ED3, and ED4), extra-curricular credentials (CRED), and age (AGE) are hypothesized to increase the productive capacity of a wife's home time (with age doing so at a declining rate), and thus raise the economic value she places on that time. Notice that the human capital perspective would also suggest inclusion of years of market work experience (EXP) in the shadow price of home time function. However, in line with Heckman's work (1974, 1976, 1979, and 1980), this particular variable is voluntarily kept out of the shadow price of home time equation in order to allow for the statistical identification of the recurrent estimation model, and hence permit the retrieval of the coefficients of the shadow price of home time function from the estimated parameters of the market wage and hours-of-work equations. (Recall that the retrieval of the coefficients for the shadow price of home time equation is conditional upon the identification of the recurrent system of equations which defined the estimation model, and that this identification is only possible if there is at least one regressor in the wage equation that is not included in the shadow price of home time function.)

In the same order of ideas, the household characteristics such as its composition, whether the home is owned or rented, the size of the house (proxied by the number of bedrooms in the current residence[11]), and the size of the yard where the household currently resides also represent regressors that are common in the standard specification of the shadow price of home time function. As such, variations in the levels of these factors are assumed to directly alter the household's demand for a wife's non-market time, especially home production time. Consequently, in addition to the human capital-related regressors, variables such as the number of children under 6 years of age (KDSLT6), between 6 and 16 years of age (KDS6~16), 16 years of age and over (KDSGE16), as well as the number

[11] The total number of rooms in the current residence is generally used to proxy the size of the house in which the household resides. However, because of a recent trend in home design which tends to promote fewer rooms but larger open areas (rather than many smaller secluded rooms), it is believed that using the total number of rooms to proxy the size of a house is simply inappropriate. As an alternative measure, the number of bedrooms in the house appears to be a better proxy. Here the reason is simple: although home design has moved toward houses with large open areas—hence reducing the total number of rooms in new or recent constructions—it seems that the number of bedrooms has been unaffected by this recent trend. As a result, while the total number of rooms may have lost its proximal meaning when it comes to assess the size of a house, the number of bedrooms a house has is still believed to be proportional to its size.

of relatives and/or friends aged 16 and over (OTHGE16) living in the household are included in the shadow price of home time equation in order to capture the impact of the household composition on the economic value the wife places on her non-market time. In terms of expectations, because the presence of young children—especially preschool children—increases the demand for all home-produced commodities (i.e. meals, cleaning, laundry, shopping, etc., as well as childcare), a positive relationship is hypothesized between the number of children under 6 years of age living in the household (KDSLT6) and the economic value the wife places on her home time. Further, a similar relationship is also hypothesized between the number of children aged 6 and over but less than 16 years of age (KDS6~16) and the wife's shadow value of home time. In contrast, inasmuch as teenagers and young adults are expected to share in the production of household commodities—thus, possibly relieving the wife from some of the home tasks she might otherwise have to perform—a negative relationship is hypothesized between the number of children of age 16 and over living in the household (KDSGE16) and the monetary value the wife confers to her non-market time. Likewise, the number of relatives and friends, aged 16 and over, permanently living in the household (OTHGE16) are also expected to share in the production of home commodities. As such, these relatives and friends might be regarded as substitutes for some of the wife's time in home production. Consequently, as with teenagers and young adults (KDSGE16), a negative relationship is hypothesized between the number of relatives and friends currently living in the household (OTHGE16) and the economic value the wife places on her home time. Home ownership (OWN), the number of bedrooms in the house (BEDROOMS), and the size of the yard to maintain (SIZEYRD) are all hypothesized to have a positive impact on a wife's shadow price of non-market time inasmuch as increases in the level of any of these variables are expected to amplify the household's demand for her home labor, ceteris paribus.

Variables such as the wife's years of marriage with her current spouse (YMARRIED), her ethnic group (RACE), the population size and the unemployment rate in her specific county of residence (CNSIZE and UNEMP respectively) are also included in the shadow price of home time function because variations in the level of these variables are expected to influence the economic value a wife places on her non-market time. More precisely, except for the unemployment rate[12], these variables are usually considered in the standard specification of the shadow price of home time function and generally treated as preference shifters. Here, since empirical evidence from past work on the direction of the influence of years of marital life (YMARRIED) and racial groups (RACE) on the monetary value wives place on their home time are mixed, no particular predictions are expressed regarding the sign of these two variables. Using the very same rationale leading to the expectations formulated for the same variables in the market wage function, while a positive relationship is posited between the size of the population in the wife's county of residence (CNSIZE) and the shadow value of her home time, an inverse relationship is expected with respect to the county's unemployment rate (UNEMP).

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[12] As already pointed out earlier, under the standard assumption of perfectly continuous budget lines (i.e. the assumption that there are no labor market constraints), the inclusion of the unemployment rate in any equation defining the recurrent estimation model is hardly tenable. However, because it is included in the market wage equation (as it is the case with the usual, standard, specification of the model), in order to avoid the statistical over-identification of the estimation model it is also included in the shadow price of home time function.

The three remaining regressors considered in the standard specification of the wife's shadow price of home time function are her husband's after-tax market wage on his primary job (SPWAGE), her household's after-tax nonlabor income (UNEARN), and her observed annual hours of market work (M^{OBS}), respectively. The usual hypotheses about these variables stem primarily from the notion about the normality of a wife's home time. Specifically, it is standard practice to assume that a wife's home time (whether it is home production or leisure time) is a normal good when contrasted to market time. That is, as income rises, the household's demand for her home time also rises. Under this assumption, increases in income simply serve to accentuate the household's demand for all normal goods, including the wife's home time. By demanding more of her home time, it follows that the household is just bidding up the shadow price of that time. Therefore, it seems reasonable to hypothesize that the household's nonlabor income (UNEARN) should be positively related to a wife's shadow price of home time, regardless whether this home time is spent in household labor or leisure activities.

The effect of the husband's primary market wage (SPWAGE) is more ambiguous, however. In fact, the impact of any change in the husband's wage on the wife's shadow price of home time not only depends on the normality assumption postulated with respect to that time, but also on the effect of this change on the husband's own time allocation between market and non-market activities, as well as on the degree of complementarity or substitutability between the spouses' home time. On one hand, if the income effect of an increase in the husband's market wage on his time allocation outweighs the substitution effect induced by such a wage increase, then, under the assumption that home time is a normal good, the husband's overall time allocation should move toward more home time and less market time. On the other hand, if the substitution effect resulting from an increase in his market wage dominates the income effect, then the husband's overall time allocation should move toward more market time and less home time. Here, inasmuch as there is a wide agreement emerging from both time series and cross-sectional studies that the labor supply of married males is, in general, *backward bending*[13]—indicating that as husbands' wage rates rise, the income effect dominates the substitution effect, and hence the amount of time they spend in the paid labor market declines—in the event that the spouses perceive themselves as complements in home activities, then any increase in the husband's market wage should be positively related to his wife's shadow price of home time. Conversely, if the spouses perceive themselves as substitutes in home activities, then any increase in the husband's market wage should be negatively related to his wife's shadow price of home time. Indeed, since no *a priori* notion about the degree of complementarity or substitutability between the spouses' home time is available, the most reasonable prediction which could be formulated is that the husband's primary market wage (SPWAGE) will be positively related to his wife's shadow price of household time if the spouses perceive themselves as complementing each other in home activities, while it will be inversely related to the shadow price of her household time if they perceive themselves as substitutes to each other in the home.

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[13] In a time-series study of the hours worked by nonagricultural married males between 1929 and 1961, Owen (1971) found the wage rate elasticity to be about –0.20. Burkhauser & Turner (1978), extended Owen's period of analysis and estimated the wage rate elasticity to be between –0.15 and –0.33. Evidence from cross-sectional studies on male market work behavior abounds and is summarized by Pencavel (1986). Again, most of the evidence indicates that the total own-wage rate effect on married males' hours of labor supply is negative, in the neighborhood of –0.12 (Pencavel, 1986, page 69).

Finally, the effect of a change in the *observed* hours a wife works on her market job (M^{OBS}) can be decomposed into two distinct parts using conventional economic theory: a substitution effect and an income effect. On one hand, the substitution effect argument is that as hours of market work increase, holding preferences and other home production factors constant, the individual has fewer non-market hours at her disposal. With fewer non-market hours available, home time (regardless whether it is home production time or leisure time) becomes more precious. Hence, a rise in the wife's annual hours of market work (M^{OBS}) must necessarily drive up the shadow value of her home time. On the other hand, the income effect argument is that holding the market wage rate constant, hours of market work must rise only in response to a decline in the individual's value of home time. Hence, a wife will take time away from non-market activities and increase her hours of market work only if time spent out of the labor market has declined in value (i.e. only if time spent in the home has become less productive than time spent in the market). Thus, while the substitution effect pushes the shadow value of home time up, the income effect pushes it down. Obviously, the total impact of an increase in the hours of market work on the wife's shadow value of home time will directly depend on the relative strengths of these two effects. However, inasmuch as past work in the area of female labor supply indicates that the substitution effect should dominate (for instance, see Heckman, 1974), a positive relationship is hypothesized between the wife's observed hours of market work (M^{OBS}) and the monetary value she places on her home time.

Indeed, given the recurrent nature of Heckman's estimation model, all the standard regressors which are used to specify the market wage and the shadow price of home time functions must necessarily reappear in the hours of market work function. This is so since, as was demonstrated earlier while presenting Heckman's estimation model—and particularly when interpreting equation (2.23b)—the intensive margin of the labor supply function (i.e. the hours of market work function) is directly proportional to the existing difference between market and reservation wages.

Consequently, although the standard regressors considered in the hours of market work equation have already been justified and signed as to their statistical expectations with respect to their impacts on the offered market wage and/or the shadow price of home time, in order to come full circle they are now briefly discussed in terms of their expected effects on the intensive margin of the labor supply function. As shall be seen, due to the recurrent nature of the estimation model, while the standard regressors contained only in the market wage function or in the shadow price of home time function lead to unambiguous expectations as to their potential impacts on the observed hours of paid market work, the other standard regressors that are included in both market wage and shadow price of home time functions, and which are generally hypothesized to be of the same sign, cannot always be so easily signed in terms of their potential impacts on the wives' hours of market work unless one has the information or simply speculates on the relative magnitudes of these variables with regard to their contributions to the underlying functions.

For instance, the age of the wife (AGE), its square (AGESQ), her highest educational achievement (ED1, ED2, ED3, or ED4), whether or not she possesses extra-curricular credentials (CRED), her ethnic group (RACE), the size of the population and the unemployment rate in her county of residence (CNSIZE and UNEMP respectively) represent explanatory variables that are included in both market wage and shadow price of home time functions. Because each of these independent variables is posited to share the same sign as to how it relates to a wife's market wage and shadow price of home time, no definite expectations could be readily formulated with respect to the impact of these regressors on the intensive margin of a wife's labor supply decision. To see why, realize that, for any particular regressor included in both the market wage and shadow price of home time functions, its corresponding coefficient in the hours of market work equation is simply given as follows:

$$b_{Mj} = (b_{Wj} - b_{Sj})/\delta ,$$

where the subscript j represents the particular regressor included in both the market wage and shadow price of home time functions. Hence, if the analyst expected regressor j to be either positively or negatively related to both the market wage and shadow price of home time (i.e. if both b_{Wj} and $b_{Sj} > 0$ or both b_{Wj} and $b_{Sj} < 0$ in terms of expectations), then it is clear that the only way to formulate an expectation as to how j relates to the hours of market work decision (i.e. as to the sign of b_{Mj}) would be to know in advance or simply speculate its relative magnitude in determining the market wage and the shadow price of home time. For example, recalling that delta is expected to be positive (i.e. $\delta > 0$), if j represents the age of the wife (AGE) and that AGE is, as established earlier, expected to be positively related to a wife's offered market wage and shadow value of home time, then without knowing if AGE is more important in determining lnW than lnS (or vice versa) it is hardly possible to posit the sign of this variable with respect to its impact on a wife's observed hours of market work. Indeed, one might speculate that the age of a wife is more important in determining her market wage than her shadow price of home time (i.e. $b_{W1} > b_{S1}$). Based on this speculation the age of a wife will be expected to be positively associated with her hours of market work (i.e. $b_{M1} > 0$). Conversely, if it is speculated that the age of a wife is more important in determining her shadow price of home time than her offered market wage (i.e. $b_{W1} < b_{S1}$), then her age should be expected to be negatively related to her hours of market work (i.e. $b_{M1} < 0$). Likewise, if j represents the square of the wife's age (AGESQ), and that AGESQ is, as hypothesized earlier, expected to be negatively associated with a wife's offered wage and shadow value of home time, then without knowing if AGESQ is more important in determining lnW than lnS, it becomes quite difficult to envision the sign of this variable with regard to its impact on a wife's hours of market work. Here the analyst might speculate that the rate at which the offered market wage of a wife is expected to decrease with her age is more important than the rate at which her shadow price of home time is expected to do so (i.e. $b_{W2} > b_{S2}$ in terms of expected magnitudes). Under such a speculation, AGESQ will be expected to be negatively related to the intensive margin of a wife's labor supply (i.e. $b_{M2} < 0$). Differently, if there are reasons to believe that the rate at which a wife's shadow price of home time is expected to decrease with her age outweighs the rate at which her market wage is expected to decrease with her age (i.e. if $b_{W2} < b_{S2}$ in terms of expected magnitudes), then AGESQ should be hypothesized to be positively related to her hours of market work (i.e. $b_{M2} > 0$).

Thus, it is obvious that the speculations of the analyst concerning the relative magnitudes (i.e. strengths) of these j regressors in determining lnW and lnS dictate the hypotheses that could be formulated for these regressors in the hours of market work function. Here, in line with the findings emerging from previous empirical work on the labor supply of married women (for instance, see Bryant et al., 1992; Heckman, 1974; 1976; 1980; Zick & Bryant, 1983) it is hypothesized that AGE, ED1, ED2, ED3, ED4, CRED, and CNSIZE will be positively related to a wife's observed hours of paid market work. As such, given that these particular regressors are expected to increase both a wife's market wage and shadow value of home time, this implies that all relationships should be of greater strength in determining a wife's market wage than her shadow price of home time. Conversely, AGESQ and UNEMP are hypothesized to be negatively related to a wife's observed hours of market work. Hence, inasmuch as these regressors are expected to decrease both a wife's market wage and shadow price of home time, this comes to say that these two specific regressors should also have greater strength in determining a wife's market wage than her shadow price of home time. As in the market wage and the shadow price of home time functions, no particular hypothesis is formulated with respect to the impact of the wife's ethnic group (RACE) on her hours of market work.

Now turning to the standard regressors considered only in the market wage or the shadow price of home time function—notably, EXP, KDSLT6, KDS6~16, KDSGE16, OTHGE16, YMARRIED, OWN, BEDROOMS, SIZEYRD, SPWAGE, and UNEARN—it should be clear that the particular relationships which are posited between these explanatory variables and the dependent variable that defines the function in which they belong necessarily dictate their expected signs in terms of their impacts on the intensive margin of a wife's labor supply. Abstracting from LAMBDA, this is so because their corresponding coefficients in the hours of market work function would be given by

$$b_{Mk} = b_{Wk} / \delta$$

for those regressors included only in the market wage equation[14], and by

$$b_{Mq} = -b_{Sq} / \delta$$

for the ones only in the shadow price of home time function. Here, while the subscript k represents those standard regressors in the market wage function that are not in the shadow price of home time function (i.e. EXP in the case on hand), the subscript q is simply used to denote those regressors appearing in the shadow price of home time function but not in the market wage function (i.e. KDSLT6, KDS6~16, KDSGE16, OTHGE16, YMARRIED, OWN, BEDROOMS, SIZEYRD, SPWAGE, and UNEARN).

Hence, given that delta is expected to be positive (i.e. $\delta > 0$), any variable that is included only in the market wage function and that is expected to be positively related to a wife's offered market wage must also be hypothesized to increase her observed hours of market work. This is indeed the case with the wife's years of market work experience (EXP) which, for the purpose of the statistical identification of the recurrent estimation model,

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[14] Note that the coefficient of LAMBDA in the hours-of-work function is just $(\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2} / \delta$ which., as seen earlier, is equal to $(\sigma_{MM})^{1/2}$.

represents the only regressor considered in the market wage function that is not in the shadow price of home time function. Likewise, any explanatory variable included only in the shadow price of home time function and posited to be negatively related to a wife's shadow price of home time must also be hypothesized to increase her observed hours of labor supply. As such, the number of children and friends or relatives age 16 and over permanently living in the wife's household (i.e. KDSGE16 and OTHGE16 respectively) are regressors that, as established earlier, are expected to be negatively related to a wife's shadow price of home time. Consequently, the level of these variables must necessarily be positively related to a wife's hours of market work, ceteris paribus. This is exactly what is hypothesized here with respect to these two particular regressors. Conversely, since any regressor that is included only in the shadow price of home time function and that is expected to increase a wife's shadow price of home time must be negatively related to a wife's hours of paid work, it is hypothesized that the number of children under 6 years of age and between 6 and 16 years of age (KDSLT6 and KDS6~16 respectively), home ownership (OWN), the number of bedrooms in the residence (BEDROOMS), the size of the yard (SIZEYRD), and the household's after-tax nonlabor income (UNEARN) are regressors for which their levels should be inversely related to the intensive margin of a wife's observed labor supply.

While no particular hypothesis is formulated regarding the possible effect of a wife's years of marriage (YMARRIED) on her hours of market work, the impact of the husband's primary market wage (SPWAGE) on his wife's hours of market work would necessarily depend on whether the spouses perceive themselves as complements or substitutes in home activities. On one hand, under the assumption that home time is a normal good and that the income effect of a change in the husband's market wage on his own hours of paid work outweighs the substitution effect induced by such a variation, if the spouses perceived themselves as complementing each other in home activities, then a negative relationship should be found between the husband's market wage and his wife's hours of paid work, ceteris paribus. On the other hand, any variation in the husband's market wage should be positively related to his wife's hours of market work if they considered themselves as substitutes in the home.

Surely, inasmuch as both intensive and extensive margins of a wife's labor supply decision are required to be determined by the very same set of regressors in Heckman's model, it should be evident that the hypothesized relationships between the standard regressors and the intensive margin of a wife's labor supply are also appropriate for the regressors considered in the specification of the extensive margin of her labor supply[15]. Accordingly, the age of a wife (AGE), her educational achievement (ED1, ED2, ED3, or ED4), her extra-curricular credentials (CRED), her market work experience (EXP), the size of the population in her county of residence (CNSIZE), the number of children and relatives or friends of 16 years of age and over (KDSGE16 and OTHGE16), are hypothesized to increase a wife's propensity to participate in the paid labor force. As such, increases in the level of any of these explanatory variables should be linked to an

[15] Here it suffices to recall that while the intensity of the labor supply (i.e. the number of hours supplied to the paid labor market) is proportional to the discrepancy existing between the offered market wage and the reservation wage, the extensive margin of the labor supply function (i.e. the decision of working in the market or not) arises from the inequality existing between the individual's market wage and her reservation wage.

increased probability of labor force participation in the Probit equation. In contrast, the square of a wife's age (AGESQ), the unemployment rate in her county of residence (UNEMP), the number of children under 6 years of age and between 6 and 16 years of age (KDSLT6 and KDS6~16 respectively), home ownership (OWN), the number of bedrooms in the residence (BEDROOMS), the size of the household's yard (SIZEYRD), and the after-tax nonlabor income of her household (UNEARN) are regressors that are all expected to be inversely related to a wife's propensity to participate in the labor market. Hence, increases in the level of any of these regressors are hypothesized to lower a wife's probability of labor market participation in the Probit function, ceteris paribus.

Once again, while no hypotheses are made with respect to the impact of the wife's ethnic group (RACE) and years of marriage (YMARRIED) on her propensity to participate in the paid labor market, the degree of complementarity or substitutability between the spouses in home activities is expected to determine the effect of the husband's primary market wage (SPWAGE) on his wife's propensity to engage in paid market employment. As such, under the assumption that home time is a normal good, and that the income effect of a change in the husband's wage on his own labor supply outweighs the substitution effect, if the spouses perceived themselves as complementing each other in the home, then any variation in the husband's market wage should be inversely related to his wife's propensity to participate in the paid labor market. Conversely, if they perceived themselves as substitutes for each other, then any change in the husband's market wage should be positively related to his wife's propensity to participate in the labor force, ceteris paribus.

The First Variant of the Standard Estimation Model: Accounting for Potentially Important Missing Labor Supply Regressors

In the second version of the model, referred to as the 'first variant' of the standard model, some potentially important regressors consistently missing from the standard specification of the estimation model—notably, from the labor-force participation Probit equation, the hours-of-work equation, and thus the shadow price of home time equation—are added to the standard set of regressors. Included among these new regressors are the wife's gender-role attitude with respect to what she views as the proper role of women in the family and society in general and the extent to which she perceives the involvement of women in market work to generate difficulty in the home, her husband's own attitude on the same gender-role construct, an index denoting the extent of her potential health limitations with respect to the type or amount of work she can possibly accomplish, an index denoting the extent of her husband's potential health limitations with respect to the type or amount of work he may possibly accomplish, a household technology index indicating the perceived adequacy of her currently available home equipment, and her perception regarding the adequacy of her household's overall money income in meeting the wants of her family unit.

Along with the other socio-demographic and economic regressors commonly considered in the standard estimation model, the shadow price of home time function for the sampled Missouri wives is derived using Heckman's two-stage estimation procedure. Direct comparisons with the results obtained from the standard version of the estimation model should allow for an empirical assessment of the bias possibly introduced in the estimated shadow values of home time and reservation wages resulting from the omission of these potentially important regressors in the standard specification of the model. Indeed, here it is expected that the added regressors would not only be highly predictive of the Missouri wives' hours of market work (i.e. the intensive margin of their labor supply decision), but also, and most importantly, their decision of whether or not to engage in market work (i.e. the extensive margin of their labor supply decision which leads to the censoring of the sample). Simply put, the new regressors included in this first variant of the standard version of the estimation model should be statistically significant in the labor-force participation Probit equation used to derive lambda as well as in the hours of market work equation. Further, the explanatory power of the labor-force participation Probit equation, as measured by different goodness-of-fit pseudo R-square statistics, should exhibit a considerable fit improvement relative to the fit achieved when only the usual (i.e. standard) regressors are considered in the estimation model. In fact, provided the new regressors truly contribute to distinguishing between the wives who choose to participate in the paid labor force and those who choose to be out of it, this should necessarily be the case. Moreover, the increase in the explanatory power of the labor-force participation Probit function should be of direct consequence on whether the selection-bias correction instrument, lambda, is statistically significant or not in both market wage and hours of market work equations. Inasmuch as lambda is constructed from the results of the first-stage Probit analysis of the labor-force participation decision in order to palliate for the unobserved personal differences presumably leading to the censoring of the sample, if the new regressors included in this first variant of the standard estimation model were to succeed in capturing critical but previously unobserved differences in the personal attributes existing between employed and nonemployed wives, then it would be rational to expect the coefficients of lambda to become statistically non-significant in the second stage of the estimation procedure. This is exactly what is expected here. While the coefficients of lambda in the standard version of the estimation model are expected to be statistically significant in the market wage and/or the hours-of-work equations, the inclusion of the new regressors should lead to the non-significance of the coefficients of lambda in this first variant of the standard model, indicating that the added regressors substantially contribute to explain the censoring of the sample of Missouri wives.

Indeed, although the new regressors included in this first variant of the standard estimation model are expected to capture certain critical personal differences thought to exist between working and non-working wives and, consequently, to substantially improve the explanatory power (i.e. fit) of the labor-force participation Probit function, it is not expected that their inclusion would yield such a comparable and striking increase with respect to the explanatory power (as measured by the adjusted R-square statistic) of the market wage and hours of market work equations. Simply put, in the eventuality that the addition of the new regressors largely contributes, as anticipated, to distinguishing between the wives who choose to participate in the paid labor market and those who do not choose so, then these additional regressors considered in this particular variant of the standard model should capture what lambda purposely captures in terms of unobserved differences in the standard version of the estimation model. Consequently, it follows that, although the pseudo R-square statistics of the optimized Probit function are expected to be markedly higher in this first variant of the standard estimation model, similar major increases in the explanatory power of the market wage and hours-of-work equations should not be observed. In other words, compared to the explanatory power of the market wage and hours-of-work equations obtained from the standard version of the model, the explanatory power of these same equations should remain practically unchanged after the inclusion of the new regressors considered in this first variant of the standard model, even though the censoring of the sample is expected to be much better explained once the additional regressors are incorporated in the model.

Empirical Specification of the First Variant of the Standard Estimation Model

For the first variant of the standard version of the estimation model, the sample selection-corrected market wage and shadow price of home time equations are expressed in terms of both standard and new regressors from the wives' data as:

$$\begin{aligned} \ln W_i = {} & \beta_{W0} + \beta_{W1}AGE_i + \beta_{W2}AGESQ_i + \beta_{W3}ED1_i + \beta_{W4}ED2_i + \beta_{W5}\,ED3_i + \beta_{W6}ED4_i + \\ & \beta_{W7}CRED_i + \beta_{W8}RACE_i + \beta_{W9}EXP_i + \beta_{W10}CNSIZE_i + \beta_{W11}UNEMP_i + \beta_{W12}MLIM_i + \\ & \xi_W LAMBDA_i + V_{Wi}\ , \end{aligned}$$

and

$$\begin{aligned} \ln S_i = {} & \beta_{S0} + \beta_{S1}AGE_i + \beta_{S2}AGESQ_i + \beta_{S3}ED1_i + \beta_{S4}ED2_i + \beta_{S5}ED3_i + \beta_{S6}ED4_i + \beta_{S7}CRED_i + \\ & \beta_{S8}RACE_i + \beta_{S9}CNSIZE_i + \beta_{S10}UNEMP_i + \beta_{S11}KDSLT6_i + \beta_{S12}KDS6{\sim}16_i + \\ & \beta_{S13}KDSGE16_i + \beta_{S14}OTHGE16_i + \beta_{S15}YMARRIED_i + \beta_{S16}OWN_i + \beta_{S17}BEDROOMS_i + \\ & \beta_{S18}SIZEYRD_i + \beta_{S19}SPWAGE_i + \beta_{S20}UNEARN_i + \beta_{S21}MLIM_i + \beta_{S22}SPMLIM_i + \\ & \beta_{S23}ATT2_i + \beta_{S24}SPATT2_i + \beta_{S25}HHTECH_i + \beta_{S26}YADEQI_i + \delta M_i^{OBS} + V_{Si} \end{aligned}$$

respectively.

While the same variables included in the standard version of the model are also found in this first variant of it, the new (non-standard) and presumably important regressors considered in this variant of the standard version of the estimation model are defined as follows:

$MLIM_i$ = an index representing the extent to which the wife is limited with respect to the type or amount of work she can possibly accomplish due to a health condition or disability[16] ;

$SPMLIM_i$ = an index representing the extent to which the wife's spouse is limited with respect to the type or amount of work he can possibly accomplish due to a health condition or disability[17] ;

$ATT2_i$ = the wife's score on a 'Home Orientation' attitudinal index denoting what she views as the proper role of women in the family and in society in general, and the extent to which she perceives market work to generate difficulty in the home[18]. (A low score on this index indicates a more egalitarian attitude, while a high score reflects a more traditional attitude.) ;

$SPATT2_i$ = the husband's score on a 'Home Orientation' attitudinal index denoting what he views as the proper role of women in the family and in society in general, and the extent to which he perceives women's involvement in the paid labor force to generate difficulty in the home[19] . (Again, a low score on this index indicates a more egalitarian attitude, while a high score reflects a more traditional attitude.) ;

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[16] The MLIM variable was scaled as follows:

'1' if the wife reported *no health-related limitation* on the amount or type of work she could do ;

'2' if she reported *a slight health-related limitation* on the amount or type of work she could do ;

'3' if she reported *an important health-related limitation* on the amount or type of work she could do ;

'4' if she reported *a total health-related limitation* on the amount or type of work she could do .

[17] The SPMLIM variable was coded using the very same scale as for MLIM, except that it is expressed in terms of the husbands' data instead of the wives' data.

[18] Refer to Appendix D for the details on how the 'Home Orientation' attitudinal index was elaborated.

[19] Refer to Appendix D for the details on how the 'Home Orientation' attitudinal index was elaborated.

$HHTECH_i$ = the wife's score on a Household-Technology Adequacy Index conveying her perception vis-à-vis the degree of adequacy of her available home tools and equipment at the time of the survey[20] ;

and

$YADEQI_i$ = the wife's score on an Income Adequacy Index conveying her perception with respect to the overall capacity of her household's money income to meet the wants of her family unit[21] .

Given that, in equilibrium, the shadow price of home time for the working wife equals her net hourly wage at the margin, it follows that market wage and shadow price of home time equations can be equated and solved in order to obtain the hours-of-work equation (i.e. the intensive margin of the labor supply decision) for the Missouri wives. Hence, equating and solving for M_i^{OBS}, the following hours of market work equation is obtained:

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[20] A three-point scale was used to generate the wife's household-technology adequacy index, HHTECH. This scale is reproduced as follows:

'1' if the wife reported an *important shortage* (i.e. "a lack") of equipment at the time of the survey ;

'2' if the wife reported only *some shortage* of equipment at the time of the survey ;

'3' if the wife reported *no shortage* (i.e. "plenty") of equipment at the time of the survey .

[21] The household (money) income adequacy index, YADEQI, was generated from the wife's response to the five-point scale reproduced below.

1 = not at all adequate ;

2 = could meet necessities only ;

3 = could meet some of the things we wanted but not everything ;

4 = could afford about everything we wanted ;

5 = could afford about everything we wanted and still save money .

$$M_i^{OBS} = \delta^{-1}[(\beta_{W0} - \beta_{S0}) + (\beta_{W1} - \beta_{S1})AGE_i + (\beta_{W2} - \beta_{S2})AGESQ_i + (\beta_{W3} - \beta_{S3})ED1_i + (\beta_{W4} - \beta_{S4})ED2_i + (\beta_{W5} - \beta_{S5})ED3_i + (\beta_{W6} - \beta_{S6})\ ED4_i + (\beta_{W7} - \beta_{S7})CRED_i + (\beta_{W8} - \beta_{S8})RACE_i + \beta_{W9}EXP_i + (\beta_{W10} - \beta_{S9})CNSIZE_i + (\beta_{W11} - \beta_{S10})UNEMP_i + (-\beta_{S11})KDSLT6_i + (-\beta_{S12})KDS6{\sim}16_i + (-\beta_{S13})KDSGE16_i + (-\beta_{S14})OTHGE16_i + (-\beta_{S15})YMARRIED_i + (-\beta_{S16})OWN_i + (-\beta_{S17})BEDROOMS_i + (-\beta_{S18})SIZEYRD_i + (-\beta_{S19})SPWAGE_i + (-\beta_{S20})UNEARN_i + (\beta_{W12} - \beta_{S21})MLIM_i + (-\beta_{S22})SPMLIM_i + (-\beta_{S23})ATT2_i + (-\beta_{S24})SPATT2_i + (-\beta_{S25})HHTECH_i + (-\beta_{S26})YADEQI_i + (\sigma_{WW} - 2\sigma_{WS} + \sigma_{SS})^{1/2}\ LAMBDA_i + (V_{Wi} - V_{Si})]$$

or simply,

$$M_i^{OBS} = \beta_{M0} + \beta_{M1}AGE_i + \beta_{M2}AGESQ_i + \beta_{M3}ED1_i + \beta_{M4}ED2_i + \beta_{M5}ED3_i + \beta_{M6}ED4_i + \beta_{M7}CRED_i + \beta_{M8}RACE_i + \beta_{M9}EXP_i + \beta_{M10}CNSIZE_i + \beta_{M11}UNEMP_i + \beta_{M12}KDSLT6_i + \beta_{M13}KDS6{\sim}16_i + \beta_{M14}KDSGE16_i + \beta_{M15}OTHGE16_i + \beta_{M16}YMARRIED_i + \beta_{M17}OWN_i + \beta_{M18}BEDROOMS_i + \beta_{M19}SIZEYRD_i + \beta_{M20}SPWAGE_i + \beta_{M21}UNEARN_i + \beta_{M22}MLIM_i + \beta_{M23}SPMLIM_i + \beta_{M24}ATT2_i + \beta_{M25}SPATT2_i + \beta_{M26}HHTECH_i + \beta_{M27}YADEQI_i + \xi_M LAMBDA_i + V_{Mi}\,.$$

Indeed, the shadow price of home time function is not directly estimable using the wives' data, but because both market wage and hours-of-work equations are directly estimable from the data on the wives who work in the market, its coefficients can easily be retrieved upon statistical identification of the recurrent system of equations[22]. Further, the inclusion of LAMBDA in the market wage and hours of market work equations

[22] Once again, the identifier for this first variant of the standard model is EXP, and its corresponding parameters, β_{W9} and β_{M9}. Specifically, inasmuch as $\delta = \beta_{W9}/\beta_{M9}$, the coefficients of the shadow price of home time equation for the first variant of the standard model may be retrieved as follows:

$b_{S0} = b_{W0} - b_{M0}*\delta$; $b_{S1} = b_{W1} - b_{M1}*\delta$; $b_{S2} = b_{W2} - b_{M2}*\delta$; $b_{S3} = b_{W3} - b_{M3}*\delta$; $b_{S4} = b_{W4} - b_{M4}*\delta$; $b_{S5} = b_{W5} - b_{M5}*\delta$; $b_{S6} = b_{W6} - b_{M6}*\delta$; $b_{S7} = b_{W7} - b_{M7}*\delta$; $b_{S8} = b_{W8} - b_{M8}*\delta$; $b_{S9} = b_{W10} - b_{M10}*\delta$; $b_{S10} = b_{W11} - b_{M11}*\delta$; $b_{S11} = -b_{M12}*\delta$; $b_{S12} = -b_{M13}*\delta$; $b_{S13} = -b_{M14}*\delta$; $b_{S14} = -b_{M15}*\delta$; $b_{S15} = -b_{M16}*\delta$; $b_{S16} = -b_{M17}*\delta$; $b_{S17} = -b_{M18}*\delta$; $b_{S18} = -b_{M19}*\delta$; $b_{S19} = -b_{M20}*\delta$; $b_{S20} = -b_{M21}*\delta$; $b_{S21} = b_{W12} - b_{M22}*\delta$; $b_{S22} = -b_{M23}*\delta$; $b_{S23} = -b_{M24}*\delta$; $b_{S24} = -b_{M25}*\delta$; $b_{S25} = -b_{M26}*\delta$; $b_{S26} = -b_{M27}*\delta$.

guarantees that, once estimated, these equations are free from selection bias, and thus can be safely used to retrieve the coefficients of the shadow price of home time function. As with the standard version of the estimation model, LAMBDA—the selection-bias correction variable—must be computed for each sampled wife from the results of a labor-force participation Probit analysis performed over the entire sample of observations prior to the estimation of the market wage and hours-of-work equations. The labor-force participation equation, which translates the extensive margin of the labor supply decision, and upon which the Probit analysis is performed, is specified as follows for the first variant of the standard model:

$$\begin{aligned} P_i^{OBS} = \phi(&\beta_{P0} + \beta_{P1}AGE_i + \beta_{P2}AGESQ_i + \beta_{P3}ED1_i + \beta_{P4}ED2_i + \beta_{P5}ED3_i + \beta_{P6}ED4_i + \beta_{P7}CRED_i + \\ &\beta_{P8}RACE_i + \beta_{P9}EXP_i + \beta_{P10}CNSIZE_i + \beta_{P11}UNEMP_i + \beta_{P12}KDSLT6_i + \beta_{P13}KDS6{\sim}16_i + \\ &\beta_{P14}KDSGE16_i + \beta_{P15}OTHGE16_i + \beta_{P16}YMARRIED_i + \beta_{P17}OWN_i + \beta_{P18}BEDROOMS_i + \\ &\beta_{P19}SIZEYRD_i + \beta_{P20}SPWAGE_i + \beta_{P21}UNEARN_i + \beta_{P22}MLIM_i + \beta_{P23}SPMLIM_i + \\ &\beta_{P24}ATT2_i + \beta_{P25}SPATT2_i + \beta_{P26}HHTECH_i + \beta_{P27}YADEQI_i\ ) \end{aligned}$$

where, as in the standard version of the estimation model,

$$P_i^{OBS} = \begin{cases} 1 \text{ if the wife is } \textit{observed} \text{ participating in the paid labor force (i.e. } M_i^{OBS} > 0\text{)} \\ 0 \text{ if the wife is out of the paid labor force (i.e. } M_i^{OBS} = 0\text{)} \end{cases}$$

and both standard and new regressors contained in this equation are defined in the very same way as before[23].

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[23] As with the standard version of the estimation model, notice that, as required, all regressors appearing in the hours-of-work equation are also included in the labor-force participation Probit equation.

Again, LAMBDA is computed for each observation in the same way as with the standard version of the model. That is, $\phi(Z_i)/[1-\Phi(Z_i)]$ {i.e. $\phi(Z_i)/\Phi(-Z_i)$}, where $\phi(Z_i)$ is the probability density function for the standard normal variable Z_i, $\Phi(Z_i)$ is the cumulative distribution function for Z_i, and Z_i is the *standardized* predicted value estimated from the Probit function of the labor-force participation decision {i.e. $Z_i = [-X_{Pi}\beta_P/(\sigma_{PP})^{1/2}]$}.

Theoretical Justifications and Statistical Expectations for the Variables Included in the First Variant of the Standard Estimation Model

Inasmuch as this first variant of the standard estimation model improves on the usual specification by adding six new, non-standard, regressors (i.e. MLIM, SPMLIM, ATT2, SPATT2, HHTECH, and YADEQI) believed to be important in the determination of a wife's labor supply decisions[24]—and hence, in the determination of the shadow price of her home time—along with the standard regressors usually considered by home and family economists when implementing the opportunity cost approach to valuing household production time, it would be redundant to reformulate the same theoretical justifications and reiterate the statistical expectations already established with regard to the standard regressors.

Simply put, except for the wife's health limitation index (MLIM) that is added in the market wage equation, the other regressors considered in the market wage function for

[24] Recall that the labor supply of any individual embodies two distinct decisions in the model developed by Heckman: a participation decision (i.e. the extensive margin of the individual's labor supply) and an hours-of-work decision (i.e. the intensive margin of the individual's labor supply).

this particular variant of the model (i.e. AGE, AGESQ, ED1, ED2, ED3, ED4, CRED, RACE, EXP, CNSIZE, and UNEMP) represent the very same regressors utilized in the standard version of the estimation model, and thus are justified via the same theoretical rationales as before. Further, the same hypothesized relationships between these standard regressors and the wife's offered market wage are also expected in this variant of the model. Likewise, except for the wife's health limitation index (MLIM), her husband's health limitation index (SPMLIM), her gender-role attitudinal score on the home-orientation index (ATT2), her husband's attitudinal score on the same home-orientation index (SPATT2), her perception vis-à-vis the adequacy of her available home technology (HHTECH) and household's money income (YADEQI), which are added as regressors in the shadow price of home time equation, the standard regressors considered in the shadow price of home time function for this first variant of the estimation model (i.e. AGE, AGESQ, ED1, ED2, ED3, ED4, CRED, RACE, CNSIZE, UNEMP, KDSLT6, KDS6~16, KDSGE16, OTHGE16, YMARRIED, OWN, BEDROOMS, SIZEYRD, SPWAGE, UNEARN, and M^{OBS} respectively) obey the same theoretical rationales and hypotheses formulated earlier for the standard version of the estimation model. Therefore, only the six new regressors considered in this particular variant of the estimation model need to be justified and discussed in terms of their statistical expectations. Accordingly, the discussion that follows focuses exclusively on these six new regressors that are considered in this particular variant of the estimation model.

Respecting the order in which these new regressors appear in the recurrent system of equations, the extent to which a wife is potentially limited with respect to the type or amount of work she can perform due to a health condition or disability (MLIM) is included in the offered wage function because it is believed that, holding other personal and demographic characteristics constant, the wage a wife can command in the market is very likely to be affected by her state of health. As such, provided that market wages should theoretically be reflective of the individuals' capacity to produce in the labor market, any health impairment which limits the type or amount of work a wife can do—and thus, which limits her productive capacity in paid employment—must be consequential in the determination of the market wage she can possibly secure in the labor force. Specifically, here it is hypothesized that a wife's offered market wage will be inversely related to her degree of health impairment, ceteris paribus. In other words, all other characteristics held constant, a higher level of MLIM is expected to be associated with a lower offered market wage.

Based upon the very same rationale that motivates its inclusion in the market wage equation, the fact that the wife's health limitation index is also included as new regressor in the shadow price of home time function should not be very surprising. Indeed, if the market productivity of a wife can be impaired by her overall state of health, it follows that her non-market productivity must also be conditioned by her state of health. Particularly, the shadow value of a wife's home labor must be affected in the same way her offered market wage is expected to be affected by a health restraint on the type or amount of work she can possibly accomplish. Hence, as with the offered market wage, an inverse relationship is hypothesized between greater levels of health impediment (MLIM) and the shadow price of a wife's home time.

The economic rationale for the inclusion of the husband's health limitation index (SPMLIM) in the wife's shadow price of home time function arises from the possible substitutability or complementarity of the spouses in labor market activities. In fact, because a husband afflicted by a health condition or disability would generally be expected to decrease—or at least restrain—his market work effort, if the spouses perceived themselves as substitutes for each other in paid market employment (and thus in the home), then it would be expected that the wife increases her paid labor supply effort in response to her husband's health affliction. Consequently, by increasing her market labor supply, it would be seen that the health impediment of the husband drives down his wife's shadow price for home time. In contrast, if the spouses perceived themselves as complements for each other in paid market work activities (and thus in the home), then it would be expected that the wife decreases her hours of market work as a result of her husband's health impairment. This decrease in her paid market labor would indicate that the shadow price the wife confers to her home time is bid up as a result of her husband's health affliction. Indeed, whether husbands and wives perceive themselves as substitutes or complements in market work activities is an empirical matter. Also, since no *a priori* notion about the degree of substitutability or complementarity between the spouses' market and non-market time is available, the most reasonable hypothesis that could be formulated here is that the shadow price of a wife's home time should decrease with the severity of her husband's health condition or disability (SPMLIM) if the spouses perceived themselves as substitutes for each other in paid market activities, while it should increase if they considered themselves as complementing each other in paid market work.

Drawing upon the studies of Dowdall (1974), Ferber (1982), Thornton et al. (1983), and Thornton & Camburn (1979), which all concur to indicate the importance of a wife's gender-role attitudes in the determination of her labor market behavior—and thus, her reservation wage—the wife's score on a special 'home-orientation' attitudinal index (ATT2) is included as a preference shifter in her shadow price of home time function. Inasmuch as a high score on this attitudinal index denotes a more traditional gender-role posture while a low score reflects a more egalitarian type of orientation with respect to what the wife perceives as the proper role of women in the family and in society in general, a positive relationship is hypothesized between the wife's score on this attitudinal index and the shadow price of her home time. In the same order of ideas, given that the gender-role attitudes of husbands vis-à-vis women employment have been found to influence their wives' own attitudes toward their labor market behavior (Astin, 1969; Folk et al., 1989; Spitze & Spaeth, 1979; Spitze & Waite, 1981), the husband's score on this 'home-orientation' attitudinal index denoting what he views as the proper role of women in the family and in society (SPATT2) is also included as a preference shifter in the specification of the wife's shadow price of home time function. Again, since a husband scoring high on this index would be characterized with more traditional expectations or beliefs toward what he considers as being the 'proper' role of women, a positive relationship is posited between the husband's score on this gender-role attitudinal index and his wife's shadow price of home time.

Another non-standard regressor considered in the wife's shadow price of home time function is a household technology index (HHTECH) that conveys her perception with respect to the degree of adequacy of her home tools and equipment. Recalling that home-produced commodities are generated by combining labor with a fixed amount of market inputs [i.e. $Z= z(H; X)$], if the market inputs used in the production processes (i.e. the X in the home production function) are linked to the array of available appliances, equipment, and other durables in the home, then it should be obvious that a wife's capacity to produce household commodities is directly conditioned by the level of home technology at her disposal. In fact, holding time input (labor) constant, it should be the case that a wife's potential capacity to produce household goods and services rises with increased levels of home technology. Further, by increasing the productive capacity of her home time, it follows that household technology must also increase the economic value a wife places on this time. Hence, based on the above rationale, a positive relationship is hypothesized between the wife's perceived adequacy of her available household technology (HHTECH) and the shadow price of her home time.

The last non-standard regressor that is added in the shadow price of home time function is an income adequacy index (YADEQI) which conveys the wife's perception with respect to the capacity of her household's money income to satisfy the wants of her family unit. As such, this particular index is included in the shadow price of her home time function as an attempt to capture the impact of the discrepancy the wife might perceive between her desired standard of income for her household and her household's actual income level. Conceptually speaking, the idea here is that lower levels of perceived income adequacy—or, equivalently, higher levels of perceived economic discomfort—add incentives for the wife to increase her labor supply effort, ceteris paribus. Indeed, any increase in her paid labor supply must necessarily result in an equivalent decrease in her non-market time. Consequently, holding the market wage she can secure in the labor force constant, the only way for her to increase her market hours is to lower the economic value she confers to her home time. Hence, inasmuch as a high score on this income adequacy index reflects, from the wife's point of view, a greater capacity of her household's money income to meet the wants of her family, a positive relationship is posited between the index (YADEQI) and the economic value the wife places on her home time. More precisely, it is hypothesized that higher levels of perceived income adequacy will raise a wife's shadow price of home time, while, in contrast, lower levels will simply decrease it, ceteris paribus.

Turning to the expected impacts of the new, non-standard, regressors on the intensive margin of a wife's labor supply (i.e. her observed hours of market work, M^{OBS}), and abstracting from her health limitation index, MLIM, which appears in both market wage and shadow price of home time functions, it is clear that the expectations which could possibly be formulated with respect to the other new regressors considered in this variant of the standard estimation model (i.e. SPMLIM, ATT2, SPATT2, HHTECH, and YADEQI) are directly dictated by the hypothesized relationships between these regressors and the wife's shadow price of home time. This is so because, as seen earlier, the corresponding coefficients of these regressors in the hours-of-work equation are given by

$$b_{Mq} = -b_{Sq}/\delta ,$$

where q simply denotes those regressors that are included in the shadow price of home time function, but not in the market wage function. Hence, if delta is, as in the standard version of the estimation model, expected to be positive (i.e. $\delta > 0$), then while any variable appearing only in the shadow price of home time equation that is hypothesized to raise a wife's shadow price of home time must be expected to be negatively related to her hours of paid market work, any variable expected to decrease the shadow price she places on her home time must necessarily be expected to be positively associated with her hours of market work, ceteris paribus.

Accordingly, given that the wife's gender-role attitude (ATT2), her spouse's gender-role attitude (SPATT2), her perceived degree of adequacy vis-à-vis her available home technology and household's money income (HHTECH and YADEQI respectively) are regressors that are all hypothesized to be positively associated with the shadow value of her home time, it follows that these particular regressors must be expected to decrease a wife's observed hours of market work, ceteris paribus. Moreover, in the event the spouses perceive themselves as complements for each other in paid market activities, the husband's health limitation index (SPMLIM) would be expected to be positively related to a wife's shadow price of home time, and thus negatively associated with her hours of market work. Conversely, if they perceived themselves as being substitutes for each other in the labor force, then SPMLIM should be found to be positively related to the wife's hours of paid work.

As with the standard regressors which appear in both market wage and shadow price of home time functions, the corresponding coefficient of MLIM in the hours of market work equation cannot be directly signed unless one speculates on the possible magnitude of this regressor on the wife's offered market wage and shadow price of home time. This is so because, as already pointed out earlier, for any regressor included in both the offered market wage and shadow price of home time functions, its corresponding coefficient in the hours of market work equation is given by

$$b_{Mj} = (b_{Wj} - b_{Sj})/\delta \ ,$$

where the subscript j denotes any particular regressor expected to affect both the wife's offered market wage and shadow price of home time. Hence, in the case of MLIM, since it is posited that a wife's market wage and shadow value of home time should decrease with increasing degree of health affliction or disability (i.e. $b_{W12} < 0$ and $b_{S21} < 0$ in terms of expectations), without knowing if a wife's health limitation is more important in determining lnW than lnS (or vice versa), it is difficult to posit the sign of this variable with respect to its impact on her observed hours of market work, M^{OBS}. Indeed, one might speculate that a wife's affliction is more important in determining her shadow price of home time than her offered market wage. Accordingly, in such a case a positive relationship will have to be hypothesized between a wife's health affliction (MLIM) and her observed hours of market work (M^{OBS}). Of course, one might also speculate that a wife's affliction is of greater magnitude in determining her offered market wage than her shadow price of home time. From this speculation a negative relationship will be posited between MLIM and M^{OBS}. This is what is expected here. More exactly, it is posited that, although both the wife's market wage and shadow price of home time will decrease with rising levels of health impairment, the decrease in her offered wage should simply outweigh the decrease in her shadow price of home time, and hence lead to a decrease in her observed hours of paid market work[25].

Finally, inasmuch as in Heckman's model both intensive and extensive margin of the labor supply decision are required to be determined by the same set of regressors, it follows that the hypotheses formulated between the new regressors included in this first variant of the standard model and the intensive margin of a wife's labor supply behavior (i.e. her observed hours of market work, M^{OBS}) must also apply to the extensive margin of her labor supply (i.e. her decision of whether or not to participate in the paid labor force, P^{OBS}) in terms of expectations. Consequently, MLIM, ATT2, SPATT2, HHTECH, and YADEQI are all hypothesized to be inversely associated with a wife's propensity to participate in the paid labor market. As such, increases in the level of any of these variables are expected to lower the wife's probability of labor force participation in the Probit equation. Additionally, as in the hours of market work equation, the sign of SPMLIM should depend on whether the spouses regard themselves as complements or substitutes for each other in market and non-market activities. On one hand, if they perceived themselves as complementing each other, then SPMLIM would be inversely related to the wife's propensity to participate in the labor market, ceteris paribus. If they considered themselves as substitutes, then SPMLIM would be positively associated with the wife's propensity to participate in the paid labor force, on the other hand.

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[25] Although strictly speculative, it seems reasonable to believe that a wife's capacity to produce in the paid labor market should be more severely affected by a health condition or disability than should her productive capacity in the home. After all, it is easier for a household to adapt the context and structure of its home to her health impairment than it is for an employer to alter the working environment in order to assist or accommodate individuals with a health restraint or disability.

The Second Variant of the Standard Estimation Model: Accounting for Both Potentially Important Missing Labor Supply Regressors and Labor Market Constraints

In the third and last version of the recurrent estimation model—which is referred to as the 'second variant' of the standard model—the standard assumption of perfectly continuous budget lines is relaxed in order to control for institutional labor market constraints affecting the labor supply behavior (and hence, the overall allocation of time) of the sampled Missouri wives. More precisely, provided that the data on hand support the fact that many sampled wives are constrained with respect to their labor supply choices, this second and more sophisticated variant of the standard estimation model controls for labor market restraints by utilizing the wives' desired hours of market work instead of the actual—and possibly constrained—number of hours currently worked in the paid labor force.

Thus, while the standard estimation model and the first variant of it simply ignore the possibility of constrained time-allocation equilibria—inasmuch as both models are based upon the implicit standard assumption that sampled observations are totally free to allocate as few or as many hours of their precious time to market and non-market activities—this particular variant of the standard estimation model fully recognizes and controls for the possibility of interfering labor market constraints which, undeniably, prevent certain sampled wives from being observed in their long-run, and hence utility-maximizing, time-allocation equilibria. Indeed, since individuals facing institutional labor market constraints are necessarily observed allocating their time in ways which cannot possibly generate the optimum amount of utility they could otherwise derive from a long-run (i.e. unconstrained) equilibrium allocation of time, replacing observed by desired labor supply behavior in the estimation model guarantees that all sampled wives are portrayed and analyzed in their long-run time-allocation equilibria.

Hence, from an empirical point of view, defining the labor supply of individuals in terms of their desired rather than observed behavior is appropriate because, as demonstrated earlier, the inclusion of undifferentiated constrained individuals in the estimation model inevitably leads to bias in the retrieved coefficients of the shadow price of home time function, and thus in any opportunity cost value of home production time derived from this function, no matter if it is derived for constrained or unconstrained individuals. Additionally, at a conceptual level, if the shadow price of home time concept is to truly represent the monetary value individuals themselves place on that time, then the use of truly unconstrained (i.e. desired) labor supply functions is necessary to ensure that any shadow price of household production time derived via the opportunity cost of time methodology is fully disentangled from adverse and obstructive exogenous labor market circumstances.

Consequently, this second variant of the standard estimation model is specified using the very same regressors included in the first variant (i.e. including both standard and generally omitted regressors), except that any labor supply-related figure for the sampled wives is defined in terms of *desired* rather than *observed* labor supply behavior. Notice carefully here that fully accounting for labor market constraints does not only require that the hours of market work equation (i.e. the intensive margin of the labor supply decision) be cast in terms of desired behavior, but also that the labor-supply participation Probit function (i.e. the extensive margin of the labor supply decision) be defined by such desired behavior as well. This is so because, as pointed out earlier, while underemployed and overemployed individuals are constrained strictly with regard to the intensity of their labor supply behavior, the involuntarily unemployed are necessarily also constrained in terms of their labor-force participation status.

Thus, considering desired (i.e. truly unconstrained) rather than observed (i.e. potentially constrained) labor supply choices in the two-stage estimation model, the coefficients of the shadow price of home time equation are retrieved upon estimation of the market wage and desired hours of market work equations. Indeed, direct comparisons with the results obtained from the previous version (i.e. from the first variant) of the estimation model should permit a direct assessment of the extent of the bias introduced in the shadow price of home time function and hence in reservation wage estimates when researchers erroneously assume that all individuals freely allocate their time to the labor market as well as to the home.

As with the first variant of the standard version of the estimation model, lambda should not be statistically significant in either the market wage equation or the desired hours-of-work equation. In fact, since the very same regressors (i.e. both standard and generally omitted important regressors) included in the first variant of the standard estimation model are also included in this second variant, it is even possible that the censoring of the sample be better explained when observed employment status is replaced by desired employment status in the first-stage Probit analysis. Here, although strictly speculative, it is believed that because involuntarily unemployed wives are more likely to share similarities with employed wives than they do with voluntarily nonemployed wives in terms of personal characteristics, the explanatory power of the labor-force participation Probit function is likely to increase when desired labor-force participation behavior is considered in the first-stage Probit. As such, if this speculation were to be accurate, then compared to the Probit results obtained from the first variant of the standard estimation model, it would be natural to expect improved goodness-of-fit measures from the Probit function characterizing the second variant of the standard estimation model. Again, direct comparisons with the results obtained from the first variant of the standard estimation model will permit to establish whether such a speculation is founded or not.

Empirical Specification of the Second Variant of the Standard Estimation Model

Using the very same regressors as in the first variant of the standard version of the model, but controlling for potential labor market constraints by replacing observed with desired hours of market work, the sample selection-corrected market wage and shadow price of home time equations for the second and last variant of the standard estimation model are expressed in terms of the wives' data as:

$$\begin{aligned}\ln W_i = {} & \beta_{W0} + \beta_{W1}AGE_i + \beta_{W2}AGESQ_i + \beta_{W3}ED1_i + \beta_{W4}ED2_i + \beta_{W5}ED3_i + \beta_{W6}ED4_i + \\ & \beta_{W7}CRED_i + \beta_{W8}RACE_i + \beta_{W9}EXP_i + \beta_{W10}CNSIZE_i + \beta_{W11}UNEMP_i + \beta_{W12}MLIM_i + \\ & \xi_W LAMBDA_i + V_{Wi}\,,\end{aligned}$$

and

$$\begin{aligned}\ln S_i = {} & \beta_{S0} + \beta_{S1}AGE_i + \beta_{S2}AGESQ_i + \beta_{S3}ED1_i + \beta_{S4}ED2_i + \beta_{S5}ED3_i + \beta_{S6}ED4_i + \beta_{S7}CRED_i + \\ & \beta_{S8}RACE_i + \beta_{S9}CNSIZE_i + \beta_{S10}UNEMP_i + \beta_{S11}KDSLT6_i + \beta_{S12}KDS6{\sim}16_i + \\ & \beta_{S13}KDSGE16_i + \beta_{S14}OTHGE16_i + \beta_{S15}YMARRIED_i + \beta_{S16}OWN_i + \beta_{S17}BEDROOMS_i + \\ & \beta_{S18}SIZEYRD_i + \beta_{S19}SPWAGE_i + \beta_{S20}UNEARN_i + \beta_{S21}MLIM_i + \beta_{S22}SPMLIM_i + \\ & \beta_{S23}ATT2_i + \beta_{S24}SPATT2_i + \beta_{S25}HHTECH_i + \beta_{S26}YADEQI_i + \delta M_i^{DES} + V_{Si}\end{aligned}$$

respectively, where

$\ln W_i$ = the natural logarithm of the actual after-tax hourly market wage for the wife currently working in the labor force, or the natural logarithm of the most recent after-tax hourly market wage for the wife currently unemployed. Again, considering both Federal and Missouri State income taxes, one minus the household's 1995 average income tax rate was used to convert gross market wages into after-tax market wage figures ;

M_i^{DES} = the wife's desired, truly unconstrained, hours of paid market work per year (i.e. the intensive margin of her labor supply decision expressed in terms of desired behavior, on a yearly basis) ;

and all other variables contained in the two equations specified above are identical to those included in the first variant of the standard estimation model.

Equating these two equations and arithmetically solving for M_i^{DES}, the intensive margin of the labor supply decision expressed in terms of the wives' desired hours-of-work equation is specified as follows:

$$\begin{aligned} M_i^{DES} = \delta^{-1}[&(\beta_{W0}-\beta_{S0}) + (\beta_{W1}-\beta_{S1})AGE_i + (\beta_{W2}-\beta_{S2})AGESQ_i + (\beta_{W3}-\beta_{S3})ED1_i + \\ &(\beta_{W4}-\beta_{S4})ED2_i + (\beta_{W5}-\beta_{S5})ED3_i + (\beta_{W6}-\beta_{S6})\ ED4_i + (\beta_{W7}-\beta_{S7})CRED_i + \\ &(\beta_{W8}-\beta_{S8})RACE_i + \beta_{W9}EXP_i + (\beta_{W10}-\beta_{S9})CNSIZE_i + (\beta_{W11}-\beta_{S10})UNEMP_i + \\ &(-\beta_{S11})KDSLT6_i + (-\beta_{S12})KDS6{\sim}16_i + (-\beta_{S13})KDSGE16_i + (-\beta_{S14})OTHGE16_i + \\ &(-\beta_{S15})YMARRIED_i + (-\beta_{S16})OWN_i + (-\beta_{S17})BEDROOMS_i + (-\beta_{S18})SIZEYRD_i + \\ &(-\beta_{S19})SPWAGE_i + (-\beta_{S20})UNEARN_i + (\beta_{W12}-\beta_{S21})MLIM_i + (-\beta_{S22})SPMLIM_i + \\ &(-\beta_{S23})ATT2_i + (-\beta_{S24})SPATT2_i + (-\beta_{S25})HHTECH_i + (-\beta_{S26})YADEQI_i + \\ &(\sigma_{WW}-2\sigma_{WS}+\sigma_{SS})^{1/2}\ LAMBDA_i + (V_{Wi}-V_{Si})] \end{aligned}$$

or just

$$\begin{aligned} M_i^{DES} = {} &\beta_{M0} + \beta_{M1}AGE_i + \beta_{M2}AGESQ_i + \beta_{M3}ED1_i + \beta_{M4}ED2_i + \beta_{M5}ED3_i + \beta_{M6}ED4_i + \\ &\beta_{M7}CRED_i + \beta_{M8}RACE_i + \beta_{M9}EXP_i + \beta_{M10}CNSIZE_i + \beta_{M11}UNEMP_i + \beta_{M12}KDSLT6_i + \\ &\beta_{M13}KDS6{\sim}16_i + \beta_{M14}KDSGE16_i + \beta_{M15}OTHGE16_i + \beta_{M16}YMARRIED_i + \beta_{M17}OWN_i + \\ &\beta_{M18}BEDROOMS_i + \beta_{M19}SIZEYRD_i + \beta_{M20}SPWAGE_i + \beta_{M21}UNEARN_i + \\ &\beta_{M22}MLIM_i + \beta_{M23}SPMLIM_i + \beta_{M24}ATT2_i + \beta_{M25}SPATT2_i + \beta_{M26}HHTECH_i + \\ &\beta_{M27}YADEQI_i + \xi_M LAMBDA_i + V_{Mi}\,. \end{aligned}$$

As with the two previous versions of the estimation model, the shadow price of home time function cannot be directly estimated from the wives' data. Nonetheless, given that the sample selection-corrected market wage and desired hours of market work equations are both directly estimable for the wives who participate in the paid labor force, it follows that upon the statistical identification of the recurrent system of equations the coefficients of the shadow price of home time function may be retrieved[26] and hence utilized to derive the reservation wage of any sampled wife, regardless of her employment status. As such, because of the inclusion of LAMBDA as regressor in the market wage and desired hours-of-work equations, it is guaranteed that the retrieved coefficients of the shadow price of home time function are exempt from sample selection bias and, therefore, can be safely used to derive opportunity cost measures of household production time for the subsample non-working observations. Obviously, LAMBDA must be calculated for each observation prior to the least squares estimation of the market wage and hours-of-work equations if it is to instrument the equations from which the coefficients of the shadow price of home time function are retrieved. Consequently, this requires the estimation of a Probit equation of the probability of labor force participation (i.e. the extensive margin of the labor supply decision) using all sampled observations. As with the hours-of-work function, the equation that translates the labor-force participation decision must also be couched in terms of desired rather than observed behavior if this second variant of the

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[26] As with the standard version of the estimation model and the first variant of it, the identifier for the second variant of the standard model is EXP, and its corresponding parameters, β_{W9} and β_{M9}. Because EXP represents the only regressor appearing in the market wage equation that is not contained in the shadow price of home time equation, one can easily identify δ, and thus retrieve the coefficients of the shadow price of home time function once both market wage and hours-of-work equations are estimated. Specifically, since $\delta = \beta_{W9}/\beta_{M9}$, the coefficients of the shadow price of home time equation for the second variant of the standard estimation model may be retrieved as follows:

$b_{S0} = b_{W0} - b_{M0}*\delta$; $b_{S1} = b_{W1} - b_{M1}*\delta$; $b_{S2} = b_{W2} - b_{M2}*\delta$; $b_{S3} = b_{W3} - b_{M3}*\delta$; $b_{S4} = b_{W4} - b_{M4}*\delta$; $b_{S5} = b_{W5} - b_{M5}*\delta$; $b_{S6} = b_{W6} - b_{M6}*\delta$; $b_{S7} = b_{W7} - b_{M7}*\delta$; $b_{S8} = b_{W8} - b_{M8}*\delta$; $b_{S9} = b_{W10} - b_{M10}*\delta$; $b_{S10} = b_{W11} - b_{M11}*\delta$; $b_{S11} = -b_{M12}*\delta$; $b_{S12} = -b_{M13}*\delta$; $b_{S13} = -b_{M14}*\delta$; $b_{S14} = -b_{M15}*\delta$; $b_{S15} = -b_{M16}*\delta$; $b_{S16} = -b_{M17}*\delta$; $b_{S17} = -b_{M18}*\delta$; $b_{S18} = -b_{M19}*\delta$; $b_{S19} = -b_{M20}*\delta$; $b_{S20} = -b_{M21}*\delta$; $b_{S21} = b_{W12} - b_{M22}*\delta$; $b_{S22} = -b_{M23}*\delta$; $b_{S23} = -b_{M24}*\delta$; $b_{S24} = -b_{M25}*\delta$; $b_{S25} = -b_{M26}*\delta$; $b_{S26} = -b_{M27}*\delta$.

standard estimation model is to fully control for labor market constraints. Accordingly, for this second variant of the standard model, the labor-force participation equation upon which the Probit analysis is performed is specified as follows:

$$P_i^{DES} = \phi(\beta_{P0} + \beta_{P1}AGE_i + \beta_{P2}AGESQ_i + \beta_{P3}ED1_i + \beta_{P4}ED2_i + \beta_{P5}ED3_i + \beta_{P6}ED4_i + \beta_{P7}CRED_i + \beta_{P8}RACE_i + \beta_{P9}EXP + \beta_{P10}CNSIZE_i + \beta_{P11}UNEMP_i + \beta_{P12}KDSLT6_i + \beta_{P13}KDS6{\sim}16_i + \beta_{P14}KDSGE16_i + \beta_{P15}OTHGE16_i + \beta_{P16}YMARRIED_i + \beta_{P17}OWN_i + \beta_{P18}BEDROOMS_i + \beta_{P19}SIZEYRD_i + \beta_{P20}SPWAGE_i + \beta_{P21}UNEARN_i + \beta_{P22}MLIM_i + \beta_{P23}SPMLIM_i + \beta_{P24}ATT2_i + \beta_{P25}SPATT2_i + \beta_{P26}HHTECH_i + \beta_{P27}YADEQI_i\,)$$

where, in contrast with the two previous versions of the estimation model,

$$P_i^{DES} = \begin{cases} 1 \text{ if the wife is } \textit{observed} \text{ or } \textit{desires} \text{ participating in the labor force (i.e. } M_i^{DES} > 0\text{)} \\ 0 \text{ if otherwise (i.e. } M_i^{DES} = 0\text{)} \end{cases}$$

and all other variables contained in the desired labor-force participation equation are similar to those in the desired hours-of-work equation[27], and thus are defined in the very same way as before.

Utilizing the results of the Probit run, LAMBDA is computed for each sampled wife i as $\phi(Z_i)/[1-\Phi(Z_i)]$ {i.e. $\phi(Z_i)/\Phi(-Z_i)$}, where Z_i is the 'standardized' predicted value obtained from the estimated Probit function of the truly unconstrained (i.e. desired) labor-force participation decision {i.e. $Z_i = [-X_{Pi}\beta_P /(\sigma_{PP})^{1/2}]$}, $\phi(Z_i)$ is the probability density function of Z_i, and $\Phi(Z_i)$ is its cumulative distribution function.

[27] As for the standard version of the model and the first variant of it, all regressors included in the desired hours-of-work equation are, as required, also included in the desired labor-force participation equation.

Theoretical Justifications and Statistical Expectations for the Variables Included in the Second Variant of the Standard Estimation Model

Inasmuch as this second variant of the standard version of the estimation model differs from the first variant of it only by its use of the wife's desired (i.e. truly unconstrained) rather than observed labor supply behavior in order to control for potential institutional labor market constraints, it follows that the same theoretical rationales upon which both standard and non-standard regressors are justified and hence included in the first variant of the standard specification also apply in this last variant of the standard estimation model. Furthermore, the fact that the wife's labor supply behavior is expressed in terms of desired rather observed behavior should not lead to different expectations with regard to how the standard and non-standard regressors relate to a wife's market wage, shadow price of home time, hours of market work, and labor force participation decision. Consequently, the very same hypotheses formulated earlier as to how both standard and non-standard regressors should influence the wife's offered market wage, shadow price of home time, hours of labor supply, and propensity to participate in the labor market are also maintained in this particular variant of the estimation model.

Table 5.1 below summarizes the expected effects posited with respect to all the variables considered in the specification of the standard version of the estimation model as well as in the specification of the first and second variants of it.

Table 5.1 Summary of the Hypothesized Effects (i.e. Signs) of the Variables considered in the Specification of the Standard Version of the Estimation Model and its Two Variants

Variables	Standard Version Expected Effects on:				First Variant Expected Effects on:				Second Variant Expected Effects on:			
	P^{OBS}	lnW	lnS	M^{OBS}	P^{OBS}	lnW	lnS	M^{OBS}	P^{DES}	lnW	lnS	M^{DES}
AGE	+	+	+	+	+	+	+	+	+	+	+	+
AGESQ	–	–	–	–	–	–	–	–	–	–	–	–
ED1 (Base: < than ED1)	+	+	+	+	+	+	+	+	+	+	+	+
ED2 (Base: < than ED1)	+	+	+	+	+	+	+	+	+	+	+	+
ED3 (Base: < than ED1)	+	+	+	+	+	+	+	+	+	+	+	+
ED4 (Base: < than ED1)	+	+	+	+	+	+	+	+	+	+	+	+
CRED (Base: 'no credentials')	+	+	+	+	+	+	+	+	+	+	+	+
RACE (Base: 'non-white')	?	?	?	?	?	?	?	?	?	?	?	?
EXP	+	+	n.a.	+	+	+	n.a.	+	+	+	n.a.	+
CNSIZE	+	+	+	+	+	+	+	+	+	+	+	+
UNEMP	–	–	–	–	–	–	–	–	–	–	–	–
KDSLT6	–	n.a.	+	–	–	n.a.	+	–	–	n.a.	+	–
KDS6~16	–	n.a.	+	–	–	n.a.	+	–	–	n.a.	+	–
KDSGE16	+	n.a.	–	+	+	n.a.	–	+	+	n.a.	–	+
OTHGE16	+	n.a.	–	+	+	n.a.	–	+	+	n.a.	–	+
YMARRIED	?	n.a.	?	?	?	n.a.	?	?	?	n.a.	?	?
OWN (Base: 'non-homeowner')	–	n.a.	+	–	–	n.a.	+	–	–	n.a.	+	–
BEDROOMS	–	n.a.	+	–	–	n.a.	+	–	–	n.a.	+	–
SIZEYRD	–	n.a.	+	–	–	n.a.	+	–	–	n.a.	+	–
SPWAGE	?	n.a.	?	?	?	n.a.	?	?	?	n.a.	?	?
UNEARN	–	n.a.	+	–	–	n.a.	+	–	–	n.a.	+	–
MLIM	n.a.	n.a.	n.a.	n.a.	–	–	–	–	–	–	–	–
SPMLIM	n.a.	n.a.	n.a.	n.a.	?	n.a.	?	?	?	n.a.	?	?
ATT2	n.a.	n.a.	n.a.	n.a.	–	n.a.	+	–	–	n.a.	+	–
SPATT2	n.a.	n.a.	n.a.	n.a.	–	n.a.	+	–	–	n.a.	+	–
HHTECH	n.a.	n.a.	n.a.	n.a.	–	n.a.	+	–	–	n.a.	+	–
YADEQI	n.a.	n.a.	n.a.	n.a.	–	n.a.	+	–	–	n.a.	+	–
M^{OBS}	n.a.	n.a.	+	n.a.	n.a.	n.a.	+	n.a.	n.a.	n.a.	n.a.	n.a
M^{DES}	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	+	n.a

n.a. = 'not applicable'

CHAPTER 6

EMPIRICAL RESULTS

This chapter presents the empirical results obtained from the estimation of the standard formulation of the model and its two particular variants on the sample of Missouri wives. Specifically, for each of the three different versions of the estimation model utilized in this study, descriptive statistics such as the means and standard deviations of the variables considered in the specification of each distinct model are presented and followed by the two-stage estimation results. A special SAS program developed in 1993 by David A. Jaeger, a statistical consultant for the Population Studies Center at the University of Michigan, was used to achieve the Heckman two-stage sample-selection correction procedure for each of the three particular versions of the estimation model employed in this study[1]. For each particular version of the model, the estimation results are contrasted to the hypotheses formulated earlier in Table 5.1, and thus discussed in relation to the theoretical expectations. Furthermore, the goodness of fit of the estimated functions in each particular version of the model is assessed and compared across the different models for the two stages of the estimation procedure.

Following the presentation of the estimation results, market wages and reservation wages are derived from each particular specification of the model. These opportunity cost of time measures are reported and compared across the subsamples of working and non-

[1] This special computational program is available for downloads directly from the SAS Institute web site at the following Internet address: Http://www.sas.com/service/techsup/faq/stat_proc/probproc998.html.

working wives, and across the three versions of the recurrent estimation model. As such, while direct comparisons between the figures obtained from the standard specification of the model and the first variant of it should permit to gauge the impact of potentially important labor supply regressors generally omitted by analysts when specifying the recurrent system of equations, direct comparisons between the figures obtained from the first and the second variants of the standard estimation model should allow for the assessment of the biases associated with the standard assumption of perfectly continuous budget lines (i.e. the assumption of no market constraints). Moreover, using the standard specification of the estimation model as the reference (i.e. base) model, the market wage and reservation wage figures derived from the first and second variants of the standard model are discussed in light of the specific refinements offered by these variants.

Lastly, an extension of the opportunity cost methodology to assessing the monetary value of home production time is implemented through a simple averaging procedure which enables the derivation of average shadow price values for the time allocated to household production activities. Not only are these average shadow price values compared across the different specifications of the estimation model and subsamples of wives but, most importantly, they are also contrasted to the standard opportunity cost measures (i.e. market and reservation wages) commonly used by home and family economists to assess the hourly value of home labor time. Utilizing these average shadow prices, the annual monetary value of household production time is assessed for the different subsamples of wives, and contrasted with the dollar figures that would normally be obtained under the standard assumption of linearly homogeneous (i.e. CRS) home production functions.

Descriptive Statistics and Empirical Results for the Standard Version of the Estimation Model

Table 6.1 Descriptive Statistics for the Variables used in the Specification of the Standard Version of the Estimation Model by *Observed* Labor-force Participation Status of the Sampled Missouri Wives

Continuous Variables		Presumably Satisfactorily Employed Wives (n=617)		Presumably Satisfactorily NonEmployed Wives (n=240)		All Sampled Wives (n=857)	
		Means	Std. Dev.	Means	Std. Dev.	Means	Std. Dev.
AGE		43.7682	8.8995	47.5667	10.7491	44.8320	9.6004
AGESQ		1994.7310	798.9404	2377.6500	999.4794	2101.9660	876.2728
EXP		18.3879	8.4718	12.1682	8.5899	16.6461	8.9475
CNSIZE[a]		4.5434	3.9298	4.8403	3.9770	4.6265	3.9430
UNEMP (%)		4.3014	1.6493	4.3865	1.4869	4.3252	1.6051
KDSLT6		0.2042	0.5164	0.3292	0.6815	0.2392	0.5698
KDS6~16		0.6548	0.9005	0.5625	0.9263	0.6289	0.9082
KDSGE16		0.5300	0.7810	0.3667	0.6776	0.4842	0.7566
OTHGE16		0.0276	0.1826	0.0208	0.1699	0.0257	0.1790
YMARRIED		20.3506	10.3820	25.0125	12.6209	21.6562	11.2439
BEDROOMS		3.3209	0.7280	3.3500	0.8547	3.3291	0.7652
SIZEYRD[b]		2.9935	1.2087	3.0625	1.1752	3.0128	1.1991
SPWAGE (net)		13.1045	7.8350	14.4055	13.0901	13.4689	9.6104
UNEARN[c]		5.2991	6.7440	12.1587	20.3274	7.2201	12.5537
M^{OBS}		1649.8270	550.4313	0.0000	0.0000	1187.7980	876.0516
lnW (net)		2.1921	0.4381	--------	--------	--------	--------
LAMBDA[d]		*0.3390*	*0.2929*	*–0.8716*	*0.4996*	*0.0000*	*0.6537*
Categorical Variables		Frequencies	%	Frequencies	%	Frequencies	%
ED0[e]		31	5.02	19	7.92	50	5.83
ED1[f]		299	48.46	148	61.67	447	52.16
ED2[g]		31	5.02	9	3.75	40	4.67
ED3[h]		204	33.06	57	23.75	261	30.46
ED4[i]		52	8.43	7	2.92	59	6.88
CRED	Yes	151	24.47	41	17.08	192	22.40
	No	466	75.53	199	82.92	665	77.60
RACE	White	604	97.89	231	96.25	835	97.43
	Other	13	2.11	9	3.75	22	2.57
OWN	Yes	592	95.95	228	95.00	820	95.68
	No	25	4.05	12	5.00	37	4.32

Table 6.1 (continued)

[a] Expressed in 100,000s of population.

[b] The household's yard size, SIZEYRD, was scaled as follows:
1= "no yard or modest yard (i.e. less than 1/8 acre or 75x75 feet)" ;
2= "small yard (i.e. 1/8 acre or more but less than 1/4 acre or 100x100 feet) " ;
3= "medium size yard (i.e. 1/4 acre or more but less than 1/2 acre or 150x150 feet)" ;
4= "large yard (i.e. 1/2 acre or more but less than 1 acre or 200x200 feet)" ;
5= "very large yard (i.e. 1 acre or more)" .

[c] Expressed in 1,000s of after-tax dollars.

[d] The means and standard deviations of LAMBDA (i.e. the sample-selection correction instrument which represents the inverse Mills ratio) are computed from the results of the *observed* labor-force participation Probit analysis performed over the entire sample of wives reported in Table 6.2.

[e] ED0 is the reference (i.e. omitted) category and represents an education level below High School.

[f] ED1 was coded 1 if the wife's highest educational level was a High School diploma, and 0 otherwise.

[g] ED2 was coded 1 if the wife's highest educational level was a Technical School diploma, and 0 otherwise.

[h] ED3 was coded 1 if the wife's highest educational level was an Undergraduate College degree, and 0 otherwise.

[i] ED4 was coded 1 if the wife's highest educational level was a Graduate or Professional College degree, and 0 otherwise.

Table 6.1 presents the descriptive statistics for all the variables used in the econometric specification of the standard version of the estimation model. While the means and standard deviations are reported for the continuous variables, frequencies and percentages are utilized for the categorical (i.e. non-continuous) variables. Further, inasmuch as the standard version of the estimation model is based on the assumption of perfectly continuous budget lines (i.e. the standard and hence usual assumption of no institutional labor market constraints), and thus because any sampled wife observed participating in the paid labor force is assumed to be satisfactorily employed, while any wife who is not observed working is assumed to be satisfactorily nonemployed, the descriptive statistics contained in Table 6.1 are reported for the entire sample of Missouri wives (n=857) as well as for the subsamples of *presumably* satisfactorily employed and nonemployed wives. Hence, under the assumption of perfectly continuous budget lines, 617 (≈72%) of the total sampled wives are *presumed* to be satisfactorily employed, and 240 (≈28%) are *presumed* satisfactorily nonemployed.

According to Table 6.1, the average observed hours of market work (M^{OBS}) for the subsample of presumably satisfactorily employed wives is 1,649.83 hours per year (i.e. roughly 32 hours per week). On average, these wives net \$8.95 per hour (i.e. $e^{2.1921}$) from paid market employment. Compared to the wives who are presumably satisfied to be nonemployed, those considered as presumably satisfactorily employed are, on average, younger (43.77 versus 47.57 years of age), although they have more years of paid market work experience (18.39 versus 12.17 years). Also, they have been married for shorter periods of time than their nonemployed counterparts (20.35 versus 25.01 years). They reside in less populated counties (4.54 versus 4.84 hundred thousands of population) where, on average, unemployment rates appear to be somewhat lower (4.30% versus 4.39%). So far as the composition of their households goes, while they have fewer preschool children (0.20 versus 0.33 children under six years of age), they have more children between ages six and 16 (0.65 versus 0.56), and more teenage children (0.53 versus 0.37), on average. Also related to the composition of their households, the wives considered as satisfactorily employed reside in households in which, on average, the presence of relatives and/or friends of 16 years of age and over (i.e. OTHGE16) is slightly greater (0.03 versus 0.02). As a proxy for the size of the house, the number of bedrooms in the current residence is slightly less for the subsample of presumably satisfactorily employed wives (3.32 versus 3.35 bedrooms). Likewise, the size of the yard where they reside is slightly smaller (2.99 versus 3.06). The wives considered as satisfactorily employed have husbands who, on average, net less from their primary market jobs ($13.10 versus $14.41 per hour). Also, their household's after-tax unearned income is considerably less on average (5.30 versus 12.16 thousand dollars). So far as the wives' human capital variables are concerned, the data reveal that fewer presumably satisfactorily employed wives have less than a high school diploma (i.e. ED0) as their highest educational achievement (5.02% versus 7.92%). Likewise, fewer have only a high school diploma (i.e. ED1) as their highest schooling achievement (48.46% versus 61.67%). In fact, a larger proportion of wives considered as satisfactorily employed possess a technical school diploma (i.e. ED2), an undergraduate college degree (i.e. ED3), or a graduate or professional college degree (i.e. ED4) as their highest educational achievement (5.02% versus 3.75%, 33.06% versus 23.75%, and 8.43% versus 2.92%, respectively). Similarly, in contrast to those considered as satisfactorily nonemployed, a larger proportion of wives reporting hours of market work have extra-curricular credentials (i.e. CRED=Yes) such as special licenses or certifications (24.47% versus 17.08%). Finally, although slightly larger for the wives assumed satisfactorily employed, the proportion of Caucasian wives (i.e. RACE=White) and the proportion of wives living in households which 'own' their houses (i.e. OWN=Yes) are almost the same in both subsamples (97.89% versus 96.25%, and 95.95% versus 95.00%, respectively)[2].

[2] Note how large are the proportions of sampled Caucasians wives and the proportions of wives who reported living in households that own their homes. As such, these large proportions of Caucasians wives and homeowners either indicate that the sampling technique utilized by *Best Mailing Lists, Inc.* over-sampled Caucasian households and homeowners, or simply that Caucasian wives and wives living in their own homes were more inclined to participate in the survey.

Hence, from a purely descriptive point of view, Table 6.1 provides important information about the potential differences and similarities existing with respect to the personal and socio-demographic characteristics between the sampled wives observed in the paid labor market and those who are not. Taken together, if the observed differences in the characteristics considered in the specification of the standard estimation model were to consistently distinguish the wives who, presumably, choose to be out of the labor force from those who opt to work, then it should be clear that a Probit analysis of the sampled wives' labor-force participation decisions which incorporates these (consistent) differences would be characterized by a much better fit than if these observed differences were simply the results of aleatory (inconsistent) variations. Further, as explained earlier, since sample selection bias is directly related to the overall capacity of the potential differences in the observed personal and socio-demographic characteristics of working and non-working wives to explicate the censoring of the sample, it is obvious that sample selection bias must necessarily decrease with increasing discriminatory power of the observed personal and socio-demographic characteristics of the sampled wives.

The four tables that follow present the results obtained from the standard formulation of the Heckman estimation model. Specifically, Table 6.2 gives the results of the maximum-likelihood Probit run performed over the entire sample of wives, and from which the inverse Mills ratio, LAMBDA, is computed for each sampled wife, and subsequently utilized to instrument the offered market wage and hours-of-work equations in order to correct for the potential problem of selectivity bias. In an effort to ease the interpretation of the labor-force participation Probit results, the maximum-likelihood parameter estimates are presented along with the marginal effects of all regressors evaluated at the means of the full sample[3]. Here the main advantage of reporting marginal effects in a Probit analysis is that these particular coefficients are easily interpretable since they represent the marginal impacts of the independent variables on the event probability (i.e. the probability of being observed working in the market). Additionally, in an attempt to assess the explanatory power—and hence the overall goodness of fit—of the Probit model, four distinct pseudo R-square statistics are offered. Among those are McFadden's pseudo R-square (also known as the likelihood ratio index, LRI), Cragg-Uhler's pseudo R-square, Efron's R-square, and the 'count' R-square. On one hand, both McFadden's and Cragg-Uhler's goodness-of-fit statistics are based on the Probit likelihood ratios. On the other hand, while Efron's measure of fit is based on the residual sum of squares between the actual event and the estimated probability of the event, the 'count' R-square is an intuitive measure of fit based on the proportion of correct predictions derived from the Probit model. Tables 6.3 and 6.4, respectively, present the results of the OLS multiple regression analyses on the offered wage and the yearly observed hours-of-work for the subsample of wives participating in the paid labor market (i.e. n=617). For these OLS regressions, both unstandardized and standardized parameter estimates are reported. Finally, the coefficients of the shadow price of home time function are presented in Table 6.5. Again, as with the market wage and observed hours-of-work regressions, unstandardized and standardized coefficients are reported.

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[3] The marginal effects (i.e. partial derivatives) were computed at the means of the full sample as follows:

$$\frac{\partial \text{Prob}(P^{OBS}=1)}{\partial \overline{X}_k} = \phi\left(\sum_{k=1}^{21} \hat{b}_{P_k} \overline{X}_k\right)\hat{b}_{P_k}$$ where, as usual, ϕ indicates the standard normal p.d.f.

Table 6.2 ML Probit Results for the *Standard Version* of the Model: Parameter Estimates for the Probability of *being Currently Observed Working* in the Market, P_i^{OBS} (n = 857, *Work* = 617, *Don't Work* = 240)

Independent Variables	ML Estimates[a]	Marginal Effects[b]
INTERCEPT	0.228051 (1.3795)	0.069351
AGE (in years)	0.023712 (0.0592)	0.007211
AGESQ	–0.000850 (0.0006)	–0.000258
ED1 (High School diploma/Base: < than ED1)	0.001704 (0.2109)	0.000518
ED2 (Technical School diploma/Base: < than ED1)	0.409317 (0.3261)	0.124475
ED3 (Undergraduate College degree/Base: < than ED1)	0.391874 (0.2312)	0.119171
ED4 (Grad. or Prof. College degree/Base: < than ED1)	0.832386 * (0.3313)	0.253132 *
CRED (Base: 'no credentials')	0.165463 (0.1315)	0.050318
RACE (Base: 'non-white')	0.577686 (0.2993)	0.175677
EXP (in years)	0.063849 *** (0.0070)	0.019417 ***
CNSIZE (in 100,000s of population)	–0.009650 (0.0149)	–0.002935
UNEMP (2nd quarter of 1996—April, May, June)	–0.028309 (0.0349)	–0.008609
KDSLT6	–0.556023 *** (0.1098)	–0.169089 ***
KDS6~16	–0.140843 * (0.0699)	–0.042831 *
KDSGE16	0.203532 * (0.0821)	0.061895 *
OTHGE16	–0.128797 (0.2864)	–0.039168
YMARRIED (in years)	–0.010163 (0.0087)	–0.003091
OWN (Base: 'non-homeowner')	0.159424 (0.2504)	0.048481

Table 6.2 (continued)

Independent Variables	ML Estimates[a]	Marginal Effects[b]
BEDROOMS	0.068966 (0.0812)	0.020973
SIZEYRD	−0.028744 (0.0470)	−0.008741
SPWAGE (in after-tax dollars)	−0.015960 * (0.0067)	−0.004853 *
UNEARN (in 1,000s of after-tax dollars)	−0.026968 *** (0.0066)	−0.008201 ***

Maximized Value of the Unrestricted Log-likelihood Function, $\ln L_{UR} = -373.8048001$

Maximized Value of the Restricted Log-likelihood Function, $\ln L_R = -508.198767$

$$\text{McFadden's Pseudo } R^2 \text{ (i.e. LRI)} = 1 - \frac{\ln L_{UR}}{\ln L_R} = 0.2645^c$$

$$\text{Cragg-Uhler's Pseudo } R^2 = \frac{L_{UR}^{2/n} - L_R^{2/n}}{(1 - L_R^{2/n})\, L_{UR}^{2/n}} = 0.3876$$

$$\text{Efron's Pseudo } R^2 = 1 - \frac{n}{n_1 n_2} \sum_{i=1}^{n} \left[P_i^{OBS} - \Phi(\hat{P}_i^{OBS})\right]^2 = 0.2983$$

$$\text{Count } R^2 = \frac{\text{Number of Correct Predictions}}{\text{Total Number of Observations}} = 0.7631$$

[a] Standard errors of the maximum-likelihood estimates in parentheses.

[b] Marginal effects on the probability of being currently observed working in the market were computed at the means of the full sample.

[c] McFadden's pseudo R^2 is equivalent to the likelihood ratio index, LRI .

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results of the maximum-likelihood Probit analysis of the observed labor-force participation decision based on the standard regressors indicate that ED4, EXP, KDSLT6, KDS6~16, KDSGE16, SPWAGE, and UNEARN are the standard personal and socio-demographic characteristics that significantly condition a wife's probability of being observed working in the paid labor force. More specifically, compared to the wives without a high school diploma (i.e. ED0), only those who earned a graduate or professional college degree (i.e. ED4) appear more likely to be observed working in the market. In fact, the marginal effect of ED4 shows that, on average, having a graduate or professional degree significantly increases a wife's probability of being observed working in the labor market by 25.31%, ceteris paribus. As expected, market work experience (i.e. EXP) is positively associated with a wife's observed employment status. As such, everything else held constant, an additional year of paid market work experience significantly raises her probability of labor force participation by 1.94%. With other factors controlled, wives with preschool children (i.e. KDSLT6) are, as hypothesized, less likely to be observed working in the market. As implied by its marginal effect, the addition of a preschool child in the household decreases the probability of labor market participation by 16.91%, on average. Likewise, but to a lesser extent, wives with children between age six and 16 (i.e. KDS6~16) are significantly less likely to be observed working outside the home. As such, the effect of an additional child in this age group is to decrease a wife's probability of working by roughly 4.28%, ceteris paribus. Again, the sign of this coefficient is in line with what was expected. In contrast, the presence of each additional teenager or older child in the household (i.e. KDSGE16) increases a wife's probability of labor market participation by nearly 6.19%. Indeed, the estimated marginal effect of KDSGE16 on her observed employment status corroborates with the hypothesis formulated earlier with respect to the sign of this particular regressor. The analysis also indicates that the wage of the husband on his primary market employment (i.e. SPWAGE) is negatively related to his wife's observed labor force participation. In fact, on average, the marginal effect of a dollar increase in the husband's after-tax market wage is to lower his wife's probability of being employed by 0.49%, ceteris paribus. Here, since there is a general agreement that the labor supply of married males is backward bending—indicating that as their wage rates raise, the income effect outweighs the substitution effect and, ultimately, results in a reduction of the time they allocate to paid employment—it follows that this inverse relationship between a husband's wage and his wife's probability of labor market participation simply illustrates the complementarity of the spouses in home-related activities. As the last statistically significant regressor in the Probit model of the standard specification, the after-tax nonlabor income of the household (i.e. UNEARN) is, as anticipated, negatively associated with a wife's likelihood of being observed working in the market. As such, other factors being constant, a one thousand dollar increase in the nonlabor income of the household induces, on average, a 0.82% decrease in the probability of labor market participation of the wife.

Different from what was expected, it seems that wives with a high school diploma (i.e. ED1), a technical school diploma (i.e. ED2), or an undergraduate college degree (ED3) are not significantly more likely to be observed working in the market than those with no high school diploma (i.e. ED0), although the signs of these variables are in the expected direction. Likewise, whether a wife has extra-curricular credentials or not (i.e. CRED), whether she is white or not (RACE), and whether her household owns its current residence or not (i.e. OWN), do not significantly affect her probability of labor market participation. The same is also true with respect to a wife's age (i.e. AGE), its square (i.e. AGESQ), the size of the population and general unemployment rate in her county of residence (i.e. CNSIZE and UNEMP, respectively), years of marriage with her current spouse (i.e. YMARRIED), the number of bedrooms in the house (i.e. BEDROOMS), the size of the household's yard (i.e. SIZEYRD), and the number of adult relatives and/or friends living in the household (i.e. OTHGE16). In fact, the estimated impacts of these variables on a wife's probability of being observed working for pay are not significantly different from zero.

The estimated Probit of the wives' observed labor force participation correctly predicts the employment status of 654 sampled wives. Given a total sample size of 857, the Probit specification based on the standard regressors accurately predicts over three-fourths of the actual observed behavior of the sampled Missouri wives. Maddala (1992) argues that if one thinks of R-square in terms of the proportion of correct predictions, then one can use this proportion as a crude goodness-of-fit measure. Accordingly, the 'count' R-square for the standard Probit specification of the wives' observed labor-force participation decisions is 0.7631. However, although this 'count' R-square is worth reporting, according to Maddala (1992) it does not have enough discriminatory power. In due course, he suggests the use of more sophisticated measures in order to assess the explanatory power of limited-dependent variable models such as the Probit. Inasmuch as it is based on the residual sum of squares, an analog to the conventional R-square measure in linear regression models is the goodness-of-fit measure developed by Efron (1978). Accordingly, Efron's pseudo R-square statistic was computed. The resulting value indicates that less than 30% (i.e. 0.2983) of the variation in the model is explained by the standard personal and socio-demographic characteristics considered in the Probit formulation of the wives' observed labor-force participation choices. More dependable goodness-of-fit measures, such as McFadden's (1974) and Cragg-Uhler's (1970) pseudo R-square statistics, were also calculated. Because these measures are based on the log-likelihood ratio, they are believed to provide a more valid basis for the assessment of the true explanatory power of a Probit function. Respectively, McFadden's pseudo R-square statistic for the wives' observed labor-force participation behavior as modeled by the Probit equation based on the standard (i.e. usual) regressors is 0.2645, while Cragg-Uhler's measure of R-square is 0.3876. Indeed, since both these pseudo R-square statistics are bounded by zero and one, it appears that the overall fit of the labor-force participation Probit model based on the standard (i.e. usual) regressors is fairly weak (even though the 'count' R-square indicates that 76.31% of the observed labor force participation behavior is correctly predicted). In other words, the explanatory power of the independent variables considered in the standard specification of the estimation model does not consistently allow reproduction of the censoring of the sampled Missouri wives. Thus, given the limited discriminatory power offered by the standard regressors, it is reasonable to expect the presence of sample selection bias in the second stage of Heckman's estimation procedure[4]—although this bias would be taken care of by the inclusion of LAMBDA in the market wage and hours-of-work equations.

[4] Recall that, as pointed out earlier, sample selection bias arises from the incapacity of the regressors to adequately discriminate between the wives who participate in the labor market and those who do not. Consequently, the lower the explanatory power of the modeled Probit of the labor-force participation decision, the more likely sample selection bias is going to be present in the recurrent system of equations used to derive the opportunity cost value of household production time.

Table 6.3 OLS Results for the *Standard Version* of the Model: ln Market Wage (i.e. lnW) Regression Corrected for Sample Selection Bias (n = 617)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
INTERCEPT	1.240761 ** (0.3860)	0.000000
AGE (in years)	0.015229 (0.0160)	0.309363
AGESQ	–0.000292 (0.0002)	–0.532562
ED1 (High School diploma/Base: < than ED1)	0.043735 (0.0700)	0.049933
ED2 (Technical School diploma/Base: < than ED1)	0.203942 * (0.0964)	0.101776 *
ED3 (Undergraduate College degree/Base: < than ED1)	0.440864 *** (0.0733)	0.473811 ***
ED4 (Grad. or Prof. College degree/Base: < than ED1)	0.748896 *** (0.0875)	0.475289 ***
CRED (Base: 'no credentials')	0.086506 * (0.0363)	0.084965 *
RACE (Base: 'non-white')	0.143376 (0.1064)	0.047041
EXP (in years)	0.020352 *** (0.0032)	0.393572 ***
CNSIZE (in 100,000s of population)	0.008961 * (0.0041)	0.080384 *
UNEMP (2nd quarter of 1996—April, May, June)	–0.008571 (0.0097)	–0.032268
LAMBDA	0.257908 ** (0.0898)	0.172433 **

ADJ. R^2 = 0.3365 , F(12, 616) = 27.035 *** , SE of ESTIMATE CORRECTED for SSB = 0.3854

[a] Consistent asymptotic standard errors of estimates in parentheses.

[b] The standardized parameter estimates were computed by dividing the unstandardized estimates by their respective ratios of the sample standard deviation of the dependent variable to the sample standard deviation of the particular independent variable.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The multiple regression analyses on the offered market wage (i.e. lnW) and observed hours-of-work (i.e. M^{OBS}) based on the standard personal and socio-demographic characteristics are performed on the subsample of wives participating in the paid labor force only (n=617). The results of both analyses are reported in Tables 6.3 and 6.4, respectively[5]. Results from the wage regression in Table 6.3 show that ED2, ED3, ED4, CRED, EXP, CNSIZE, and LAMBDA are significantly related to the natural log value of the offered market wage for employed Missouri wives. Everything else being equal, compared to the wives who did not graduate from high school (i.e. ED0), those who have a technical school diploma (i.e. ED2), an undergraduate college degree (i.e. ED3), or a graduate or professional college degree (i.e. ED4) secure significantly higher wages—although the market wages of high school graduates (i.e. ED1) do not significantly differ from those earned by the wives without a high school diploma. Wives who have extra-curricular credentials (i.e. CRED) also receive significantly higher wages than those who do not, ceteris paribus. Clearly, and as expected, the stock of human capital embodied in a wife—as assessed by the signaling power of her diplomas and credentials—plays an important role in the determination of her market wage. As hypothesized, a wife's years of market experience (i.e. EXP) is also positively associated with her rate of pay. Further, with other factors controlled, wives living in more populated counties (i.e. CNSIZE) earn more from market employment than those residing in less populated counties.

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[5]As a precautionary measure, the simple correlation coefficients between the explanatory variables in the market wage and observed hours-of-work regressions, and the Variance Inflation Factors (i.e. VIFs) of the explanatory variables considered in these regressions, were investigated to detect any potential problem of severe multicollinearity in the recurrent system of equations. Abstracting from AGE and AGESQ which, for obvious reasons, were highly correlated with each other, the simple correlation coefficients and VIFs were found to be small enough to suggest that, although present, multicollinearity is not alarming in the standard specification of the estimation model.

That the sample-selection correction instrument, LAMBDA, is found to be statistically significant is not very surprising given the modest overall capacity of the standard personal and socio-demographic characteristics to adequately discriminate between working and non-working wives. As such, the statistical significance of LAMBDA just indicates that the regressors contained in the standard version of the estimation model do not discriminate enough in terms of the important characteristics that distinguish employed from nonemployed sampled wives. Because important characteristics are not accounted for in the standard estimation model, without the inclusion of LAMBDA in the market wage equation, any use of the estimated market wage function would normally have to be limited to the subsample of employed wives. In other words, important unobserved differences between employed and nonemployed wives would prevent the generalization of the estimated market wage function to the subsample of nonemployed wives. Hence, without the proper inclusion of LAMBDA in the market wage function, it would be impossible to obtain consistent estimates of the potential market wages for the subsample of nonemployed wives, inasmuch as these estimates would be plagued by sample selection bias. Fortunately, since the instrumental purpose of LAMBDA is to capture these important differences in the unobserved characteristics of employed and nonemployed wives, it follows that the estimated wage function may be used to predict the offered market wages of nonemployed as well as employed wives. Therefore, the statistical significance of LAMBDA simply comes to confirm the incapacity of the standard regressors to adequately discriminate between working and non-working sampled wives, which incapacity would—in the absence of LAMBDA—normally lead to sample selection bias in the estimated market wages of nonemployed wives.

Comparisons based on the magnitude of the standardized coefficients for the statistically significant variables indicate that only three regressors rank before LAMBDA in terms of importance in determining the offered market wages of the sampled wives (i.e. ED3, ED4, and EXP). As such, this finding illustrates the relative importance of the differences existing in the unobserved (i.e. omitted) characteristics of working and non-working wives accounted for by LAMBDA in the market wage regression.

The overall fit of the market wage regression, as given by the adjusted R-square, indicates that roughly 34% (i.e. 0.3365) of the variation in the natural log value of the wives' offered wages is explained by the standard regressors and LAMBDA. Further, the standard error of the market wage regression corrected for sample selection bias—which gives the 'average' size of the regression residuals—is 0.3854. Thus, the explanatory power of the market wage regression is somewhat modest, a result consistent with the findings of similar analyses (for instance, see Bryant et al., 1992; Duncan, 1992; Ferber & Green, 1985; Pappalardo, 1987; Puang & Metzen, 1993; Zick & Bryant, 1983).

Now turning to the results of the regression of the observed hours of market work (i.e. the observed intensive margin of the labor supply decision, M^{OBS}) performed on the standard personal and socio-demographic characteristics of the employed wives, Table 6.4 shows that the only statistically significant variables are ED2 and EXP. Contrary to expectations, it appears that employed Missouri wives with a technical school diploma (i.e. ED2) work less than those who did not graduate from high school (i.e. ED0). Although ED1, ED3, and ED4 are not statistically significant, it seems that, relative to the

Table 6.4 OLS Results for the *Standard Version* of the Model: *Observed* Hours-of-Work (i.e. M^{OBS}) Regression Corrected for Sample Selection Bias (n = 617)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
INTERCEPT	2021.346502 *** (569.8285)	0.000000
AGE (in years)	3.703629 (24.2835)	0.059881
AGESQ	−0.188314 (0.2744)	−0.273334
ED1 (High School diploma/Base: < than ED1)	−107.733692 (96.2253)	−0.097896
ED2 (Technical School diploma/Base: < than ED1)	−287.347714 * (137.0777)	−0.114130 *
ED3 (Undergraduate College degree/Base: < than ED1)	−171.102260 (107.6335)	−0.146356
ED4 (Grad. or Prof. College degree/Base: < than ED1)	−115.036201 (135.2430)	−0.058106
CRED (Base: 'no credentials')	85.030528 (51.1478)	0.066469
RACE (Base: 'non-white')	41.536122 (152.3382)	0.010846
EXP (in years)	21.419487 ** (6.6772)	0.329672 **
CNSIZE (in 100,000s of population)	3.630981 (5.9270)	0.025923
UNEMP (2nd quarter of 1996—April, May, June)	1.098468 (13.4740)	0.003291
KDSLT6	−55.093092 (69.6989)	−0.051687
KDS6~16	−44.576675 (29.2963)	−0.072924
KDSGE16	−36.021691 (34.0979)	−0.051108
OTHGE16	81.997307 (116.9607)	0.027197
YMARRIED (in years)	1.782561 (3.4667)	0.033622
OWN (Base: 'non-homeowner')	−187.952481 (108.3679)	−0.067382

Table 6.4 (continued)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
BEDROOMS	−19.521490 (33.5011)	−0.025819
SIZEYRD	−20.125160 (18.1826)	−0.044194
SPWAGE (in after-tax dollars)	−4.840730 (3.2151)	−0.068905
UNEARN (in 1,000s of after-tax dollars)	5.078799 (4.1056)	0.062227
LAMBDA	−409.096780 (222.9487)	−0.217688

ADJ. R^2 = 0.2319 , F(22, 616) = 9.455 *** , SE of ESTIMATE CORRECTED for SSB = 533.0005

[a] Consistent asymptotic standard errors of estimates in parentheses.

[b] The standardized parameter estimates were computed by dividing the unstandardized estimates by their respective ratios of the sample standard deviation of the dependent variable to the sample standard deviation of the particular independent variable.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

reference category (i.e. ED0), there is this general tendency that employed wives with higher educational achievements tend to supply fewer hours of their time to paid market work than those who did not graduate from high school. Relating these results to the ones obtained in the Probit analysis of the extensive margin of the labor supply decision, it is seen that although higher educational achievements increase a wife's probability of working for pay, once the decision of working is made, employed wives with the lowest schooling achievement—those without high school diploma (i.e. ED0)—tend to supply more hours in the market, ceteris paribus. The other factor found to be statistically significant in the determination of a wife's observed hours of work is her labor market experience (i.e. EXP). As expected, the more experienced is a wife, the more hours she devotes to paid market employment, ceteris paribus.

Note here that, although statistically non-significant, characteristics such as AGE, AGESQ, CRED, CNSIZE, KDSLT6, KDS6~16, OTHGE16, OWN, BEDROOMS, and SIZEYRD have coefficients the signs of which are all in the hypothesized directions. Unfortunately, due to the non-significance of these regressors, it would be unsuitable to force any substantive conclusion based on these regressors. The same is also true with respect to the signs of the coefficients obtained on UNEMP, KDSGE16, and UNEARN, which appear to be contradictory to the theoretical expectations formulated earlier.

In contrast to what was found from the results of the market wage regression, LAMBDA is not statistically significant in the observed hours-of-work regression. Hence, from an econometric perspective, this implies that sample selection bias might not be of real concern in the determination of the intensive margin of the labor supply decision characterizing Missouri wives. Stated differently, the non-significance of LAMBDA in the observed hours-of-work regression indicates that, taken together, the personal and socio-demographic characteristics considered in the standard estimation model appear to have sufficient discriminatory power to avoid the bias associated with the generalization of the estimated hour-of-work equation to the subsample of nonemployed wives.

The adjusted R-square for the observed hours-of-work regression is modest (i.e. 0.2319) and consistent with the results of comparable analyses. The large standard error of the regression (i.e. 533.0005) also portrays the limited fit of this hours-of-work regression for prediction purposes.

Table 6.5 Retrieved Coefficients of the Shadow Price of Home Time Equation (i.e. ln S) for the *Standard Specification* of the Estimation Model

Independent Variables	Retrieved Coefficients[a]	
	Unstandardized	Standardized[b]
INTERCEPT	−0.679847	0.000000
AGE (in years)	0.011710	0.237876
AGESQ	−0.000113	−0.206248
ED1 (High School diploma/Base: < than ED1)	0.146100	0.166804
ED2 (Technical School diploma/Base: < than ED1)	0.476969	0.238029
ED3 (Undergraduate College degree/Base: < than ED1)	0.603439	0.648535
ED4 (Grad. or Prof. College degree/Base: < than ED1)	0.858199	0.544658
CRED (Base: 'no credentials')	0.005713	0.005612
RACE (Base: 'non-white')	0.103910	0.034093
CNSIZE (in 100,000s of population)	0.005511	0.049436
UNEMP (2nd quarter of 1996)	−0.009615	−0.036197
KDSLT6	0.052347	0.061706
KDS6~16	0.042355	0.087058
KDSGE16	0.034227	0.061014
OTHGE16	−0.077911	−0.032468
YMARRIED (in years)	−0.001694	−0.040139
OWN (Base: 'non-homeowner')	0.178586	0.080442
BEDROOMS	0.018549	0.030823
SIZEYRD	0.019122	0.052760
SPWAGE (in after-tax dollars)	0.004600	0.082260
UNEARN (in 1,000s of after-tax dollars)	−0.004826	−0.074288
M^{OBS}	0.000950	1.193829

[a] Market work experience, EXP, was used as the *identifier* to retrieve the coefficients of the shadow price of home time function.

[b] Using the standardized parameter estimates in the market wage and *observed* hours-of-work regressions (instead of their unstandardized parameter estimates), the standardized coefficients for the shadow price of home time function were retrieved in the very same fashion as the unstandardized coefficients.

Table 6.5 presents the retrieved coefficients of the shadow price of home time function (i.e. lnS) for the standard specification of the estimation model. These coefficients are solved utilizing the coefficient on years of market work experience (i.e. EXP) in the offered wage and observed hours-of-work regressions to identify the coefficient of M^{OBS} (i.e. δ) in the shadow price of home time function. Notice here that the choice of market work experience as the identifier is statistically sound inasmuch as this particular regressor is statistically significant in both market wage and observed hours-of-work regressions. Also, because of the inclusion of LAMBDA in the market wage and hours-of-work regressions, the retrieved shadow price of home time function is not restricted to the subsample of working wives. In fact, its coefficients are generalizable to both working and non-working sampled Missouri wives, and shadow price values derived from this retrieved function—including reservation wages—are free from sample selection bias.

A particularity worth reporting from the results of Table 6.5 is that, except for the sign of the coefficient on the number of teenagers or older children living in the household (i.e. KDSGE16) and on the after-tax nonlabor income of the household (i.e. UNEARN), all other standard personal and socio-demographic characteristics in the shadow price of home time function have coefficients with signs that align with the hypothesized relationships formulated earlier.

Specifically, the age of a wife (i.e. AGE) appears to increase the shadow price of her home time at a decreasing rate. With other factors controlled, and as indicated by the positive coefficients on ED1, ED2, ED3, and ED4, the shadow value of a wife's home time is shown to increase with higher educational achievements. This also appears to be true with respect to the holding of extra-curricular credentials (i.e. CRED). The effect of the race variable (i.e. RACE) suggests that being Caucasian raises the shadow price of a wife's home time, ceteris paribus. As predicted, while the population size in a wife's county of residence (i.e. CNSIZE) is positively associated with the shadow price of her home time, a higher unemployment rate in her county (i.e. UNEMP) seems to have the opposite effect. The positive coefficients on preschool children (i.e. KDSLT6) and children between six and 16 years of age (i.e. KDS6~16) suggest increasing shadow prices of home time with increasing levels in these particular household characteristics. Conversely, and also as hypothesized, the presence of adult relatives and/or adult friends living in the household (i.e. OTHGE16) is negatively related to the shadow value a wife confers to her home time. All other characteristics being held constant, the negative coefficient on years of marriage (i.e. YMARRIED) suggests that the economic value a wife places on her home time diminishes with years of marital union. Residing in an 'owned' home (i.e. OWN) seems to increase a wife's shadow value of home time, ceteris paribus. Not surprisingly, the number of bedrooms (i.e. BEDROOMS)—as a proxy for the size of the house—as well as the size of the yard where the household resides (i.e. SIZEYRD) are factors that are positively associated with a wife's shadow price of home time. The sign of the coefficient for the husband's after-tax market wage on his primary job (i.e. SPWAGE) suggests that the effect of an increase in his net rate of pay results in an increase in the economic value his wife places on her home time. Again, this result suggests a certain level of complementarity of the spouses in household-related activities.

Finally, as should be the case, a wife's shadow price of home time rises with increased levels of observed hours of paid market work (i.e. M^{OBS}).

That the coefficient on the number of teenagers and older children living in the household (i.e. KDSGE16) is positive rather than negative as expected suggests that these particular family members are not substitutes for a wife's home time. Rather, as with preschool children (i.e. KDSLT6) and children between six and 16 years of age (i.e. KDS6~16), this positive coefficient on teenagers and older children in the household suggests that these family members simply bid up a wife's shadow price of non-market time by increasing the demand for her time at home.

Under the assumption that home time is a normal good, the negative sign of the coefficient on the household after-tax nonlabor income (i.e. UNEARN) is somewhat disturbing. Specifically, a negative relationship between the household nonlabor income and the wife's shadow price of home time seems to be inconsistent with standard economic theory. Here no obvious explanation for this divergence appears to be satisfying.

Descriptive Statistics and Empirical Results for the First Variant of the Standard Estimation Model

Inasmuch as this particular econometric specification of the estimation model differs from the standard specification only by the addition of new and presumably important characteristics of the sampled wives, Table 6.6 presents the descriptive statistics for only the new variables utilized in the specification of this first variant of the standard estimation model. Again, as with the standard specification of the model, because this particular variant is based on the assumption of perfectly continuous budget lines, the means and standard deviations reported in Table 6.6 are for the whole sample of Missouri wives and for the subsamples of *presumably* satisfactorily employed and nonemployed wives. Also, since the addition of new regressors in the estimation model necessarily impacts on the inverse Mills ratio, the new means and standard deviations of LAMBDA for this first variant of the standard estimation model are reported as well.

Table 6.6 Descriptive Statistics for the New (i.e. non-standard) Variables used in the Specification of the First Variant of the Standard Estimation Model by *Observed* Labor-force Participation Status of the Sampled Missouri Wives

New Variables	Presumably Satisfactorily Employed Wives (n=617)		Presumably Satisfactorily NonEmployed Wives (n=240)		All Sampled Wives (n=857)	
	Means	Std. Dev.	Means	Std. Dev.	Means	Std. Dev.
MLIM[a]	1.1248	0.3767	1.5208	0.9100	1.2357	0.6041
SPMLIM[a]	1.2464	0.6327	1.3292	0.7626	1.2695	0.6722
ATT2[b]	12.0308	3.0733	15.7521	3.2478	13.0729	3.5408
SPATT2[b]	13.2877	3.2081	15.2458	3.0467	13.8361	3.2821
HHTECH[c]	2.7536	0.4708	2.7917	0.4555	2.7643	0.4666
YADEQI[d]	3.4473	1.0308	3.5125	1.1534	3.4656	1.0663
LAMBDA[e]	*0.2767*	*0.3210*	*−0.7113*	*0.5458*	*0.0000*	*0.5953*

Table 6.6 (continued)

[a] Both the MLIM and SPMLIM variables were scaled as follows:
1= "no health-related limitation" ;
2= "slight health-related limitation" ;
3= "important health-related limitation" ;
4= "total health-related limitation" .

[b] For both the wife and her spouse, a high score to the Home-Orientation attitudinal index (i.e. ATT2 and SPATT2) represents a more traditional gender-role attitude, while a low score depicts a more egalitarian attitude. (The lowest possible score was 6 and the highest possible score was 24 for both indices.)

[c] The Household-Technology Adequacy Index (i.e. HHTECH) was scaled as follows:
1= "important shortage (i.e. lack) of home equipment" ;
2= "some shortage of home equipment" ;
3= "no shortage (i.e. plenty) of home equipment" .

[d] The Income Adequacy Index (i.e. YADEQI) was scaled as follows:
1= "not at all adequate" ;
2= "could meet necessities only";
3= "could meet some of the things we want but not everything" ;
4= "could afford about everything we want" ;
5= "could afford about everything we want and still save money" .

[e] The means and standard deviations of LAMBDA (i.e. the sample-selection correction instrument which represents the inverse Mills ratio) are computed from the results of the *observed* labor-force participation Probit analysis performed over the entire sample of wives reported in Table 6.7.

Thus, according to Table 6.6, the wives presumed to be satisfactorily employed are, as measured by the health-related limitation index (i.e. MLIM), on average, healthier than those who are out of the paid labor market (i.e. 1.1248 versus 1.5208). Likewise, the means on SPMLIM—the health-related limitation index for the spouse—tend to indicate that the subsample of wives considered satisfactorily employed have husbands with better health than the nonemployed wives (i.e. 1.2464 versus 1.3292). As reflected by the home-orientation attitudinal indices (i.e. ATT2 and SPATT2), not only do the wives considered as satisfactorily employed have a more egalitarian (i.e. less traditional) attitude than their nonemployed counterparts with regard to what they perceive as the proper role of women in the home and in society (i.e. 12.0308 versus 15.7521), but also they have husbands whose scores on the same attitudinal construct suggest a more egalitarian orientation on average (i.e. 13.2877 versus 15.2458). So far as the adequacy of home equipment and tools is concerned (i.e. HHTECH), compared to the employed wives, non-working wives tend to perceive their available household technology as slightly more adequate, on average (i.e. 2.7536 versus 2.7917). Similarly, as measured by the income adequacy scale (i.e. YADEQI), the wives observed working in the labor market perceive the income of their households as being less adequate than do the wives who are not employed (i.e. 3.4473 versus 3.5125).

Indeed, the new variables considered in this first variant of the standard estimation model might convey additional important information regarding the differences possibly existing in the personal characteristics that distinguish the subsample of working wives from the subsample of non-working wives. Consequently, in the event that this new information truly contributes to consistently distinguishing the wives who, presumably, opt to be employed from those who choose to be out of the labor market, it follows that a Probit analysis of the wives' labor-force participation decisions which incorporates this additional information, along with the information provided by the standard regressors, should be characterized by a much better fit than if this information were omitted from the analysis. Also, because sample selection bias is linked to the overall capacity of the observed characteristics of the sampled wives to explain—and hence predict—the actual censoring of the sample, an increase in the explanatory power of the Probit analysis of the labor-force participation decisions should essentially reduce the bias associated with sample selectivity, and thus the eventuality that LAMBDA would be found statistically significant in the market wage and hours-of-work regressions.

The four tables that follow report the empirical results obtained from the first variant of the standard specification of the estimation model. Table 6.7 presents the results of the maximum-likelihood Probit analysis conducted over the entire sample of Missouri wives—analysis from which LAMBDA, the sample-selection correction instrument, is computed for each sampled wife, and subsequently included in the offered market wage and yearly hours-of-work equations. Again, the maximum-likelihood parameter estimates are presented along with the marginal effects of all regressors evaluated at the means of the full sample of wives. As for the standard version of the model, McFadden's pseudo R-square, Cragg-Uhler's pseudo R-square, Efron's pseudo R-square, and the 'count' R-square are provided as goodness-of-fit measures. Tables 6.8 and 6.9 present the results of the OLS multiple regression analyses on the offered market wage and observed hours-of-work based on the subsample of wives observed working in the labor force[6]. For both these regressions, unstandardized and standardized parameter estimates are reported. Lastly, the solved coefficients of the shadow price of home time function are given in Table 6.10. As with the offered wage and observed hours of market work regressions, both unstandardized and standardized coefficients are presented.

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[6] As with the standard specification of the model, the simple correlation coefficients between the explanatory variables in the offered market wage and hours-of-work regressions, and the Variance Inflation Factors (i.e. VIFs) of the explanatory variables included in these regressions, were examined to identify any possible severe multicollinearity problem in the recurrent system of equations. Once again, except for AGE and AGESQ which were found to be highly correlated with each other, the simple correlation coefficients and VIFs were sufficiently small to suggest that multicollinearity is not a serious concern with the first variant of the standard version of the recurrent estimation model.

Table 6.7 ML Probit Results for the *First Variant* of the Standard Model: Parameter Estimates for the Probability of *being Currently Observed Working* in the Market, P_i^{OBS} (n = 857, *Work* = 617, *Don't Work* = 240)

Independent Variables	ML Estimates[a]	Marginal Effects[b]
INTERCEPT	3.503769 * (1.6027)	0.967541 *
AGE (in years)	0.029008 (0.0654)	0.008010
AGESQ	−0.000624 (0.0007)	−0.000172
ED1 (High School diploma/Base: < than ED1)	0.137705 (0.2307)	0.038026
ED2 (Technical School diploma/Base: < than ED1)	0.609172 (0.3561)	0.168219
ED3 (Undergraduate College degree/Base: < than ED1)	0.426162 (0.2552)	0.117682
ED4 (Grad. or Prof. College degree/Base: < than ED1)	0.594801 (0.3632)	0.164250
CRED (Base: 'no credentials')	0.189721 (0.1463)	0.052390
RACE (Base: 'non-white')	0.625473 (0.3317)	0.172720
EXP (in years)	0.040539 *** (0.0079)	0.011194 ***
CNSIZE (in 100,000s of population)	−0.012566 (0.0166)	−0.003470
UNEMP (2nd quarter of 1996—April, May, June)	0.007666 (0.0394)	0.002117
KDSLT6	−0.609437 *** (0.1260)	−0.168292 ***
KDS6~16	−0.137638 (0.0776)	−0.038008
KDSGE16	0.214556 * (0.0904)	0.059248 *
OTHGE16	−0.287164 (0.3033)	−0.079298
YMARRIED (in years)	−0.016711 (0.0096)	−0.004615
OWN (Base: 'non-homeowner')	0.213889 (0.2790)	0.059064

Table 6.7 (continued)

Independent Variables	ML Estimates[a]	Marginal Effects[b]
BEDROOMS	−0.015665 (0.0893)	−0.004326
SIZEYRD	−0.003873 (0.0527)	−0.001069
SPWAGE (in after-tax dollars)	−0.017145 * (0.0081)	−0.004734 *
UNEARN (in 1,000s of after-tax dollars)	−0.029380 *** (0.0076)	−0.008113 ***
MLIM	−0.646152 *** (0.1010)	−0.178430 ***
SPMLIM	−0.053331 (0.0956)	−0.014727
ATT2 (a high score=traditional gender-role attitude)	−0.178127 *** (0.0215)	−0.049188 ***
SPATT2 (a high score=traditional gender-role attitude)	0.014139 (0.0220)	0.003904
HHTECH	−0.048916 (0.1353)	−0.013508
YADEQI	−0.079041 (0.0649)	−0.021827

Maximized Value of the Unrestricted Log-likelihood Function, $\ln \mathcal{L}_{UR} = -306.6403323$

Maximized Value of the Restricted Log-likelihood Function, $\ln \mathcal{L}_{R} = -508.198767$

$$\text{McFadden's Pseudo } R^2 \text{ (i.e. LRI)} = 1 - \frac{\ln \mathcal{L}_{UR}}{\ln \mathcal{L}_{R}} = 0.3966^{c}$$

$$\text{Cragg-Uhler's Pseudo } R^2 = \frac{\mathcal{L}_{UR}^{2/n} - \mathcal{L}_{R}^{2/n}}{(1-\mathcal{L}_{R}^{2/n})\,\mathcal{L}_{UR}^{2/n}} = 0.5403$$

$$\text{Efron's Pseudo } R^2 = 1 - \frac{n}{n_1 n_2} \sum_{i=1}^{n} \left[P_i^{OBS} - \Phi(\hat{P}_i^{OBS})\right]^2 = 0.4317$$

$$\text{Count } R^2 = \frac{\text{Number of Correct Predictions}}{\text{Total Number of Observations}} = 0.8250$$

[a] Standard errors of the maximum-likelihood estimates in parentheses.

[b] Marginal effects on the probability of being currently observed working in the market were computed at the means of the full sample.

[c] McFadden's pseudo R^2 is equivalent to the likelihood ratio index, LRI.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The Probit analysis of the observed labor-force participation decision based on both standard and non-standard (i.e. new) regressors considered in this particular version of the estimation model shows that EXP, KDSLT6, KDSGE16, SPWAGE, UNEARN, MLIM, and ATT2 are the characteristics which significantly determine a wife's probability of being observed participating in paid market work.

These results suggest, as expected, that the labor market experience of a wife (i.e. EXP) is positively related to her observed employment status. In fact, an additional year of market experience raises the probability of labor force participation by 1.12% on average, ceteris paribus. With other characteristics held constant, the presence of preschool children in the household (i.e. KDSLT6) deters a wife from market employment. As illustrated by its marginal effect, the addition of a preschool child in the home decreases the probability of market participation by 16.83%. Conversely, the presence of teenagers or older children (i.e. KDSGE16) increases her probability of labor market participation by 5.92%, ceteris paribus. The estimated effects of KDSLT6 and KDSGE16 on a wife's observed employment status align with the hypotheses formulated earlier regarding the signs of these particular regressors. Further, these results are consistent with the ones obtained in the previous Probit analysis reported in Table 6.2. As in the Probit analysis based on only the standard personal and socio-demographic characteristics, the present analysis also indicates that the net wage of the husband on his primary market job (i.e. SPWAGE) is inversely associated with his wife's observed employment status. On average, the marginal impact of a dollar increase in the husband's after-tax market wage is to decrease the probability of market participation of his wife by 0.47%. Drawing from the general agreement regarding the backward-bending labor supply function of married males, this negative relationship between the husband's wage and his wife's probability of market participation appears to denote the complementarity of the spouses in the home—a conclusion also reached when only the standard regressors are considered in the Probit analysis. The nonlabor income of the household (i.e. UNEARN) is, as posited, inversely associated with a wife's likelihood of market participation. Specifically, other factors held constant, a one thousand dollar increase in the real nonlabor income of the household lowers the probability of labor force participation for the wife by 0.81%, on average. Once again, the marginal effects of SPWAGE and UNEARN are in line with previous Probit results reported in Table 6.2.

Among the additional characteristics considered in this particular variant of the standard specification, only the health-related limitation index of the wife (i.e. MLIM) and her own gender-role attitude (i.e. ATT2) significantly affect her observed employment status. As hypothesized, it is found that the probability of labor force participation for a wife decreases with increased health problems. For instance, a one-point increase in her health-related limitation index lowers her probability of market participation by 17.84%, ceteris paribus. Of course, this result should not be very surprising. Likewise, wives with a more traditional gender-role orientation are associated with a lower propensity to participate in the labor market, a result consistent with the studies of Dowdall (1974), Ferber (1982), Thornton et al. (1983), and Thornton & Camburn (1979). As such, all other factors being held constant, a one-point increase in the wife's gender-role attitudinal index induces a 4.92% decrease in her probability of working for pay. Hence, the wife's state of health and gender-role attitude are shown to have an important impact in the determination of her observed employment status. In due course, these two particular personal characteristics—along with the other standard characteristics found to significantly condition a wife's labor-force participation decision—should essentially lead to a better explanation of the sample censoring, and thus contribute to increase the overall explanatory power of the Probit analysis of the wives' labor-force participation behavior.

Contrary to what was anticipated, it appears that the marginal effects of the spouse's state of health (i.e. SPMLIM) and gender-role attitude (i.e. SPATT2) are not significantly related to the observed employment status of a wife. The same is also true with respect to a wife's perceived adequacy of her available home technology (i.e. HHTECH) and household's overall income (i.e. YADEQI), although the signs of these coefficients are in the predicted directions.

The Probit analysis of the wives' observed labor force participation for this particular variant of the standard specification accurately predicts the employment status of 707 sampled wives—an increase of 8.10% over the 654 correctly predicted cases from the standard Probit specification. The 'count' R-square for this variant of the standard Probit specification of the wives' observed labor-force participation decisions is 0.8250. As Maddala (1992) suggests, though, this 'count' R-square measure does not possess enough discriminatory power to justify any substantive conclusion. Although useful to report, more sophisticated measures are needed in order to gauge the explanatory power of limited-dependent variable models such as the Probit. Based on the residual sum of squares between actual (i.e. observed) employment status and estimated probabilities of market participation, Efron's R-square indicates that over 43% (i.e. 0.4317) of the variation in the Probit estimates is explained by this more refined specification which includes both standard and non-standard characteristics. Thus, according to this particular goodness-of-fit measure, it appears that the inclusion of the new personal characteristics in the standard specification results in a striking 44.72% increase in the overall explanatory power of the Probit regression. This substantial improvement in the discriminatory power of the Probit regression due to the new regressors is also confirmed from goodness-of-fit measures based on the log-likelihood ratio. For instance, McFadden's pseudo R-square is 0.3966, and, compared to the same statistic obtained from the standard specification of the model (i.e. 0.2645), this particular goodness-of-fit measure suggests that the new regressors induce a 49.94% increase in the explanatory power of the Probit regression. Similarly, Cragg-Uhler's R-square statistic (i.e. 0.5403) indicates that, taken together, the new characteristics improve the fit of the Probit regression by 39.40%. Hence, the addition of the new regressors clearly benefits the explanatory power of the Probit analysis. As a consequence of this substantial improvement in the overall capacity of the personal and socio-demographic characteristics to distinguish between working and non-working sampled wives—and hence to explain the censoring of the sample—it seems reasonable to expect a decrease in the bias associated with sample selection in the second stage of the Heckman estimation procedure. Examination of the coefficient of LAMBDA in the offered market wage and observed hours-of-work regressions should therefore corroborate with this expectation.

Table 6.8 OLS Results for the *First Variant* of the Standard Model: ln Market Wage (i.e. lnW) Regression Corrected for Sample Selection Bias (n = 617)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
INTERCEPT	1.661187 *** (0.3491)	0.000000
AGE (in years)	0.006317 (0.0150)	0.128321
AGESQ	–0.000139 (0.0002)	–0.252937
ED1 (High School diploma/Base: < than ED1)	0.059356 (0.0677)	0.067767
ED2 (Technical School diploma/Base: < than ED1)	0.180531 * (0.0914)	0.090093 *
ED3 (Undergraduate College degree/Base: < than ED1)	0.424632 *** (0.0700)	0.456366 ***
ED4 (Grad. or Prof. College degree/Base: < than ED1)	0.710088 *** (0.0821)	0.450660 ***
CRED (Base: 'no credentials')	0.078020 * (0.0341)	0.076630 *
RACE (Base: 'non-white')	0.095893 (0.1018)	0.031462
EXP (in years)	0.014835 *** (0.0024)	0.286885 ***
CNSIZE (in 100,000s of population)	0.010058 * (0.0039)	0.090220 *
UNEMP (2nd quarter of 1996—April, May, June)	–0.007018 (0.0091)	–0.026422
MLIM	–0.114349 ** (0.0424)	–0.098314 **
LAMBDA	0.073846 (0.0630)	0.054106

ADJ. R^2 = 0.3341 , F(13, 616) = 24.771 *** , SE of ESTIMATE CORRECTED for SSB = 0.3556

[a] Consistent asymptotic standard errors of estimates in parentheses.

[b] The standardized parameter estimates were computed by dividing the unstandardized estimates by their respective ratios of the sample standard deviation of the dependent variable to the sample standard deviation of the particular independent variable.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Results from the offered wage (i.e. lnW) regression in Table 6.8 indicate that ED2, ED3, ED4, CRED, EXP, CNSIZE, and MLIM are significantly related to the natural log value of the wage rate employed Missouri wives receive from market employment.

Hence, as with the standard specification of the estimation model, the results obtained from the offered wage regression with this particular variant of the standard specification show that, as expected, the amount of human capital embodied in a wife—an amount that, in this study, is assessed by the signaling power of her highest educational achievement—is a significant determinant of the wage rate she ultimately secures in the labor force. As such, other factors held constant, compared to the wives without a high school diploma (i.e. ED0), those who have a technical school diploma (i.e. ED2), an undergraduate college degree (i.e. ED3), or a graduate or professional college degree (i.e. ED4) command significantly higher wages from market employment. Although the wives with a high school diploma (i.e. ED1) do not appear to earn significantly higher wages than those who did not graduate from high school, it seems that the wage a wife secures in the labor market increases with her highest educational achievement, ceteris paribus. The same is also true with respect to extra-curricular credentials (i.e. CRED). That is, everything else being equal, wives with extra-curricular certifications receive significantly higher wages than those without such credentials. Similarly, the market work experience of a wife (i.e. EXP) is, as predicted, positively related to her offered wage. As portrayed by the positive coefficient on CNSIZE, wives living in more populated counties earn significantly more from paid employment than those in less populated counties, a result consistent with the hypothesis formulated earlier. The coefficient on the new regressor MLIM is negative and statistically significant. As such, this indicates that the market wage a wife commands in the labor force decreases with increasing health-related impediments, ceteris paribus. Inasmuch as the productive capacity of an individual usually falls with increasing degree of health affliction, this result is in line with what was expected.

Notice that, compared to the results obtained from the wage regression in the standard estimation model, LAMBDA—the sample-selection correction instrument derived from the results of the labor-force participation Probit regression—ceases to be statistically significant in the market wage regression presented above. That LAMBDA ceases to be significant is indeed indicative that the additional personal characteristics included in this variant of the standard specification importantly contribute to distinguish the wives who, presumably, choose to work from those who do not[7]. In other words, taken together, the standard and non-standard (i.e. new) regressors considered in this estimation model are sufficient to capture the existing differences in personal and socio-demographic characteristics that distinguish working from non-working wives, and this is reflected by the non-significance of LAMBDA.

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[7] It is very important to recall here that the purpose of the inverse Mills ratio, LAMBDA, is to capture the unobserved important differences which might exist between working and non-working wives. Consequently, when the coefficient of LAMBDA in the market wage regression is found to be significant (as it is the case in Table 6.3), this is indicative that important distinguishing characteristics have been left out of the estimation model, and that LAMBDA must instrument the wage equation in order to avoid the bias resulting from the generalization of the estimated wage equation to the nonemployed wives. Conversely, when the coefficient of LAMBDA is not statistically significant (as it is the case in Table 6.8), this is indicative that the characteristics considered in the estimation model are sufficient to consistently discriminate between working and non-working wives. In this case, the inclusion of LAMBDA in the wage regression is immaterial since, even if LAMBDA is not used to instrument the wage equation, the results obtained from the wage regression performed on the characteristics of working wives will not lead to sample selection bias when also applied to the non-working wives.

The adjusted R-square of the market wage regression for this particular variant of the standard estimation model indicates that 33% of the variation in the natural log value of the wives' offered wage is explained by the standard and non-standard characteristics accounted for in the model. This adjusted R-square is very similar to the one achieved by the sample selection-corrected market wage regression based solely on the standard regressors (i.e. 0.3341 versus 0.3365). This similarity in the adjusted R-square of both regressions is fully consistent with what was expected. After all, what MLIM now captures in terms of observed differences between working and non-working wives was previously captured through LAMBDA in the wage regression based exclusively on the standard regressors. The standard error of the market wage regression for this variant of the model is slightly smaller relative to the standard error obtained for the standard specification (i.e. 0.3556 versus 0.3854 respectively). Inasmuch as the standard error of a regression is reflective of the 'average' size of the regression residuals, it seems that the overall fit of the market wage regression improves with the inclusion of MLIM.

Turning now to the results of the multiple regression of the observed hours of market work (i.e. M^{OBS}) on the standard and non-standard characteristics of the employed wives, Table 6.9 below indicates that, according to this first variant of the standard estimation model, the important determinants of a wife's observed hours of market work are ED2, CRED, EXP, SPWAGE, and YADEQI. In fact, as in the hours-of-work regression based on only the standard characteristics, it is found that wives with a technical school diploma (i.e. ED2) work significantly less compared to the wives who do not possess a high school diploma (i.e. ED0), ceteris paribus. Also, although ED1, ED3, and ED4 are

Table 6.9 OLS Results for the *First Variant* of the Standard Model: *Observed* Hours-of-Work (i.e. M^{OBS}) Regression Corrected for Sample Selection Bias (n=617)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
INTERCEPT	2289.499793 *** (534.8177)	0.000000
AGE (in years)	4.842445 (22.9468)	0.078294
AGESQ	−0.211979 (0.2516)	−0.307683
ED1 (High School diploma/Base: < than ED1)	−110.147534 (91.6293)	−0.100089
ED2 (Technical School diploma/Base: < than ED1)	−251.043238 * (126.3078)	−0.099711 *
ED3 (Undergraduate College degree/Base: < than ED1)	−169.614745 (98.3758)	−0.145083
ED4 (Grad. or Prof. College degree/Base: < than ED1)	−123.383820 (116.4247)	−0.062323
CRED (Base: 'no credentials')	98.464377 * (46.3543)	0.076971 *
RACE (Base: 'non-white')	77.302576 (139.3385)	0.020186
EXP (in years)	24.070804 *** (3.7191)	0.370479 ***
CNSIZE (in 100,000s of population)	3.261509 (5.5521)	0.023285
UNEMP (2nd quarter of 1996—April, May, June)	−1.748767 (12.3997)	−0.005240
KDSLT6	−95.416431 (52.2008)	−0.089517
KDS6~16	−48.387163 (26.4313)	−0.079157
KDSGE16	−19.944347 (29.5765)	−0.028297
OTHGE16	76.545033 (108.9084)	0.025388
YMARRIED (in years)	1.417125 (3.2165)	0.026729
OWN (Base: 'non-homeowner')	−190.607985 (102.3919)	−0.068334

Table 6.9 (continued)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
BEDROOMS	−18.008455 (31.0671)	−0.023818
SIZEYRD	−20.461895 (16.9640)	−0.044933
SPWAGE (in after-tax dollars)	−8.046468 ** (3.0296)	−0.114536 **
UNEARN (in 1,000s of after-tax dollars)	2.293876 (3.5790)	0.028105
MLIM	−52.662081 (66.5633)	−0.036036
SPMLIM	−20.389523 (33.5375)	−0.023435
ATT2 (a high score=traditional gender-role attitude)	−8.308432 (11.4048)	−0.046390
SPATT2 (a high score=traditional gender-role attitude)	−11.028603 (7.1166)	−0.064278
HHTECH	−60.124380 (42.8961)	−0.051429
YADEQI	44.868108 * (21.3544)	0.084026 *
LAMBDA	−274.433223 (153.6250)	−0.160032

ADJ. R^2 = 0.2639 , F(28, 616) = 8.889 *** , SE of ESTIMATE CORRECTED for SSB = 484.1173

[a] Consistent asymptotic standard errors of estimates in parentheses.

[b] The standardized parameter estimates were computed by dividing the unstandardized estimates by their respective ratios of the sample standard deviation of the dependent variable to the sample standard deviation of the particular independent variable.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

statistically non-significant, compared to the reference category (i.e. ED0), there seems to be this general tendency that employed wives with higher schooling achievements supply fewer hours of their time to paid market work activities. As with the standard specification of the estimation model, this result is contrary to what was expected. When the new regressors are considered in the estimation model, CRED becomes significantly associated with a wife's labor supply, and thus indicates that wives with extra-curricular credentials work significantly more hours per year in the market than those without any credential, ceteris paribus. This positive association between extra-curricular credentials and the intensity of a wife's observed labor supply was hypothesized. Consistent with the previous results, the effect of market work experience (i.e. EXP) is statistically significant and positively related to a wife's observed hours of paid work. Contrary to what was found in the previous hours-of-work analysis based strictly on the standard regressors, the wage rate the husband secures on his primary market job (i.e. SPWAGE) is, in this model, significantly associated with his wife's observed labor supply. Specifically, with other factors controlled, the wage of the husband is inversely related to his wife's observed hours of market work. Recalling the general agreement concerning the backward-bending labor supply of married males, this result seems to confirm the complementarity of the spouses in home activities. (Note that, although statistically non-significant, the sign of this coefficient was also negative in the standard specification of the model.) Among the new personal characteristics considered in this first variant of the standard estimation model, only the wife's perception with regard to the adequacy of her household income (i.e. YADEQI) appears to significantly condition the intensity of her labor supply. Yet, contrary to what was expected, it seems that the greater the perceived adequacy of her household income, the more hours she devotes to paid market employment, ceteris paribus.

Surprisingly enough, the wife's health-related limitation index (i.e. MLIM)—an index which clearly conveys important information about her state of health—and gender-role attitudinal orientation (i.e. ATT2) do not figure among the statistically significant regressors in this hours-of-work regression, although the signs of their coefficients are negative as expected. Thus, in spite of the fact that these two particular characteristics were found to be significantly related to a wife's labor-force participation decision, once the decision of working has taken place, it appears that neither her state of health nor her gender-role attitudinal orientation significantly matters in the determination of the intensive margin of her observed labor supply decision.

It is worth noting that, although statistically non-significant, standard characteristics such as AGE, AGESQ, CNSIZE, UNEMP, KDSLT6, KDS6~16, OTHGE16, OWN, BEDROOMS, and SIZEYRD have coefficients the signs of which are all in the predicted directions. The same is also true with regard to non-standard characteristics such as SPMLIM, SPATT2, and HHTECH. Further, as in the precedent analysis of the observed hours of market work, LAMBDA—the sample-selection correction instrument—is non-significant. That LAMBDA is non-significant in this particular observed hours-of-work regression was predictable since it was already non-significant in the standard specification of the estimation model; that is, prior to the inclusion of the new regressors.

The adjusted R-square and standard error of the hours-of-work regression are 0.2639 and 484.1173, respectively. Compared to the same statistics for the standard version of the model (i.e. 0.2319 and 533.0005), it appears that the new personal characteristics increase both explanatory and predictive powers of the hours-of-work regression, although only YADEQI was found to be statistically significant among the new regressors. Indeed, while this increase is appreciable, as expected, it is modest relative to the increase induced by these new regressors in the labor-force participation Probit analysis.

The retrieved coefficients of the shadow price of home time function (i.e. lnS) for the first variant of the standard specification of the estimation model are presented in Table 6.10. As with the standard version of the estimation model, these coefficients are solved utilizing the estimated parameter of market work experience (i.e. EXP) in the market wage and observed hours-of-work regressions in order to identify the coefficient of M^{OBS} (i.e. δ) in the shadow price of home time equation. Again, the choice of market work experience as the identifier is sensible since this particular characteristic is statistically significant in the market wage regression as well as in the observed hours-of-work regression. Theoretically, although both the offered market wage and hours-of-work OLS regressions have been performed on only the subsample of working wives, the inclusion of LAMBDA in these regressions guarantees that the retrieved coefficients for the shadow price of home time function also applies to the subsample of non-working wives. Yet, since the coefficient of LAMBDA in the wage and hours of market work regressions was found to be statistically non-significant after the inclusion of the new and usually unobserved characteristics, it turns out that the retrieved shadow price of home time function for this variant of the standard estimation model would normally be generalizable to the subsample of non-working wives even without the correction for sample selection bias.

Table 6.10 Retrieved Coefficients of the Shadow Price of Home Time Equation (i.e. ln S) for the *First Variant* of the Standard Specification of the Estimation Model

Independent Variables	Retrieved Coefficients[a] Unstandardized	Standardized[b]
INTERCEPT	0.250153	0.000000
AGE (in years)	0.003333	0.067693
AGESQ	–0.000008	–0.014679
ED1 (High School diploma/Base: < than ED1)	0.127241	0.145273
ED2 (Technical School diploma/Base: < than ED1)	0.335251	0.167306
ED3 (Undergraduate College degree/Base: < than ED1)	0.529167	0.568713
ED4 (Grad. or Prof. College degree/Base: < than ED1)	0.786130	0.498920
CRED (Base: 'no credentials')	0.017336	0.017027
RACE (Base: 'non-white')	0.048251	0.015831
CNSIZE (in 100,000s of population)	0.008048	0.072188
UNEMP (2nd quarter of 1996)	–0.005940	–0.022364
KDSLT6	0.058806	0.069319
KDS6~16	0.029821	0.061296
KDSGE16	0.012292	0.021912
OTHGE16	–0.047175	–0.019660
YMARRIED (in years)	–0.000873	–0.020698
OWN (Base: 'non-homeowner')	0.117473	0.052915
BEDROOMS	0.011099	0.018444
SIZEYRD	0.012611	0.034795
SPWAGE (in after-tax dollars)	0.004959	0.088693
UNEARN (in 1,000s of after-tax dollars)	–0.001414	–0.021764
MLIM	–0.081893	–0.070409
SPMLIM	0.012566	0.018147
ATT2 (a high score=traditional gender-role attitude)	0.005121	0.035923
SPATT2 (a high score=traditional gender-role attitude)	0.006797	0.049774
HHTECH	0.037055	0.039825
YADEQI	–0.027653	–0.065066
M^{OBS}	0.000616	0.774363

[a] Market work experience, EXP, was used as the *identifier* to retrieve the coefficients of the shadow price of home time function.

[b] Using the standardized parameter estimates in the market wage and *observed* hours-of-work regressions (instead of their unstandardized parameter estimates), the standardized coefficients for the shadow price of home time function were retrieved in the very same fashion as the unstandardized coefficients.

The results in Table 6.10 show that except for the sign of the coefficient on the number of teenagers or older children in the home (i.e. KDSGE16), the after-tax nonlabor income of the household (i.e. UNEARN), and the wife's perceived adequacy of her household's overall income (i.e. YADEQI), all other personal and socio-demographic characteristics—standard and non-standard—used to specify the shadow price of home time function in this particular version of the recurrent estimation model have coefficients with signs that are consistent with hypothesized relationships.

Specifically, other characteristics being held constant, the age of a wife (i.e. AGE) raises her shadow price for home time at a decreasing rate. Further, as portrayed by the coefficients on ED1, ED2, ED3, and ED4, the value she places on her home time consistently increases with higher educational achievements, ceteris paribus. Holding extra-curricular credentials such as special licenses or certifications (i.e. CRED) also increases the shadow value of her home time, as expected. So far as the race of a wife is concerned (i.e. RACE), it seems that being white raises the economic value she places on her home time as well. With other factors controlled, while the size of the population in a wife's county of residence (i.e. CNSIZE) is positively related to the shadow price of her home time, a higher general unemployment rate in the county (i.e. UNEMP) has the opposite effect. Additionally, as depicted by the positive coefficient on preschool children (i.e. KDSLT6) and children between six and 16 years of age (i.e. KDS6~16), the larger the number of children in these age groups, the more valuable a wife's home time becomes, ceteris paribus. Inversely, the presence of adult relatives and/or friends in the household (i.e. OTHGE16) is negatively associated with a wife's shadow value of home time. All other factors constant, a wife's shadow price of home time is shown to decrease with years of marriage (i.e. YMARRIED). As predicted, living in a house owned by her family (i.e. OWN) raises a wife's shadow value of home time. Similarly, the number of bedrooms in the house (i.e. BEDROOMS) and the size of the yard where she resides (i.e. SIZEYRD) are characteristics that are positively related to the shadow value of her home time. The positive coefficient for the husband's primary market wage (i.e. SPWAGE) suggests that an increase in his wage raises his wife's shadow price of home time, ceteris paribus. Thus, postulating that the labor supply of married males is backward bending, this result is indicative of the spouses' complementarity in the home. As hypothesized, the poorer the state of health of a wife (i.e. MLIM), the lower the economic value she places on her home time, ceteris paribus. Conversely, with other personal and socio-demographic factors held constant, the poorer the state of health of her husband (i.e. SPMLIM), the greater the shadow value of her home time. Likewise, and also as hypothesized, the more traditional the gender-role attitudinal orientation of a wife (i.e. ATT2), the greater the economic value she places on her home time. As expected, the same is also true with respect to her spouse's gender-role attitude (i.e. SPATT2), ceteris paribus. Finally, the shadow value of a wife's home time increases with her observed hours of market work (i.e. M^{OBS}), as was anticipated.

As in the standard specification of the estimation model, that the coefficient on the number of teenagers and older children in the household (i.e. KDSGE16) is positive rather than negative as hypothesized indicates that these particular household members may not be substitutes at all for a wife's home time. In fact, as with preschool children (i.e. KDSLT6) and children between six and 16 years of age (i.e. KDS6~16), the positive sign of this coefficient suggests that these family members increase the shadow price of a wife's home time through an increased demand for her non-market time.

Once again, based on the usual assumption that home time is a normal commodity relative to market time, the negative sign of the coefficient on nonlabor income (i.e. UNEARN) is troubling. In fact, as in the standard specification of the estimation model, a negative relationship between the household nonlabor income and the wife's shadow price of home time seems to disagree with economic theory. However, even though no clear explanation for this divergence could be provided, it is nevertheless comforting to note that, in contrast to the coefficient obtained in the standard version of the model, the effect of the household nonlabor income on a wife's shadow price of home time appears to be relatively weaker in this particular variant of the standard estimation model[8].

The negative sign of the coefficient on the household income adequacy index (i.e. YADEQI) is somewhat disconcerting as well. As such, if this index is a proxy for the gap existing between actual level and desired standard of income then, as expected, a positive relationship between this index and the shadow price of a wife's home time should be found. Yet, according to this particular variant of the standard estimation model, the opposite relationship seems to hold with this sample of Missouri wives.

[8] A comparison of the standardized coefficients for UNEARN in Table 6.5 and Table 6.10 above reveals that, while a one standard deviation increase in the level of UNEARN results in a decrease of 0.074288 standard deviations in the natural log value of the shadow price of home time in the standard model, the same one standard deviation increase in UNEARN results in a decrease of only 0.021764 standard deviations in the natural log value of a wife's home time in this particular variant of the standard model.

**Institutional Labor Market Constraints
Faced by Sampled Missouri Wives**

So far, the standard version of the model and the first variant of it have been based upon the assumption that any sampled wife observed working in the market was fully satisfied with her employment situation, whereas any sampled wife observed out of the labor force was fully satisfied with her non-employment situation. Hence, since the previous specifications used the observed labor supply behavior of the sampled wife as if it was the result of her own unconstrained time-allocation decision, it follows that the estimation results obtained from these models are valid to the extent that there are no labor market constraints imposed on the sample of Missouri wives. However, as demonstrated below, although this assumption of perfectly continuous budget lines is standard in the application of the opportunity cost of time methodology, it does not conform to reality.

Table 6.11 illustrates how institutional labor market constraints operate through the sample of Missouri wives. For instance, examination of this table reveals that, among the 857 sampled wives who, under the standard assumption of perfectly continuous budget lines, are presumed fully satisfied with their current employment or non-employment situation, more than half (i.e. 436) were in fact constrained with respect to their labor supply behavior at the time of the survey. Specifically, among the 617 wives who, in the previous analyses, were considered as satisfactorily employed, only 196 were in fact satisfactorily employed, 108 were underemployed, and 313 were overemployed. Moreover, among the 240 wives previously considered as satisfactorily nonemployed, 15 of them were involuntarily unemployed, and thus actively searching for a paid market job.

Table 6.11 Institutional Labor Market Constraints and the Sample of Missouri Wives (n=857)

	Presumably Satisfactorily Employed Wives (n=617)			Presumably Satisfactorily NonEmployed Wives (n=240)	
	Satisfactorily Employed	UnderEmployed	OverEmployed	Satisfactorily NonEmployed	UnEmployed[a]
Number of Cases	196	108	313	225	15
% of Subsample	31.767	17.504	50.729	93.750	6.250
Mean of M^{OBS}	1,571.204	1,134.956	1,876.716	0.000	0.000
Mean of M^{DES}	1,571.204	1,507.926	1,432.807	0.000	1,594.333
Mean Difference[b]	0.000	−372.970	+443. 909	0.000	−1,594.333
Standard Deviation[c]	0.000	263.627	295.745	0.000	541.739
Minimum Difference	0.000	−10.000	+7.500	0.000	−800.000
Maximum Difference	0.000	−1,280.000	+1,680.000	0.000	−2,040.000

[a] To qualify as 'unemployed', not only did a wife have to report that she was looking for a market job at the time of the survey, but also that she had been employed in the calendar year preceding the survey. Information about the rate of pay on her last market job also needed to be available. Any sampled wife who reported being 'unemployed' but did not meet the above criteria was considered as satisfactorily nonemployed.

[b] Expressed in hours of work per year and computed by subtracting the mean of desired hours from the mean of observed hours (i.e. Mean Difference = Mean of M^{OBS} – Mean of M^{DES}).

[c] These are standard deviations of the differences between observed and desired annual hours of market work.

Contrasting the means of observed and desired annual hours of market work (i.e. the means of M^{OBS} and M^{DES}, respectively), it is found that, on average, underemployed wives would normally be working an additional 372.97 hours per year on their current jobs—at their current regular wages—if they were actually free to allocate as many hours of their time as they would like to paid market employment. In the same order of ideas, on average, involuntarily unemployed wives would be working 1,594.33 hours per year in the labor market if they could find a job offering a wage at least equal to the rate of pay they had on their last market jobs. Conversely, overemployed sampled wives would essentially be working 443.91 fewer hours per year, on average, if they were truly free to allocate as few hours of their time to their current market jobs.

Hence, given the number of constrained wives in this Missouri sample and the nature of the differences between observed and desired hours of paid market work, it is clear that the assumption of perfectly continuous budget lines becomes hardly tenable. Yet, this assumption was maintained in the two precedent versions of the estimation model. Consequently, since the previous econometric specifications of the recurrent estimation model do not permit accounting for the existence of institutional labor market constraints, it is obvious that any function estimated or retrieved from the previous estimation models is biased as a result of undifferentiated constrained wives[9]. However, as pointed out in an earlier section, a very simple solution to control for labor market constraints is to formulate the recurrent estimation model in terms of desired rather than observed labor supply behavior. Accordingly, in the last version of the estimation model, the first variant of the standard specification is reestimated using the sampled wives' desired (i.e. truly unconstrained) labor supply behavior.

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[9] For instance, in both models, the results of the labor-force participation Probit analysis are biased because of the 15 unemployed wives who are wrongly presumed satisfactorily nonemployed. Indeed, the long-run time-allocation equilibria of these wives would require that they be employed. That the results of the Probit analysis are biased also implies that inverse Mills ratios are biased. Hence, if inverse Mills ratios are biased, then the market wage and hours-of-work regressions are contaminated through the inclusion of LAMBDA. Furthermore, the results of the hours-of-work regression in both models are not only biased through the inclusion of LAMBDA, but also by the large proportion of sampled wives who are erroneously presumed satisfactorily employed whereas they are in fact underemployed or overemployed. Clearly, if the results of the market wage and hours-of-work regressions are biased, then it follows that the retrieved shadow price of home time function must be biased as well.

Descriptive Statistics and Empirical Results for the Second Variant of the Standard Estimation Model

In contrast to the standard specification of the estimation model and the first variant of it, which assume that all sampled wives are fully free to allocate as many or as few hours of their time to paid employment (i.e. the standard assumption of perfectly continuous budget lines), this particular version of the model controls for the reality of institutional labor market constraints by recognizing that, while some sampled wives maximize utility in their long-run (i.e. unconstrained) time-allocation equilibria, others are compelled to allocate their time in less than fully satisfying circumstances. Specifically, by utilizing information available on the wives' desired labor supply behavior, this particular variant of the estimation model ensures that all sampled Missouri wives are truly analyzed maximizing utility in their long-run time-allocation equilibria rather than blindly assuming that this important condition holds for the entire sample of wives.

Table 6.12 presents the descriptive statistics for the personal and socio-demographic characteristics used in the specification of this particular version of the estimation model. Because this last variant of the standard model makes use of the wives' desired labor supply behavior to control for the institutional labor market constraints imposed on the sample of wives, the descriptive statistics are reported according to the desired rather than observed employment status of the sampled wives. Moreover, since the use of desired hours of work ensures that all sampled wives are 'observed' allocating their time in their long-run (i.e. utility-maximizing) equilibria, the statistics contained in Table 6.12 are presented for the subsamples of *truly* satisfactorily employed and nonemployed wives.

Table 6.12 Descriptive Statistics for the Variables used in the Specification of the Second Variant of the Standard Estimation Model by *Desired* Labor-force Participation Status of the Sampled Missouri Wives

Continuous Variables		**Truly Satisfactorily Employed (n=632)**		**Truly Satisfactorily NonEmployed (n=225)**		**All Sampled Wives (n=857)**	
		Means	Std. Dev.	Means	Std. Dev.	Means	Std. Dev.
AGE		43.6835	8.8914	48.0578	10.7397	44.8320	9.6004
AGESQ		1987.1800	797.6861	2424.3780	1000.1400	2101.9660	876.2728
EXP		18.2655	8.4815	12.0972	8.6667	16.6461	8.9475
CNSIZE[a]		4.5733	3.9369	4.7761	3.9650	4.6265	3.9430
UNEMP (%)		4.2998	1.6404	4.3967	1.5025	4.3252	1.6051
KDSLT6		0.2136	0.5254	0.3111	0.6755	0.2392	0.5698
KDS6~16		0.6598	0.9007	0.5422	0.9255	0.6289	0.9082
KDSGE16		0.5237	0.7757	0.3733	0.6900	0.4842	0.7566
OTHGE16		0.0301	0.1885	0.0133	0.1488	0.0257	0.1790
YMARRIED		20.2685	10.3667	25.5541	12.6372	21.6562	11.2439
BEDROOMS		3.3180	0.7287	3.3600	0.8604	3.3291	0.7652
SIZEYRD[b]		2.9937	1.2048	3.0667	1.1840	3.0128	1.1991
SPWAGE (net)		13.1239	7.8106	14.4377	13.4095	13.4689	9.6104
UNEARN[c]		5.2369	6.6845	12.7908	20.8352	7.2201	12.5537
MLIM[d]		1.1297	0.3847	1.5333	0.9258	1.2357	0.6041
SPMLIM[d]		1.2453	0.6282	1.3378	0.7801	1.2695	0.6722
ATT2[e]		12.0870	3.0989	15.8422	3.2270	13.0729	3.5408
SPATT2[e]		13.2761	3.1895	15.4089	3.0229	13.8361	3.2821
HHTECH[f]		2.7516	0.4710	2.8000	0.4532	2.7643	0.4666
YADEQI[g]		3.4351	1.0345	3.5511	1.1489	3.4656	1.0663
M^{DES}		1492.4000	467.0978	0.0000	0.0000	1100.5780	769.7815
lnW (net)		2.1909	0.4368	--------	--------	--------	--------
LAMBDA[h]		*0.2576*	*0.3120*	*-0.7236*	*0.5563*	*0.0000*	*0.5825*
Categorical Variables		Frequencies	%	Frequencies	%	Frequencies	%
ED0[i]		32	5.06	18	8.00	50	5.83
ED1[j]		307	48.58	140	62.22	447	52.16
ED2[k]		32	5.06	8	3.56	40	4.67
ED3[l]		207	32.75	54	24.00	261	30.46
ED4[m]		54	8.54	5	2.22	59	6.88
CRED	Yes	152	24.05	40	17.78	192	22.40
	No	480	75.95	185	82.22	665	77.60
RACE	White	618	97.78	217	96.44	835	97.43
	Other	14	2.22	8	3.56	22	2.57
OWN	Yes	607	96.04	213	94.67	820	95.68
	No	25	3.96	12	5.33	37	4.32

Table 6.12 (continued)

[a] Expressed in 100,000s of population.

[b] The household's yard size, SIZEYRD, was scaled as follows:
1= "no yard or modest yard (i.e. less than 1/8 acre or 75x75 feet)" ;
2= "small yard (i.e. 1/8 acre or more but less than 1/4 acre or 100x100 feet) " ;
3= "medium size yard (i.e. 1/4 acre or more but less than 1/2 acre or 150x150 feet)" ;
4= "large yard (i.e. 1/2 acre or more but less than 1 acre or 200x200 feet)" ;
5= "very large yard (i.e. 1 acre or more)" .

[c] Expressed in 1,000s of after-tax dollars.

[d] Both the MLIM and SPMLIM variables were scaled as follows:
1= "no health-related limitation" ;
2= "slight health-related limitation" ;
3= "important health-related limitation" ;
4= "total health-related limitation" .

[e] For both the wife and her spouse, a high score to the Home-Orientation attitudinal index (i.e. ATT2 and SPATT2) represents a more traditional gender-role attitude, while a low score depicts a more egalitarian attitude. (The lowest possible score was 6 and the highest possible score was 24 for both indices.)

[f] The Household-Technology Adequacy Index (i.e. HHTECH) was scaled as follows:
1= "important shortage (i.e. lack) of home equipment" ;
2= "some shortage of home equipment" ;
3= "no shortage (i.e. plenty) of home equipment" .

[g] The Income Adequacy Index (i.e. YADEQI) was scaled as follows:
1= "not at all adequate" ;
2= "could meet necessities only";
3= "could meet some of the things we want but not everything" ;
4= "could afford about everything we want" ;
5= "could afford about everything we want and still save money" .

[h] The means and standard deviations of LAMBDA (i.e. the sample-selection correction instrument which represents the inverse Mills ratio) are computed from the results of the *desired* labor-force participation Probit analysis performed over the entire sample of wives reported in Table 6.13.

[i] ED0 is the reference (i.e. omitted) category and represents an education level below High School.

[j] ED1 was coded 1 if the wife's highest educational level was a High School diploma, and 0 otherwise.

[k] ED2 was coded 1 if the wife's highest educational level was a Technical School diploma, and 0 otherwise.

[l] ED3 was coded 1 if the wife's highest educational level was an Undergraduate College degree, and 0 otherwise.

[m] ED4 was coded 1 if the wife's highest educational level was a Graduate or Professional College degree, and 0 otherwise.

Using the desired employment status of the sampled Missouri wives, it is found that 632 (≈74%) wives would normally be satisfactorily employed in the absence of institutional labor market constraints, while 225 (≈26%) would be fully satisfied being nonemployed. On average, working wives would allocate 1,492.40 hours per year (i.e. nearly 29 hours per week) to their market job, and make \$8.94 (i.e. $e^{2.1909}$) per hour. Relative to the wives who would freely choose to be nonemployed, satisfactorily employed wives are, on average, younger (43.68 versus 48.06 years old), and they have more years of paid market work experience (18.27 versus 12.10). Also, they have been married for shorter periods of time (20.27 versus 25.55 years), and reside in less populated counties (4.57 versus 4.78 hundred thousands of population) where, on average, unemployment rates are lower (4.30% versus 4.40%). While they have fewer preschool children (0.21 versus 0.31 children under six years of age), they have more children between six and 16 years of age (0.66 versus 0.54), and more teenagers or adult children (0.52 versus 0.37). Their households are characterized by a greater presence of adult relatives and/or friends as well (0.03 versus 0.01). On average, their houses have fewer bedrooms (3.32 versus 3.36), and their yards are relatively smaller (2.99 versus 3.07). Their husbands net less from their primary market employment (\$13.12 versus \$14.44 per hour), and the nonlabor income of their household is considerably less on average (5.24 versus 12.79 thousand dollars). In a different order of ideas, employed wives are, according to the health-related limitation index, characterized by better health (1.13 versus 1.53), on average. This is also true with respect to the health of their husband (1.25 versus 1.34). As implied by the scores on the gender-role attitude scale, they are also less traditional than their nonemployed counterparts regarding what they consider as the proper role of women in society (12.09 versus 15.84). Their husbands also are less traditional about what they see as the appropriate societal role of women (13.28 versus 15.41). On average, compared to the wives who would normally be satisfied being nonemployed, satisfactorily employed wives do not only perceive their home technology as less adequate (2.75 versus 2.80), but they also consider their overall family income as less adequate (3.44 versus 3.55). So far as the differences in educational achievements are concerned, in terms of proportions, fewer employed wives have less than a high school diploma (i.e. ED0) as their highest schooling achievement (5.06% versus 8.00%). Similarly, fewer have only a high school diploma (i.e. ED1) as their highest schooling accomplishment (48.58% versus 62.22%). In fact, a larger proportion of employed wives have a technical school diploma (i.e. ED2), an undergraduate college degree (i.e. ED3), or a graduate or professional college degree (i.e. ED4) as their highest educational achievement (5.06% versus 3.56%, 32.75% versus 24.00%, and 8.54% versus 2.22%, respectively). A larger proportion of employed wives have extra-curricular credentials (i.e. CRED=Yes) such as special licenses or certifications (24.05% versus 17.78%). The proportion of Caucasian wives (i.e. RACE=White) is slightly larger in the subsample of employed wives than in the subsample of nonemployed wives (97.78% versus 96.44%). Finally, the proportion of wives living in households which 'own' their houses (i.e. OWN=Yes) is larger in the subsample of employed wives than in the subsample of housewives (96.04% versus 94.67%).

The results obtained from this last variant of the recurrent estimation model are presented in the four tables that follow. Specifically, Table 6.13 reports the results of the maximum-likelihood Probit analysis based on the desired labor-force participation choices of the sampled wives. These Probit results are then used to derive LAMBDA—the sample-selection correction instrument—for each sampled wife, which is subsequently included as regressor in the offered market wage and desired hours-of-work equations. Again, as in the two previous versions of the estimation model, the maximum-likelihood parameter estimates are reported along with the marginal effects of all regressors evaluated at the means of the full sample. McFadden's pseudo R-square, Cragg-Uhler's pseudo R-square, Efron's pseudo R-square, and the simple 'count' R-square are provided as goodness-of-fit measures for the Probit regression. Tables 6.14 and 6.15 give the results of the OLS regression analyses on the offered market wage and desired hours of market work for the subsample of employed wives[10]. Both unstandardized and standardized parameter estimates are reported for these OLS regressions. Lastly, Table 6.16 presents the retrieved coefficients of the shadow price of home time function and, once again, both unstandardized and standardized coefficients are given.

[10] As with the standard specification of the estimation model and the first variant of it, the simple correlation coefficients between the explanatory variables considered in the market wage and desired hours-of-work regressions, as well as the Variance Inflation Factors (i.e. VIFs) of these variables, were investigated in order to detect any problem of multicollinearity potentially affecting the recurrent system of equations. Once again, except for AGE and AGESQ which, unsurprisingly, were highly correlated with each other, it was found that both simple correlation coefficients and VIFs were sufficiently small to suggest that the second variant of the standard estimation model was not plagued by any important multicollinearity problem.

Table 6.13 ML Probit Results for the *Second Variant* of the Standard Model: Parameter Estimates for the Probability of *being Currently Observed Working* in the Market or *in Search of Work*, P_i^{DES} (n = 857, *Work* = 632, *Don't Work* = 225)

Independent Variables	ML Estimates[a]	Marginal Effects[b]
INTERCEPT	2.933752 (1.7096)	0.753561
AGE (in years)	0.065550 (0.0696)	0.016667
AGESQ	−0.001025 (0.0007)	−0.000261
ED1 (High School diploma/Base: < than ED1)	0.135234 (0.2426)	0.034384
ED2 (Technical School diploma/Base: < than ED1)	0.730437 (0.3883)	0.185720
ED3 (Undergraduate College degree/Base: < than ED1)	0.390794 (0.2685)	0.099363
ED4 (Grad. or Prof. College degree/Base: < than ED1)	0.838115 * (0.4205)	0.213098 *
CRED (Base: 'no credentials')	0.094211 (0.1544)	0.023954
RACE (Base: 'non-white')	0.573588 (0.3522)	0.145840
EXP (in years)	0.039881 *** (0.0083)	0.010140 ***
CNSIZE (in 100,000s of population)	−0.005957 (0.0176)	−0.001515
UNEMP (2nd quarter of 1996—April, May, June)	0.008124 (0.0419)	0.002066
KDSLT6	−0.545736 *** (0.1340)	−0.138758 ***
KDS6~16	−0.134094 (0.0825)	−0.034095
KDSGE16	0.172437 (0.0947)	0.043844
OTHGE16	−0.013718 (0.3532)	−0.003488
YMARRIED (in years)	−0.016721 (0.0102)	−0.004251
OWN (Base: 'non-homeowner')	0.363805 (0.2935)	0.092501

Table 6.13 (continued)

Independent Variables	ML Estimates[a]	Marginal Effects[b]
BEDROOMS	–0.027029 (0.0940)	–0.006872
SIZEYRD	0.000564 (0.0558)	0.000143
SPWAGE (in after-tax dollars)	–0.017975 * (0.0085)	–0.004570 *
UNEARN (in 1,000s of after-tax dollars)	–0.032918 *** (0.0080)	–0.008370 ***
MLIM	–0.613935 *** (0.1040)	–0.156098 ***
SPMLIM	–0.058064 (0.1011)	–0.014763
ATT2 (a high score=traditional gender-role attitude)	–0.169841 *** (0.0224)	–0.043184 ***
SPATT2 (a high score=traditional gender-role attitude)	–0.002596 (0.0232)	–0.000660
HHTECH	–0.059816 (0.1437)	–0.015209
YADEQI	–0.104801 (0.0691)	–0.026647

Maximized Value of the Unrestricted Log-likelihood Function, $\ln \mathcal{L}_{UR} = -292.8467776$
Maximized Value of the Restricted Log-likelihood Function, $\ln \mathcal{L}_{R} = -493.375609$

McFadden's Pseudo R^2 (i.e. LRI) $= 1 - \dfrac{\ln \mathcal{L}_{UR}}{\ln \mathcal{L}_{R}} = 0.4064$[c]

Cragg-Uhler's Pseudo $R^2 = \dfrac{\mathcal{L}_{UR}^{2/n} - \mathcal{L}_{R}^{2/n}}{(1 - \mathcal{L}_{R}^{2/n})\mathcal{L}_{UR}^{2/n}} = 0.5465$

Efron's Pseudo $R^2 = 1 - \dfrac{n}{n_1 n_2} \sum_{i=1}^{n} [P_i^{DES} - \Phi(\hat{P}_i^{DES})]^2 = 0.4373$

Count $R^2 = \dfrac{\text{Number of Correct Predictions}}{\text{Total Number of Observations}} = 0.8285$

[a] Standard errors of the maximum-likelihood estimates in parentheses.
[b] Marginal effects on the probability of being currently observed working in the market or in search of work were computed at the means of the full sample.
[c] McFadden's pseudo R^2 is equivalent to the likelihood ratio index, LRI.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results of the maximum-likelihood Probit analysis of the unconstrained (i.e. desired) labor-force participation behavior of the sampled Missouri wives indicate that ED4, EXP, KDSLT6, SPWAGE, UNEARN, MLIM, and ATT2 represent the personal and socio-demographic characteristics which significantly affect a wife's probability of being employed in the market in absence of institutional labor market constraints (i.e. in her long-run time-allocation equilibrium).

Hence, these Probit results suggest that, relative to the wives who did not graduate from high school (i.e. ED0), only those with a graduate or professional college degree (i.e. ED4) seem more likely to be observed participating in the paid labor market in their long-run time-allocation equilibria. Specifically, the marginal effect of ED4 shows that, in contrast to the wives without a high school diploma, the completion of a graduate or professional degree significantly raises a wife's probability of desired market participation by 21.31%, ceteris paribus. As expected, market work experience (i.e. EXP) is positively associated with a wife's desired employment status. In fact, a wife's probability of being employed in her long-run time-allocation equilibrium increases by 1.10% with each additional year of paid market work experience, ceteris paribus. Conversely, with other factors held constant, the presence of preschool children (i.e. KDSLT6) deters a wife from market employment. For instance, the addition of a preschool child in the home decreases a wife's probability of being employed in her long-run time-allocation equilibrium by 13.88%, on average. Similarly, and also as hypothesized, the husband's market wage on his primary employment (i.e. SPWAGE) and the nonlabor income of the household (i.e. UNEARN) are factors that are inversely related with a wife's probability of market participation in her long-run time-allocation equilibrium. In fact, the marginal effect of a dollar increase in the husband's after-tax market wage is to decrease the probability of market participation for his wife by 0.46%, ceteris paribus. Likewise, other factors held constant, the effect of a one-thousand dollar increase in the nonlabor income of the household is to lower a wife's probability of being employed in her long-run time-allocation equilibrium by 0.84% on average. The last two regressors found to significantly impact on a wife's desired employment status are her health-related limitation index (i.e. MLIM) and gender-role attitude (i.e. ATT2). The effect of each regressor is negative as expected. As such, a one-point increase in the wife's health-related limitation index lowers her probability of market participation at her long-run time-allocation equilibrium by 15.61%, ceteris paribus. Additionally, everything else constant, a one-point increase in her gender-role attitudinal index results in a 4.32% decrease in the probability that she participates in the paid labor market in her long-run time-allocation equilibrium.

Using desired instead of observed employment status to distinguish employed from nonemployed wives, the present Probit specification based on both standard and non-standard regressors correctly predicts the true (i.e. desired) employment status of 710 sampled wives. Given a total sample size of 857 wives, this accuracy in predictions implies a 'count' R-square of 0.8285. Based on the residual sum of squares between currently desired employment status and estimated probabilities of desired labor market participation, Efron's pseudo R-square suggests that nearly 44% (i.e. 0.4373) of the variation in the Probit estimates is explained by this particular variant of the estimation model. Alternatively, based on the Probit likelihood ratio, McFadden's and Cragg-Uhler's R-square statistics are 0.4064 and 0.5465, respectively.

Thus, comparing these goodness-of-fit measures to the ones obtained with the first variant of the standard specification (and reported in Table 6.7), it is found that the overall explanatory power of the Probit regression increases slightly as a direct result of controlling for the institutional labor market constraints previously imposed on the participation status of 15 involuntarily unemployed wives. In fact, because these 15 involuntarily unemployed wives were simply not distinguished from the voluntarily nonemployed wives in the previous Probit analysis, and because unemployed wives would normally be employed rather than nonemployed in absence of labor market constraints, it is natural that the discriminatory power of the Probit regression increases when those unemployed wives are allowed, as they wish, to enter the labor market.

Table 6.14 OLS Results for the *Second Variant* of the Standard Model: ln Market Wage (i.e. lnW) Regression Corrected for Sample Selection Bias (n = 632)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
INTERCEPT	1.655718 *** (0.3458)	0.000000
AGE (in years)	0.007025 (0.0149)	0.143007
AGESQ	−0.000153 (0.0002)	−0.278762
ED1 (High School diploma/Base: < than ED1)	0.060900 (0.0664)	0.069746
ED2 (Technical School diploma/Base: < than ED1)	0.182870 * (0.0898)	0.091872 *
ED3 (Undergraduate College degree/Base: < than ED1)	0.432882 *** (0.0687)	0.465523 ***
ED4 (Grad. or Prof. College degree/Base: < than ED1)	0.711900 *** (0.0808)	0.456007 ***
CRED (Base: 'no credentials')	0.072413 * (0.0336)	0.070917 *
RACE (Base: 'non-white')	0.094284 (0.0973)	0.031797
EXP (in years)	0.015379 *** (0.0023)	0.298654 ***
CNSIZE (in 100,000s of population)	0.009184 * (0.0038)	0.082789 *
UNEMP (2nd quarter of 1996—April, May, June)	−0.007653 (0.0090)	−0.028746
MLIM	−0.120010 ** (0.0402)	−0.105694 **
LAMBDA	0.101583 (0.0633)	0.072565

ADJ. R^2 = 0.3392 , F(13, 631) = 25.911 *** , SE of ESTIMATE CORRECTED for SSB = 0.3551

[a] Consistent asymptotic standard errors of estimates in parentheses.

[b] The standardized parameter estimates were computed by dividing the unstandardized estimates by their respective ratios of the sample standard deviation of the dependent variable to the sample standard deviation of the particular independent variable.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results from the market wage (i.e. lnW) regression presented in Table 6.14 indicate that ED2, ED3, ED4, CRED, EXP, CNSIZE, and MLIM significantly affect the natural log value of the market wage *truly* satisfactorily employed wives secure in the paid labor force.

Thus, consistent with the estimation results obtained from the first variant of the standard specification, this particular version of the estimation model reveals that the stock of human capital embodied in a wife is significantly related to the wage she earns in the labor market. In fact, holding other personal and socio-demographic characteristics constant, wives with a technical school diploma (i.e. ED2), an undergraduate college degree (i.e. ED3), or a graduate or professional college degree (i.e. ED4) secure significantly higher wages relative to those who did not graduate from high school (i.e. ED0). Also, even though wives with only a high school diploma (i.e. ED1) do not appear to command significantly higher wages than those who did not complete high school, it is seen that the market wage of a wife invariably increases with her highest schooling achievement. A similar significant effect is also recorded with regard to extra-curricular credentials (i.e. CRED). Specifically, wives with extra-curricular credentials earn significantly more from market employment, ceteris paribus. As shown by the positive coefficient on market work experience (i.e. EXP), everything else held constant, wives with more years of labor market experience command significantly higher wages. Also indicated by the positive and statistically significant coefficient on CNSIZE, the wives who reside in counties more populated earn significantly higher wages from market work than those living in less populated counties, ceteris paribus. Finally, as already confirmed in the previous specification of the model, the market wage a wife secures in the labor force significantly decreases with increased health-related limitations (i.e. MLIM).

Notice that, as in the first variant of the standard estimation model, the coefficient on LAMBDA—the sample-selection correction instrument—remains statistically non-significant in this particular variant of the estimation model. This should indeed be the case since the results of the Probit analysis on the desired (i.e. unconstrained) labor-force participation behavior of the sampled wives reveal a slightly better discriminatory power of the Probit model when institutional labor market constraints are fully controlled. Note also that, as they should be, the results presented above are consistent not only with theoretical expectations, but also with the empirical results obtained from the first variant of the standard estimation model.

The adjusted R-square of the market wage regression for this second variant of the standard estimation model indicates that 34% (i.e. 0.3392) of the variation in the natural log value of the wives' offered wage is explained by the standard and non-standard personal and socio-demographic characteristics considered in the model. As implied by the standard error of the market wage regression, the 'average' size of the regression residuals is 0.3551. Once again, these results are very similar to those obtained from the first variant of the standard specification of the model (i.e. 0.3341 and 0.3556, respectively).

Table 6.15 OLS Results for the *Second Variant* of the Standard Model: *Desired* Hours-of-Work (i.e. M^{DES}) Regression Corrected for Sample Selection Bias (n = 632)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
INTERCEPT	3091.824935 *** (451.2820)	0.000000
AGE (in years)	−27.763849 (19.5332)	−0.528495
AGESQ	0.191914 (0.2158)	0.327741
ED1 (High School diploma/Base: < than ED1)	−249.293468 ** (77.0728)	−0.266957 **
ED2 (Technical School diploma/Base: < than ED1)	−354.286362 *** (106.5440)	−0.166427 ***
ED3 (Undergraduate College degree/Base: < than ED1)	−227.096509 ** (82.4291)	−0.228354 **
ED4 (Grad. or Prof. College degree/Base: < than ED1)	−276.235136 ** (99.0050)	−0.165447 **
CRED (Base: 'no credentials')	27.281882 (38.7981)	0.024982
RACE (Base: 'non-white')	−57.815378 (113.7020)	−0.018231
EXP (in years)	16.624474 *** (3.0392)	0.301866 ***
CNSIZE (in 100,000s of population)	−8.886807 (4.6184)	−0.074902
UNEMP (2nd quarter of 1996—April, May, June)	−15.150182 (10.4846)	−0.053207
KDSLT6	−89.338474 * (41.5288)	−0.100483 *
KDS6~16	−34.218973 (22.2542)	−0.065981
KDSGE16	15.482697 (24.5304)	0.025711
OTHGE16	66.015293 (89.3038)	0.026646
YMARRIED (in years)	0.386422 (2.7068)	0.008576
OWN (Base: 'non-homeowner')	−97.386981 (87.5824)	−0.040671

Table 6.15 (continued)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
BEDROOMS	−40.416825 (26.1471)	−0.063054
SIZEYRD	−4.858955 (14.2595)	−0.012533
SPWAGE (in after-tax dollars)	−4.751124 (2.5664)	−0.079447
UNEARN (in 1,000s of after-tax dollars)	−2.054503 (3.0620)	−0.029401
MLIM	−13.995284 (53.5080)	−0.011525
SPMLIM	56.938926 * (28.4600)	0.076573 *
ATT2 (a high score=traditional gender-role attitude)	−22.481792 * (9.2033)	−0.149154 *
SPATT2 (a high score=traditional gender-role attitude)	−3.866254 (5.9503)	−0.026400
HHTECH	−6.872950 (36.0379)	−0.006931
YADEQI	−1.462277 (18.1898)	−0.003239
LAMBDA	−185.974060 (129.6434)	−0.124218

ADJ. R^2 = 0.2419 , $F(28, 631) = 8.191$ *** , SE of ESTIMATE CORRECTED for SSB = 408.9985

[a] Consistent asymptotic standard errors of estimates in parentheses.

[b] The standardized parameter estimates were computed by dividing the unstandardized estimates by their respective ratios of the sample standard deviation of the dependent variable to the sample standard deviation of the particular independent variable.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Turning to the results of the desired hours-of-work (i.e. M^{DES}) regression on the standard and non-standard personal and socio-demographic characteristics of the employed wives, Table 6.15 indicates that the characteristics which significantly affect a wife's desired (i.e. truly unconstrained) hours of market work are ED1, ED2, ED3, ED4, EXP, KDSLT6, SPMLIM, and ATT2.

More specifically, it is found that, in absence of institutional labor market constraints, satisfactorily employed wives with a high school diploma (i.e. ED1), a technical school diploma (i.e. ED2), an undergraduate college degree (i.e. ED3), or a graduate or professional college degree (i.e. ED4), work significantly fewer hours per year compared to the wives without a high school diploma (i.e. ED0), ceteris paribus. Thus, contrary to expectations, higher schooling accomplishments lower the desired intensity of a wife's labor supply. Conversely, with other factors constant, a wife's unconstrained labor supply significantly increases with her years of market work experience (i.e. EXP), as expected. In line with the hypotheses formulated earlier, the presence of preschool children in the household (i.e. KDSLT6) significantly decreases wife's desired hours of market work, ceteris paribus. The positive and statistically significant coefficient on SPMLIM indicates that a wife's unconstrained hours of paid work rise with increased limitations in the health of her spouse. Conversely, all other factors held constant, the more traditional the gender-role attitudinal orientation of a wife with regard to what she considers as the appropriate role of women in society (i.e. ATT2), the fewer hours she works in the market in her long-run time-allocation equilibrium. Indeed, this negative relationship between ATT2 and a wife's desired hours of market work was hypothesized.

Also from the results of the desired hours-of-work regression, it is important to note that, contrary to the results obtained with the first variant of the standard estimation model, the coefficients on both UNEARN and YADEQI are negative as they should be under the usual assumption that home time is a normal commodity relative to market time. Thus, controlling for institutional labor market constraints makes the signs of these coefficients consistent with standard economic theory. Notice also that LAMBDA remains statistically non-significant when desired (i.e. unconstrained) hours of paid market work replace observed hours in the estimation model. As in the market wage regression, this was predictable given the explanatory power of the desired labor-force participation Probit analysis.

The adjusted R-square and standard error of the desired hours of market work regression are 0.2419 and 408.9985, respectively. Hence, in contrast to the same statistics obtained from the first variant of the standard estimation model (i.e. 0.2639 and 484.1173), it seems that, although the explanatory power of this regression remains about the same with the use of desired hours of market work, the decrease in the 'average' size of the regression residuals suggests an appreciable improvement of the model for prediction purposes.

The retrieved coefficients of the shadow price of home time equation (i.e. lnS) for this particular version of the estimation model are reported in Table 6.16. These coefficients are calculated using the estimated parameter of market work experience (i.e. EXP) in the market wage and desired hours-of-work regressions to identify the coefficient of M^{DES}

Table 6.16 Retrieved Coefficients of the Shadow Price of Home Time Equation (i.e. ln S) for the *Second Variant* of the Standard Specification of the Estimation Model

Independent Variables	Retrieved Coefficients[a] Unstandardized	Standardized[b]
INTERCEPT	−1.204473	0.000000
AGE (in years)	0.032709	0.665879
AGESQ	−0.000331	−0.603015
ED1 (High School diploma/Base: < than ED1)	0.291517	0.333863
ED2 (Technical School diploma/Base: < than ED1)	0.510614	0.256529
ED3 (Undergraduate College degree/Base: < than ED1)	0.642965	0.691448
ED4 (Grad. or Prof. College degree/Base: < than ED1)	0.967440	0.619694
CRED (Base: 'no credentials')	0.047175	0.046200
RACE (Base: 'non-white')	0.147768	0.049835
CNSIZE (in 100,000s of population)	0.017405	0.156894
UNEMP (2^{nd} quarter of 1996)	0.006362	0.023895
KDSLT6	0.082645	0.099414
KDS6~16	0.031655	0.065279
KDSGE16	−0.014323	−0.025437
OTHGE16	−0.061070	−0.026362
YMARRIED (in years)	−0.000358	−0.008485
OWN (Base: 'non-homeowner')	0.090091	0.040238
BEDROOMS	0.037389	0.062483
SIZEYRD	0.004495	0.012400
SPWAGE (in after-tax dollars)	0.004395	0.078601
UNEARN (in 1,000s of after-tax dollars)	0.001901	0.029089
MLIM	−0.107063	−0.094291
SPMLIM	−0.052673	−0.075758
ATT2 (a high score=traditional gender-role attitude)	0.020798	0.147567
SPATT2 (a high score=traditional gender-role attitude)	0.003577	0.026119
HHTECH	0.006358	0.006857
YADEQI	0.001353	0.003204
M^{DES}	0.000925	0.989361

[a] Market work experience, EXP, was used as the *identifier* to retrieve the coefficients of the shadow price of home time function.

[b] Using the standardized parameter estimates in the market wage and *desired* hours-of-work regressions (instead of their unstandardized parameter estimates), the standardized coefficients for the shadow price of home time function were retrieved in the very same fashion as the unstandardized coefficients.

(i.e. δ) in the shadow price of home time function. As in the previous specifications of the recurrent estimation model, the choice of market experience as the identifier is appropriate because this personal characteristic is statistically significant in both the offered market wage and desired hours-of-work regressions.

An important particularity worth reporting from Table 6.16 is that, except for the sign of the coefficient on the county unemployment rate (i.e. UNEMP), all other personal and socio-demographic characteristics considered in this last version of the estimation model have calculated coefficients with signs that are consistent with the hypotheses advanced earlier in Table 5.1.

For instance, Table 6.16 shows that the shadow price of a wife's home time increases with her age (i.e. AGE) and, as expected, at a decreasing rate. Also, as indicated by the coefficients on ED1, ED2, ED3, and ED4, higher schooling achievements raise a wife's shadow price of home time, ceteris paribus. As such, relative to the reference group (i.e. ED0), it appears that the economic value a wife places on her home time is an increasing function of educational achievements. Indeed, this result is consistent with human capital theory. With other personal and socio-demographic characteristics constant, the same is also true with regard to the holding of extra-curricular credentials (i.e. CRED). More precisely, the positive coefficient on this characteristic indicates that the holding of extra-curricular certifications and/or special licenses increases a wife's shadow price of home time, ceteris paribus. So far as the race of a wife is concerned (i.e. RACE), it is found that being Caucasian raises the shadow price of a wife's home time. Other factors held constant, the size of the population in a wife's county of residence (i.e. CNSIZE) is positively associated with her shadow price of home time. Also, as illustrated by the positive coefficients on KDSLT6 and KDS6~16, the presence of preschool children and children between six and 16 years of age in the household raises, as expected, the economic value of a wife's home time, ceteris paribus. Inversely, the presence of teenagers and older children (i.e. KDSGE16) as well as the presence of adult relatives and friends (i.e. OTHGE16) decrease a wife's shadow price of home time when other factors are controlled. With all other personal and socio-demographic characteristics held constant, a wife's shadow price of home time decreases with years of marital union (i.e. YMARRIED). Moreover, as hypothesized, living in a house owned by her household (i.e. OWN) increases a wife's shadow price of home time. Likewise, the number of bedrooms in her current residence (i.e. BEDROOMS) and the size of the yard where the household resides (i.e. SIZEYRD) represent factors that are positively associated with the shadow price of a wife's home time. The positive sign of the coefficient on the husband's primary market wage (i.e. SPWAGE) indicates that a wife's shadow price of home time rises with increases in her spouse's net wage, ceteris paribus. Here, if the backward-bending labor supply of married males is a sensible assumption, then it appears that the positive relationship found between the husband's wage rate and his wife's shadow price of home time is illustrative of the spouses' complementarity in home-related activities. In a similar order of ideas, the higher the level of after-tax nonlabor income of a wife's household (i.e. UNEARN), the greater the economic value she places on her non-market time, ceteris paribus. Thus, contrary to the results obtained from the two previous specifications, in this more refined model the marginal effect of nonlabor income on a wife's shadow price of home time accords with standard economic theory. Also as predicted, holding other characteristics constant, the poorer the state of health of wife (i.e. MLIM), the lower the economic value she places on her non-market time. Similarly, the poorer the health of her husband (i.e. SPMLIM), the lower the shadow value of her home time. Further, and also as hypothesized, a wife characterized by a more traditional gender-role attitudinal orientation toward what she considers as the proper role of women in today's society (i.e. ATT2) places a greater economic value on her home time than a wife with a more egalitarian view, ceteris paribus. Indeed, the positive sign of the coefficient on SPATT2 suggests that the same is also true concerning the impact of her spouse's gender-role orientation on her shadow price of home time. That is, the more traditional the gender-role attitudinal orientation of her husband, the greater the economic value she places on her home time, ceteris paribus. Both a wife's perceived adequacy with regard to her available home technology (i.e. HHTECH) and her household's overall income (i.e. YADEQI) are factors that are positively related to her shadow price of home time. Thus, as expected, it seems that the more 'adequate' the home equipment and tools available to a wife, the greater the value she places on her non-market time, ceteris paribus. Likewise, with other characteristics being held constant, the greater the perceived adequacy of her household's income, the more valuable becomes her home time, as expected. Finally, as should necessarily be the case, the shadow price of a wife's home time is positively associated with her unconstrained (i.e. desired) hours of market work, ceteris paribus.

Comparison of the Market Wages and Reservation Wages Derived from Each of the Three Particular Versions of the Estimation Model

In this section, the mean offered market wages and the mean estimated reservation wages obtained from each particular specification of the estimation model for the subsamples of employed and nonemployed Missouri wives are presented. While direct comparisons between the figures obtained from the standard formulation of the estimation model and the first variant of it are used to illustrate the biases due to the omission of important labor supply regressors from the estimation model, direct comparisons between the mean figures derived from the first and second variants of the standard model are utilized to assess the biases that would normally result from the non-control of institutional labor market constraints imposed on the sample of Missouri wives.

Since the standard version of the recurrent estimation model and the first variant of it are both based upon the usual assumption of perfectly continuous budget lines (i.e. the assumption that the sampled wives are fully free to allocate as little or as much of their time to paid market employment)—and thus, because these models were specified using the actual labor supply behavior of the sampled wives without controlling for the reality of labor market constraints portrayed in Table 6.11—the mean offered market wages and the mean reservation wages derived from these two particular specifications of the estimation model are reported based on the naïve presumption that the sampled wives observed working in the market are satisfactorily employed, while those observed out of the labor force are satisfactorily nonemployed. Accordingly, under these circumstances, the mean offered market wages and the mean reservation wages reported for the standard version of the estimation model and the first variant of it are for the subsamples of *presumably satisfactorily employed* wives (n=617) and *presumably satisfactorily nonemployed* wives (n=240). In contrast, given that the second variant of the standard estimation model directly controls for institutional labor market constraints by specifying the recurrent system of equations in terms of the wives' desired (i.e. truly unconstrained) rather than observed labor supply behavior, it follows that this particular variant of the estimation model guarantees that any sampled wife is analyzed maximizing utility in her long-run time-allocation equilibrium. Consequently, the mean offered market wages and the mean reservation wages obtained with this last particular variant of the standard estimation model are, relative to the mean figures derived from the standard model and the first variant of it, fully disentangled from the biases introduced by labor market constraints. Thus, the mean market wages and reservation wages reported for the second variant of the standard estimation model relate to the subsamples of *truly satisfactorily employed* wives (n=632) and *truly satisfactorily nonemployed* wives (n=225).

For the three different versions of the estimation model, the market wage and reservation wage figures reported in this section were converted from their log values into dollars. These figures are all expressed in after-tax dollars. Also, while the mean market wages for the subsamples of employed wives were computed from the actual after-tax wage rates secured by these wives on their market jobs, the mean offered market wages for the subsamples of nonemployed wives are *potential* after-tax market wages estimated via the sample selection-corrected market wage equations. Finally, the retrieved shadow price of home time functions were used to compute the mean estimated reservation wage figures.

Table 6.17 Mean Market Wages and Reservation Wages of the Sampled Missouri Wives (n=857) according to the Standard Specification of the Recurrent Estimation Model and the Two Particular Variants of it

Standard Specification of the Estimation Model			
Presumably Satisfactorily Employed Wives (n=617)		Presumably Satisfactorily NonEmployed Wives (n=240)	
Actual Market Wage[a]	Estimated Reservation Wage[b]	Estimated Market Wage[c]	Estimated Reservation Wage
$8.95400	$1.49987	$5.02013	$1.32007
First Variant of the Standard Specification of the Estimation Model			
Presumably Satisfactorily Employed Wives (n=617)		Presumably Satisfactorily NonEmployed Wives (n=240)	
Actual Market Wage	Estimated Reservation Wage[d]	Estimated Market Wage[e]	Estimated Reservation Wage
$8.95400	$3.02686	$6.51244	$2.80938
Second Variant of the Standard Specification of the Estimation Model			
Truly Satisfactorily Employed Wives (n=632)		Truly Satisfactorily NonEmployed Wives (n=225)	
Actual Market Wage	Estimated Reservation Wage[f]	Estimated Market Wage[g]	Estimated Reservation Wage
$8.94326	$2.09411	$6.22795	$2.04636

Table 6.17 (continued)

[a] The "Actual" Market Wages is simply the means of the current hourly rates of pay for the particular subsamples of wives, expressed in after-tax dollars.

[b] For the Standard Specification of the model, the "Estimated" Reservation Wages were computed from the retrieved shadow price of home time function presented in Table 6.5 using the mean values of the corresponding regressors reported in Table 6.1, and setting observed hours of market work to zero (i.e. $S|_{M^{OBS}=0}$).

[c] For the Standard Specification of the model, the "Estimated" Market Wages were computed from the estimated wage function presented in Table 6.3 using the mean values of the corresponding regressors reported in Table 6.1. As for "Actual" Market Wages, these are after-tax figures.

[d] For the First Variant of the Standard Specification, the "Estimated" Reservation Wages were computed from the retrieved shadow price of home time function presented in Table 6.10 using the mean values of the corresponding regressors reported in Tables 6.1 and 6.6, and setting observed hours of market work to zero (i.e. $S|_{M^{OBS}=0}$).

[e] For the First Variant of the Standard Specification, the "Estimated" Market Wages were computed from the estimated wage function presented in Table 6.8 using the mean values of the corresponding regressors reported in Tables 6.1 and 6.6. As for "Actual" Market Wages, these are after-tax figures.

[f] For the Second Variant of the Standard Specification, the "Estimated" Reservation Wages were computed from the retrieved shadow price of home time function presented in Table 6.16 using the mean values of the corresponding regressors reported in Table 6.12, and setting desired hours of market work to zero (i.e. $S|_{M^{DES}=0}$).

[g] For the Second Variant of the Standard Specification, the "Estimated" Market Wages were computed from the estimated wage function presented in Table 6.14 using the mean values of the corresponding regressors reported in Table 6.12. As for "Actual" Market Wages, these are after-tax figures.

Table 6.17 shows that, according to the standard specification of the estimation model, the mean actual hourly after-tax market wage for the subsample of wives presumed satisfactorily employed is \$8.95, while the mean estimated reservation wage for the same subsample of wives is \$1.50. Indeed, to the employed wives the actual after-tax market wage represents the monetary return of an additional hour of market work—which recall that, in Heckman's model, is constant and thus invariant to the number of hours worked in the market—whereas the reservation wage conceptually denotes the shadow price of the very last yearly hour of home time *prior to labor market entry* (i.e. at full home time). Also according to the standard specification of the estimation model, the mean estimated hourly market wage and the mean estimated reservation wage for the subsample of wives presumed satisfactorily nonemployed are \$5.02 and \$1.32, respectively. On one hand, the mean estimated market wage is the *potential* hourly rate of pay the average sampled non-working wife would be offered given her particular personal characteristics if she were in fact devoting time to the labor market. On the other hand, the mean estimated reservation wage represents, as with the subsample of working wives, the shadow price of the *last annual hour of home time* to the average presumably satisfactorily nonemployed wife, and thus the net rate of pay she would require if she were to consider 'trading' her very last hour of home time for a *single* and *very first* hour of paid market work.

Notice that, because of the inclusion of lambda in the market wage and hours-of-work regressions, the mean market wage and reservation wage figures obtained from the standard version of the recurrent estimation model for the presumably satisfactorily nonemployed wives are free from sample selection bias.

Biases Due to the Omission of Important Labor Supply Regressors

Turning to the figures obtained from the first variant of the standard version of the estimation model, Table 6.17 reveals that, while the mean actual after-tax market wage for the subsample of wives considered as satisfactorily employed remains $8.95, the mean estimated reservation wage changes from $1.50 to $3.03 after the inclusion of the new non-standard regressors in the recurrent estimation model. Thus, it appears that the inclusion of the non-standard characteristics (i.e. MLIM, SPMLIM, ATT2, SPATT2, HHTECH, and YADEQI), along with the regressors usually considered in the standard formulation of the recurrent estimation model, raises the estimated reservation wages of the presumably satisfactorily employed wives by 102% on average. In other words, the mean estimated reservation wage for the sampled wives presumed satisfactorily employed is biased downward by as much as 50% as a result of omitting the additional non-standard characteristics from the estimation model. Also according to the first variant of the standard model, the mean estimated hourly market wage and the mean estimated reservation wage for the subsample of presumably satisfactorily nonemployed wives are $6.51 and $2.81, respectively. Hence, compared to the mean estimated figures obtained from the standard specification of the model for the same subsample of nonemployed wives (i.e. $5.02 and $1.32), it is found that the addition of the non-standard regressors results in an increase of nearly 30% in the mean estimated market wage, whereas this addition induces a stunning increase of 113% in the mean estimated reservation wage. Thus, as with the wives presumed satisfactorily employed, the estimated reservation wages of the wives considered as satisfactorily nonemployed are, on average, biased downward by as much as 53% when regressors such as MLIM, SPMLIM, ATT2, SPATT2, HHTECH, and YADEQI are left out of the recurrent estimation model. A similar result is also true with respect to the mean estimated market wage. As such, the mean estimated market wage derived with the standard set of regressors underestimates the potential market wage of these wives by as much as 23%, on average.

Indeed, these substantial differences in the mean estimated offered market wages and the mean estimated reservation wages obtained with the standard formulation of the model and the first variant of it shed light on the magnitude of the biases that would normally be generated from the omission of non-standard characteristics such as MLIM, SPMLIM, ATT2, SPATT2, HHTECH, and YAQEQI in the recurrent system of equations. Undoubtedly, if the standard assumption of perfectly continuous budget lines were to depict reality, the estimated market wage and reservation wage figures derived from the first variant of the standard estimation model would be better estimates of the true market wage and reservation wage values than the figures derived from the standard version of the estimation model. This is so because, as seen previously, even though these new non-standard regressors do not necessarily increase the explanatory power (i.e. the adjusted R-squares) of the market wage and hours-of-work equations, their inclusion in the recurrent system of equations appreciably lowers the average size of the residuals (i.e. the standard error of the estimates) in both offered market wage and annual hours of market work regressions. Hence, by reducing the average size of the residuals in the market wage and hours-of-work regressions, it follows that the average size of the residuals in the shadow price of home time regression must also be reduced as a result of the inclusion of the new non-standard regressors in the recurrent system of equations.

Another important reason that leads to favor the mean estimated market wage and reservation wage figures obtained from the first variant of the standard model over those obtained from the standard estimation model is the fact that these figures are free from sample selection bias not because of the inclusion of lambda in the market wage and hours-of-work regressions, but because of the added discriminatory power offered by the new regressors in distinguishing working from non-working sampled wives.

Biases Due to Institutional Labor Market Constraints

The last figures reported in Table 6.17 are the mean offered market wage and reservation wage values obtained from the second variant of the standard estimation model. Accordingly, it is shown that, after controlling for labor market constraints, the mean actual after-tax market wage and the mean estimated reservation wage for the subsample of truly satisfactorily employed Missouri wives are $8.94 and $2.09, respectively. Further, the mean estimated market wage for the subsample of truly satisfactorily nonemployed wives is $6.23, while the mean estimated reservation wage for the same subsample of housewives is $2.05. Indeed, inasmuch as specifying the recurrent estimation model in terms of the wives' desired labor supply behavior improves on the first variant of the standard model by ensuring (rather than blindly assuming) that all sampled wives—whether they work or not—are properly analyzed allocating time in their long-run (i.e. unconstrained) utility-maximizing equilibria, it follows that the mean offered market wage and reservation wage figures derived from this last and more refined variant of the standard model are, in addition to being free from sample selection bias, fully disentangled from the bias associated with the discontinuity of budget lines due to institutional labor market restraints. Consequently, it must be the case that the mean estimated figures obtained from this second variant of the standard estimation model are more dependable measures of the sampled wives' true market wage and reservation wage values than those derived from the previous specifications of the estimation model. As pointed out previously when presenting the OLS regression results of Tables 6.14 and 6.15, from a statistical standpoint, the decrease of the average size of the residuals in the market wage and hours-of-work regression that results from the use of desired labor supply behavior in the recurrent system of equations is illustrative of this last assertion.

Naturally, since the second variant of the standard estimation model differs from the first variant only by its use of the wives' desired (i.e. truly unconstrained) labor supply behavior, it follows that direct comparisons between the mean figures derived from the second variant and the first variant of the standard estimation model are appropriate to assess the magnitude of the biases that would normally result from the non-control of institutional labor market constraints. In due course, contrasting the mean figures obtained from this more refined version of the estimation model to those obtained from the first variant of the standard model, it is found that, without the appropriate control of labor market constraints which operate through the sample of Missouri wives, *estimated* market wages and reservation wages are importantly biased. For instance, although the mean actual market wages for the subsamples of presumably satisfied and truly satisfied employed wives are almost identical regardless whether market constraints are controlled or not (i.e. \$8.95 versus \$8.94, respectively), it appears that the mean estimated reservation wages for the same subsamples of wives importantly differ (i.e. \$3.03 versus \$2.09). Further, substantial differences in the mean estimated market wages and the mean estimated reservation wages between the subsamples of presumably satisfied and truly satisfied nonemployed wives are recorded as well (i.e. \$6.51 versus \$6.23, and \$2.81 versus \$2.05, respectively). Thus, it is seen that, without controlling for institutional labor market constraints, the mean estimated reservation wage for the subsample of wives presumed satisfactorily employed overestimates the mean reservation wage of the truly satisfactorily employed wives by nearly 45%. Likewise, whereas the mean estimated offered market wage for the subsample of presumably satisfactorily nonemployed wives overestimates the mean offered market wage of the truly satisfactorily nonemployed wives by approximately 5%, the mean estimated reservation wage for the same subsample of presumably satisfactorily nonemployed wives overestimates the mean reservation wage of the truly satisfactorily nonemployed wives by almost 38%.

Clearly, blindly assuming that the sampled wives' observed labor supply behavior reflects their desired behavior (i.e. the standard assumption of perfectly continuous budget lines) leads to substantial biases in the mean estimated figures one gets, and this is particularly true with respect to the mean estimated reservation wage figures. That the mean reservation wage figures are more importantly biased than the mean market wage figures as a result of institutional labor market restraints should not be very surprising. In fact, since the shadow price of home time function includes hours of market work as a regressor, whereas the market wage function does not, it should be evident that any discrepancy existing between observed and desired (i.e. truly unconstrained) labor supply behavior must necessarily be of greater impact in the determination of reservation wages than in the determination of market wages per se.

A Special Note on the Market Wage and Reservation Wage Figures Derived from the Three Particular Specifications of the Estimation Model

Worth noting from the figures reported in Table 6.17 is the fact that, regardless which specification of the estimation model is used, the mean estimated reservation wages are always substantially lower than the mean actual or estimated hourly market wages. While economic theory supports a reservation wage below the offered market wage for employed individuals, the estimated reservation wages for the subsamples of employed wives appear low in relation to their prevailing market wages. Moreover, at first glance, it seems hardly conceivable that nonemployed wives have reservation wages below their potential market wages. After all, according to economic theory, if this were the case then one should rationally expect that nonemployed wives would in fact be employed in their long-run time-allocation equilibria. Yet, according to the three different versions of the estimation model, the mean estimated reservation wages for the subsamples of nonemployed wives are lower than the mean estimated market wages these wives could potentially secure in the labor force.

A possible reason which can be advanced to explain these seemingly disconcerting results is linked to the very nature of the reservation wage and market wage concepts, and how these concepts were in fact implemented through the specifications of the recurrent system of equations that defined the estimation model utilized in this study. For instance, inasmuch as the reservation wage denotes the shadow price of home time evaluated at full non-market time (i.e. at zero hours of market work), and because the shadow price of home time rises with increasing hours of market work whereas the value of market time (i.e. the market wage) is, in the recurrent system of equations, required to be invariant to hours of market work, it follows that the discrepancies between market and reservation wages may not be sensible for 'predicting' whether a wife would (or should) be employed or not. This is so because, being fixed, market wages must in fact represent *average* monetary values of the decreasing marginal returns of some predefined lengthy periods of time devoted to market production, while reservation wages represent *marginal* values of the least valuable hour of home time prior to labor market entry. Consequently, since the reservation wage conceptually denotes the economic value the wife places on her very last annual hour of home time, and thus *after having allocated the totality of her time to home activities such as leisure and home production*, then it seems logical that this reservation wage value be very low relative to a market wage that is meant to reflect the average economic value of the wife's productive capacity in market employment. Indeed, under the standard assumption of linearly homogeneous (i.e. CRS) home production functions, the above rationale is of no substance inasmuch as reservation wages are, in much the same way as market wages, regarded as average rather than marginal values. However, as shall be demonstrated in the following section, this rationale makes a great deal of sense when market and reservation wages are contrasted to average shadow prices of time spent in home production activities.

An Extension of the Opportunity Cost of Time Methodology: The Derivation of Average Shadow Prices for Household Production Time

According to the opportunity cost of time approach, to the employed individual the opportunity cost of household production time is the net rate of pay secured on her/his market job. In contrast, the opportunity cost of household production time to the nonemployed person is her/his reservation wage—or, more specifically, the shadow price of her/his home time evaluated at full non-market time (i.e. at zero hours of market work)—which denotes the lowest real wage rate required to make the individual indifferent between trading her/his very last (i.e. least valuable) hour home time for a very first hour of paid market time. However, as already pointed out earlier, since the reservation wage is the shadow price of the last hour of non-market time, it follows that taking the reservation wage of the nonemployed person to 'price' her/his intramarginal hours of home labor (i.e. all those hours that are not the very last hour of home labor) necessarily underestimates the true economic value of her/his household production time. This is so because, like any other input in a production process, home labor obeys the law of diminishing marginal returns. Yet, under the implicit standard assumption of linearly homogeneous (i.e. CRS) home production function, the reservation wage of the nonemployed person (i.e. $S_i|_{M=0}$) is invariably utilized as the opportunity cost measure for all hours of household work. Similarly, even though it was demonstrated that the net hourly market wage secured by the employed person theoretically coincides with the shadow price of her/his last hour of home labor in equilibrium, it should be clear that the market wage is only a valid opportunity cost measure for that person's last hour of home production. Consequently, the fact that reservation wages and market wages only provide for the value of home production time at the margin importantly limits these opportunity cost measures in terms of their capability to render the true economic value of household production time from an individual's perspective. Without doubt, to be valid assessments of the genuine economic value generated in the home, opportunity cost measures should be fully disentangled from their 'at-the-margin' limitations.

A simple way to get an opportunity cost measure that is applicable to all hours devoted to home production is to use the averaging procedure developed in equation (3.1) in conjunction with the information available on hours of home labor in order to compute an average shadow price measure for this time. Thus, using the shadow price of home time function derived from each of the three different specifications of the recurrent estimation model used in this study, average shadow prices for home time devoted to household production activities can be computed for both working and non-working sampled Missouri wives. Notice here that, inasmuch as the standard version of the estimation model and the first variant of it both used the sampled wives' observed hours of market work, M^{OBS}, to derive opportunity cost figures for household production time, average shadow prices of home labor derived from these two specifications must also be based on the wives' observed behavior in household work (i.e. H^{OBS}). Conversely, since the second and most refined variant of the standard specification of the model utilized the wives' desired labor supply behavior, M^{DES}, as a way to control for institutional labor market constraints, desired (i.e. unconstrained) hours of household work, H^{DES}, are needed to derive average shadow prices of home labor for this particular variant of the standard specification.

Hence, before deriving average shadow prices for household production time, Table 6.18 presents the mean observed and desired yearly hours of home labor for the subsamples of working and non-working Missouri wives. Examination of this table reveals that, at the time of the survey, sampled wives observed participating in the paid labor force were allocating 1,720.65 hours annually (i.e. roughly 33 hours per week), on average, to home production activities such as household work, yard work, household resource management, shopping for the needs of the household, childcare, and care to other family members, while full-time housewives were, on average, devoting 2,759.15 hours per year (i.e. roughly 53 hours per week) to such home production activities. Of course, under the assumption of perfectly continuous budget lines which characterizes the standard specification of the estimation model and the first variant of it, these 'observed' annual hours of home labor are presumed to result from the wives' desired (i.e. unconstrained) time-allocation behavior. However, as was shown in Table 6.11, the assumption of perfectly continuous budget lines does not correspond to reality for many sampled wives. As such, using the discrepancies between actual (i.e. observed) and desired hours of market work, it was found that, prior to the control of labor market constraints implemented in the second variant of the standard estimation model, only 196 out of the 617 presumably satisfactorily employed wives were in fact fully satisfied with their employment situations, while 225 out of the 240 presumably satisfactorily nonemployed wives were fully content being housewives. Specifically, at the time of the survey, 108 wives were underemployed, 313 were overemployed, and 15 were unemployed because of labor market constraints. Thus, on one hand, sampled wives who were facing an upper-bound labor market constraint at the time of the survey—that is, those who were

Table 6.18 Mean Observed and Desired Yearly Hours of Home Labor of the Sampled Missouri Wives (n=857)

Observed Hours of Home Labor[a], H^{OBS}		Desired Hours of Home Labor[b], H^{DES}	
Presumably Satisfactorily Employed Wives (n=617)	1,720.65	Truly Satisfactorily Employed Wives (n=632)	1,764.44
Presumably Satisfactorily NonEmployed Wives (n=240)	2,759.15	Truly Satisfactorily NonEmployed Wives (n=225)	2,761.26

[a] Weekly hours reported on three general categories of household work were multiplied by 52 to obtain yearly figures of home labor. The three categories of home labor activities considered in this study are presented below.

Category 1: Household & Yard Work

Activities in this category were: indoor cleaning and maintenance, laundry and ironing, repairs and alterations to clothing, sewing and/or knitting home goods, meal preparation, dishwashing, indoor and outdoor home repairs, yard and garden maintenance, and automobile care.

Category 2: Household Resource Management & Shopping

Activities in this category were: preparing the household budget and/or spending plan, managing routine finances such as keeping bills and records, managing the investments and savings of the household, preparing shopping and grocery lists, and shopping for the needs of the household.

Category 3: Care of Children & Other Household Members

Activities in this category were: active care to children, at home or away (i.e. attending needs, helping with school work, reading to them, transportation to school and recreational activities, etc.), and active care to other household members, at home or away.

[b] Information on desired hours of home labor was not collected in the survey. However, because 196 employed wives were not constrained with respect to their time-allocation behavior (see Table 6.11) prior to the control of labor market constraints implemented in the second variant of the standard estimation model, it was possible to estimate a desired hours of home labor function by regressing the personal and socio-demographic characteristics of these 196 unconstrained working wives on their observed hours of home production. The results of this OLS regression—which appear in Table E.1 presented in Appendix E—were then used to estimate the desired annual hours of home labor for the wives who, in Table 6.11, were identified as underemployed, overemployed, and unemployed prior to the control of labor market restraints. Additionally, for the 225 nonemployed wives identified as unconstrained with respect to their time-allocation behavior, observed hours of household production were used as desired hours of home labor.

unemployed or underemployed—had necessarily more time available to them for home-related activities such as household production and leisure than they would normally have in their long-run (i.e. desired) time-allocation equilibria. On the other hand, those wives who were facing a lower-bound market constraint—that is, those who were overemployed—were inevitably having less time available for home-related activities than they would otherwise have in their long-run (i.e. desired) time-allocation equilibria. Indeed, with the use of desired labor supply behavior in the second variant of the standard estimation model, these wives who were constrained but presumably satisfied in the standard version of the model and the first variant of it, are allowed to reach their long-run (i.e. unconstrained) time-allocation equilibria. Consequently, once labor market restraints are controlled for—as in the second variant of the standard model—these wives' (desired) hours of household production are likely to differ from the hours they reported allocating to home production activities at the time of the survey. Therefore, the derivation of average shadow prices for the time devoted to household production activities based on the results obtained from the second variant of the standard estimation model requires that information on desired hours of home labor be available to the analyst. Unfortunately, this particular information was not collected when surveying Missouri wives. Nonetheless, because 196 employed wives were not constrained with regard to their time-allocation behavior prior to the control of labor market constraints implemented in the second variant of the standard estimation model, it was possible to estimate a desired hours of home labor function by regressing the characteristics of these 196 wives on their reported yearly hours of home production (see Appendix E for the results of this particular regression). Once estimated, this desired hours of home labor function was then used to impute the desired yearly hours of home labor for the wives who were constrained at the time of the survey, but allowed to reach their utility-maximizing time-allocation equilibria in the second variant of the standard estimation model. Accordingly, looking back to Table 6.18, it is found that, after controlling for institutional labor market constraints, truly satisfactorily employed wives would normally allocate 1,764.44 hours per year (i.e. roughly 34 hours per week) to household production activities, whereas truly satisfactorily nonemployed wives would devote 2,761.26 hours annually (i.e. 53 hours per week) to household labor, on average.

Contrasting the figures presented in Table 6.18, it is seen that there are no real major differences between observed and desired annual hours of home production. Clearly, this should be the case for the subsample of nonemployed wives since only 15 out of 240 non-working wives were unemployed prior to the control of market constraints. However, it is somewhat surprising to find out that the difference between observed and desired annual hours of home labor is not more pronounced for the subsample of employed wives. To some extent, this appears to indicate that, *on average*, institutional labor market constraints do not spawn any important impact on the amount of time employed wives normally devote to household production activities.

Using the information on observed annual hours of household production contained in Table 6.18, Figures 6.1 and 6.2 illustrate the economic value of each intramarginal hour of home labor to the presumably satisfactorily employed and nonemployed Missouri wives, respectively, based on the shadow price of home time function derived in Table

6.5 for the standard specification of the estimation model. Likewise, Figures 6.3 and 6.4 also utilize observed annual hours of household production to delineate the monetary value of each intramarginal hour of home labor to the same subsamples of presumably satisfactorily employed and nonemployed wives, but according to the shadow price of home time function derived in Table 6.10 for the first variant of the standard specification of the estimation model. Lastly, Figures 6.5 and 6.6 use the estimated desired (i.e. unconstrained) hours of household work reported in Table 6.18 to illustrate the economic value of each intramarginal hour of home labor to the truly satisfactorily employed and nonemployed wives, respectively, based on the shadow price of home time function derived in Table 6.16 for the second variant of the standard version of the model.

For each of the three particular specifications of the estimation model used in this study, average shadow prices of home time allocated to household production activities are computed for the subsamples of working and non-working Missouri wives by simply taking the arithmetic mean of the monetary values derived for all intramarginal hours of home labor accomplished within a typical year by these wives. The resulting average shadow prices of home labor time are then contrasted to the reservation wage estimates and the market wage figures derived earlier from each particular specification of the recurrent estimation model for each subsample of working and nonworking Missouri wives.

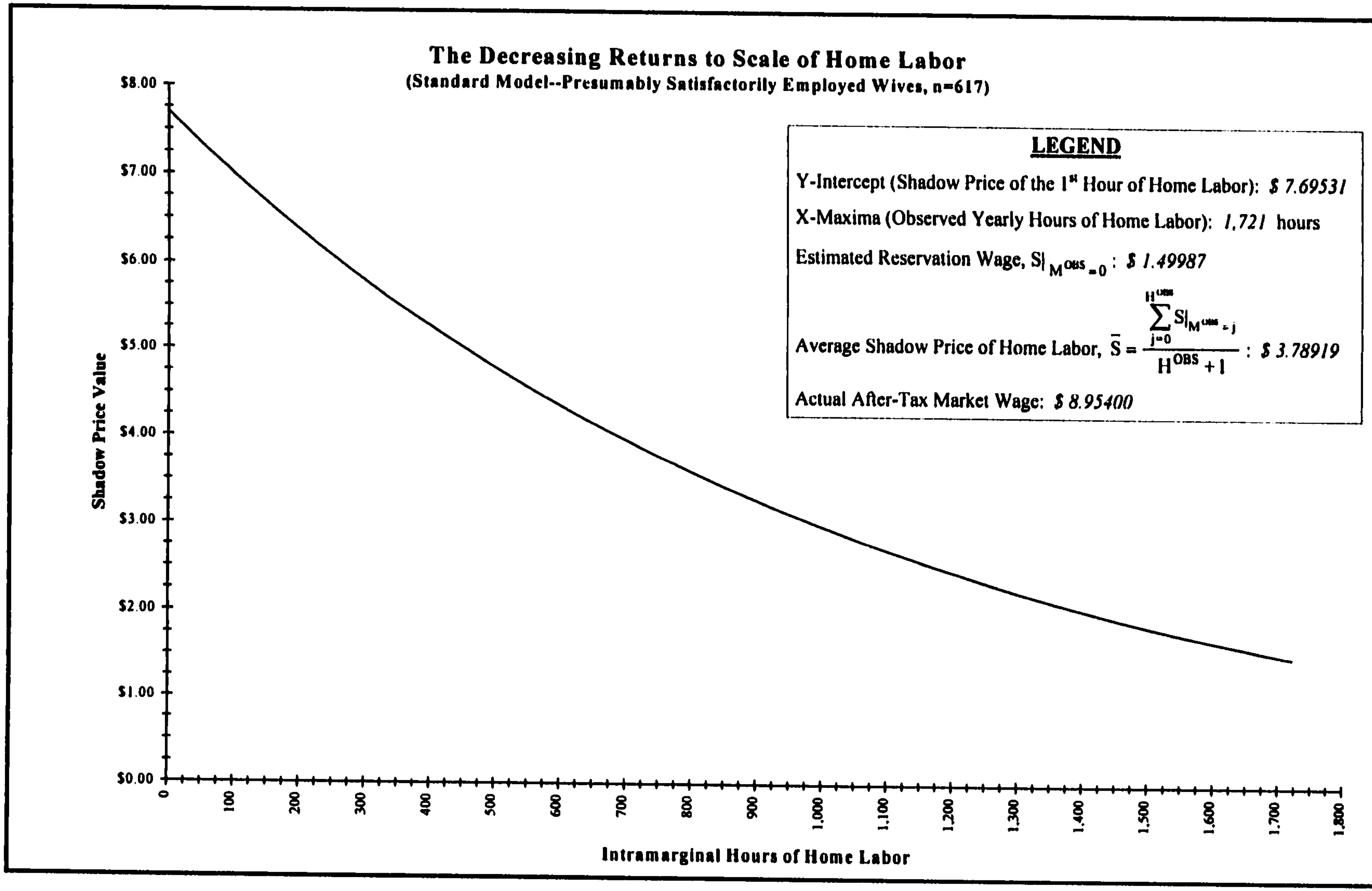

Figure 6.1 Illustration of the Decreasing Returns to Scale of Home Labor Time for the Subsample of Presumably Satisfactorily Employed Missouri Wives (n=617), according to the Standard Specification of the Estimation Model

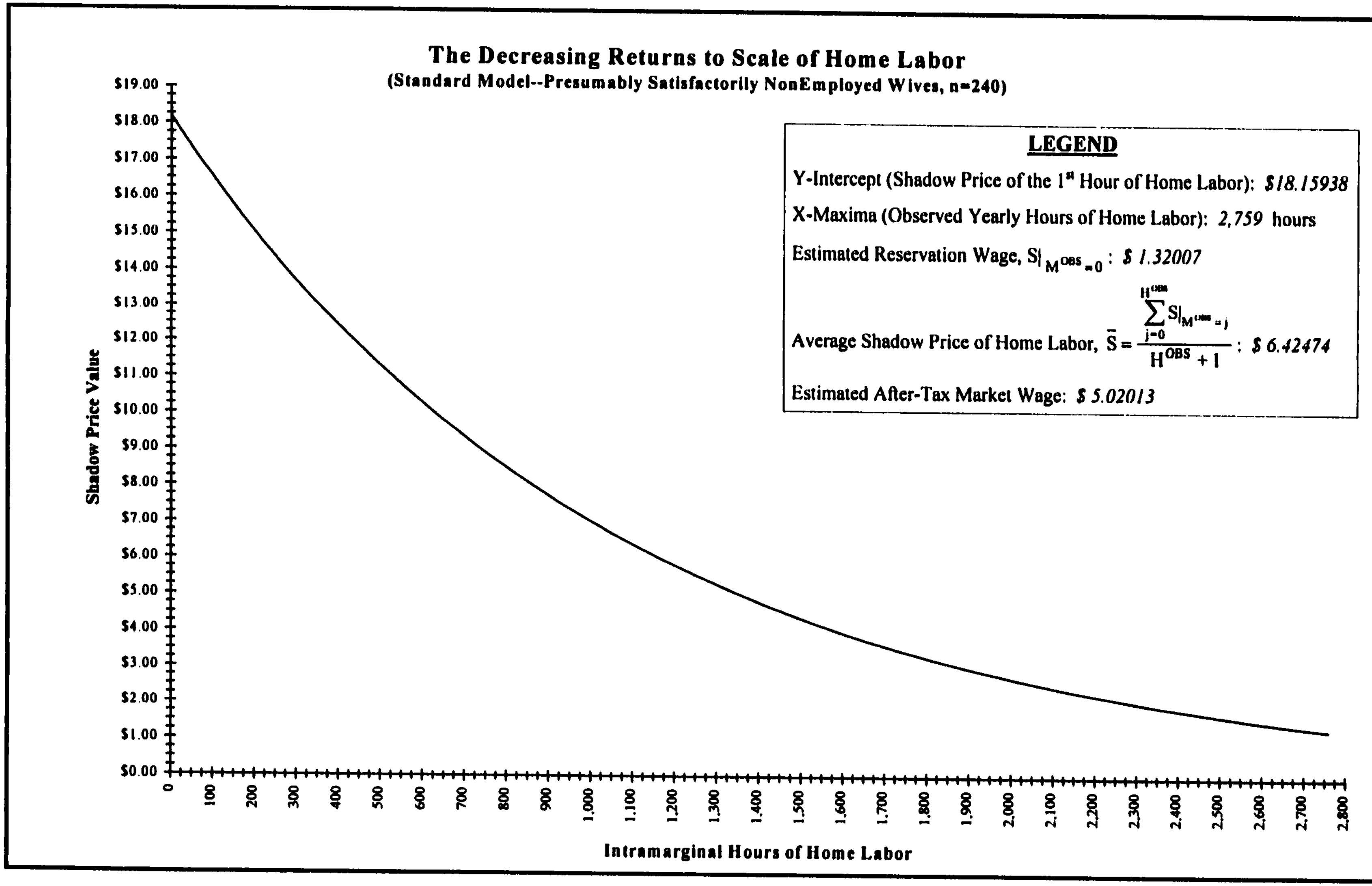

Figure 6.2 Illustration of the Decreasing Returns to Scale of Home Labor Time for the Subsample of Presumably Satisfactorily NonEmployed Missouri Wives (n=240), according to the Standard Specification of the Estimation Model

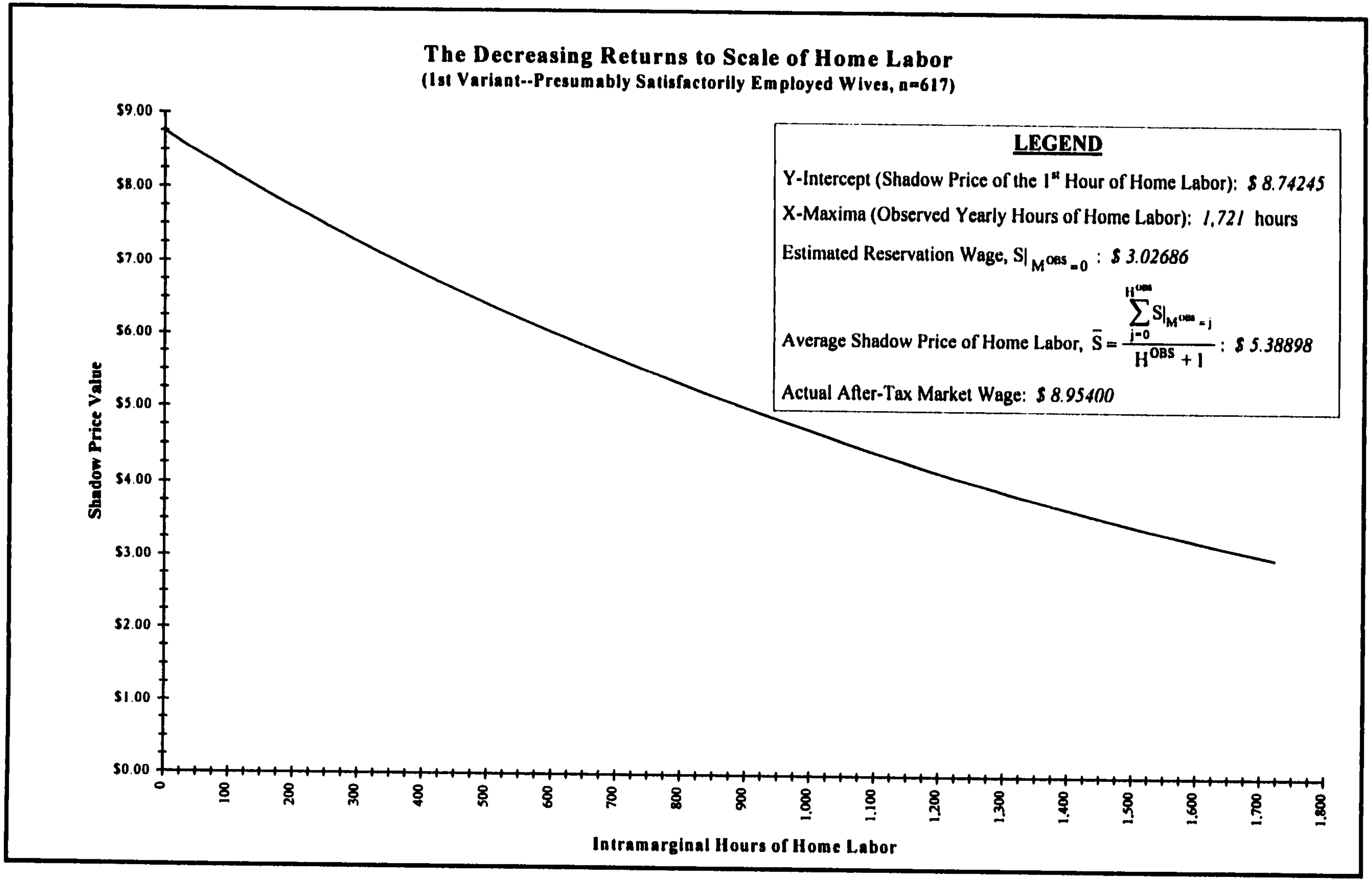

Figure 6.3 Illustration of the Decreasing Returns to Scale of Home Labor Time for the Subsample of Presumably Satisfactorily Employed Missouri Wives (n=617), according to the First Variant of the Standard Estimation Model

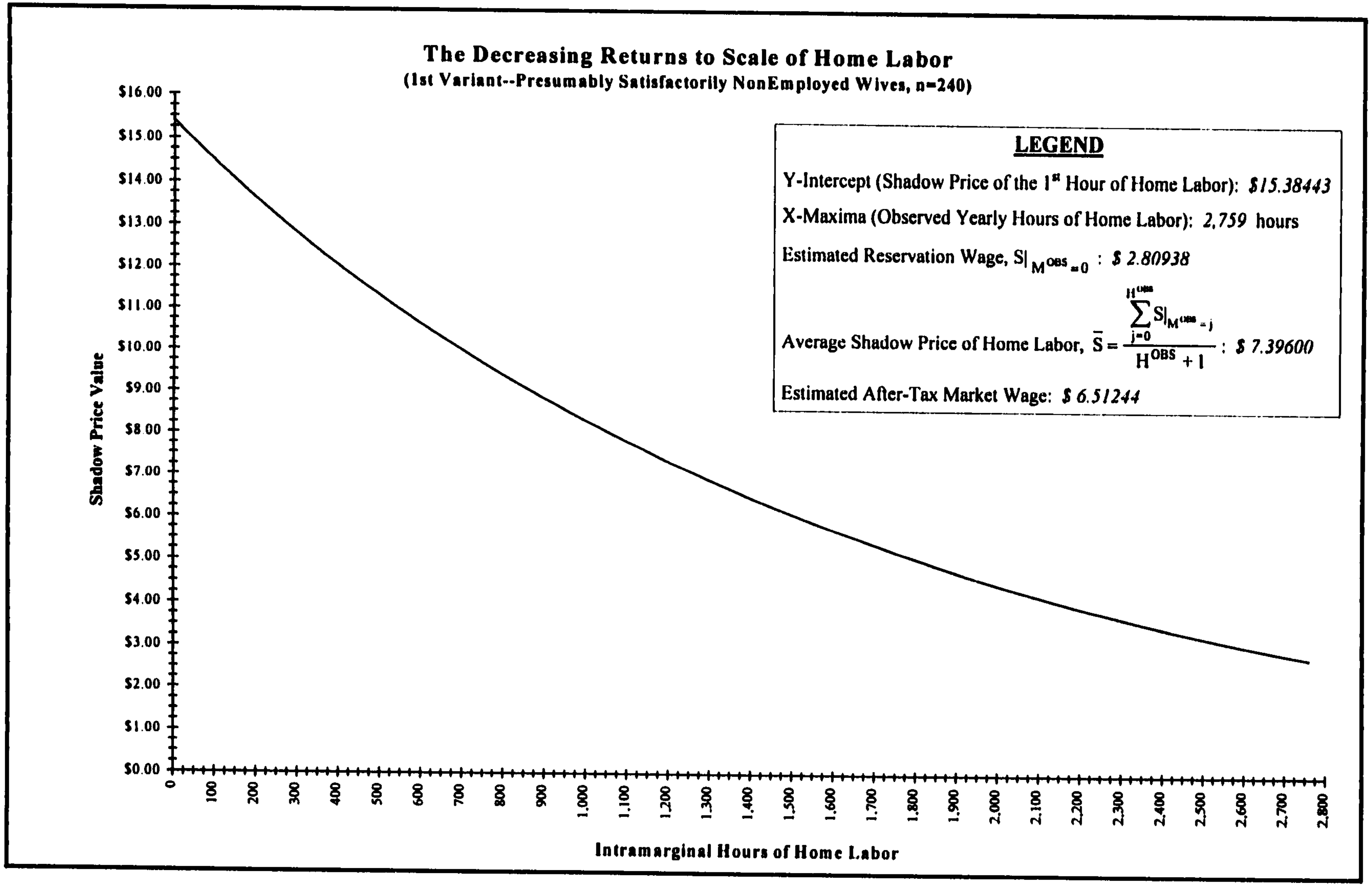

Figure 6.4 Illustration of the Decreasing Returns to Scale of Home Labor Time for the Subsample of Presumably Satisfactorily NonEmployed Missouri Wives (n=240), according to the First Variant of the Standard Estimation Model

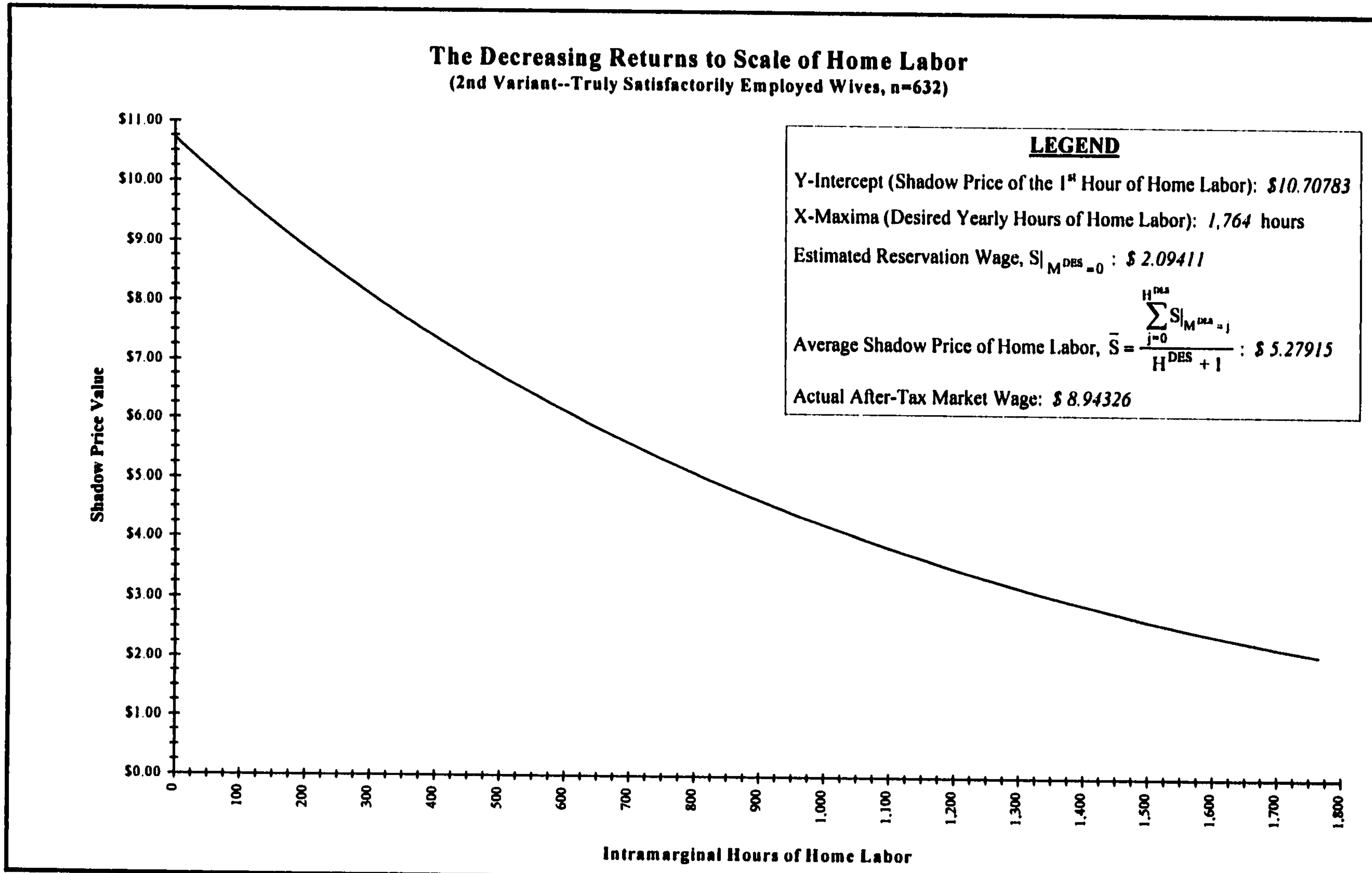

Figure 6.5 Illustration of the Decreasing Returns to Scale of Home Labor Time for the Subsample of Truly Satisfactorily Employed Missouri Wives (n=632), according to the Second Variant of the Standard Estimation Model

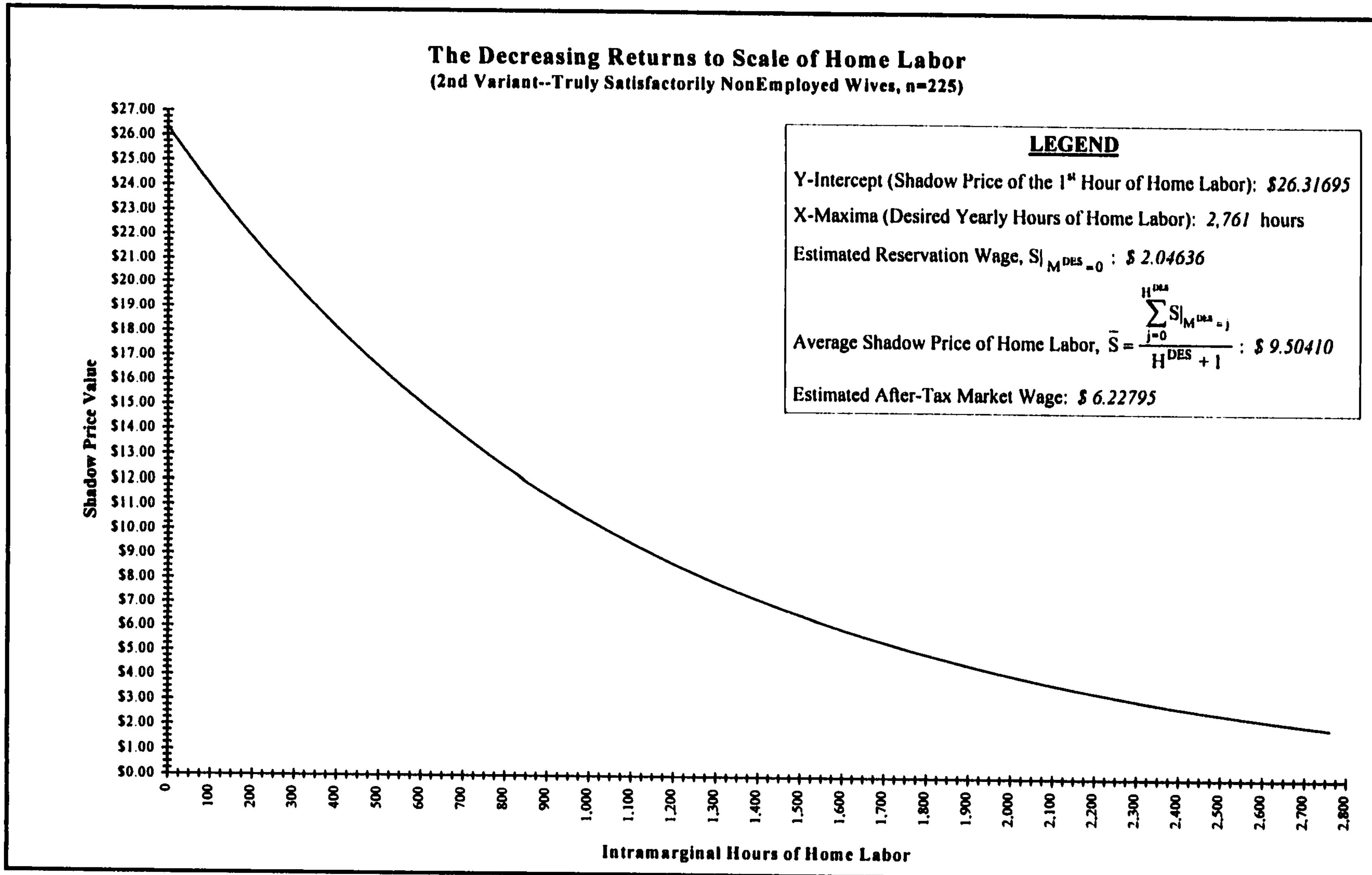

Figure 6.6 Illustration of the Decreasing Returns to Scale of Home Labor Time for the Subsample of Truly Satisfactorily NonEmployed Missouri Wives (n=225), according to the Second Variant of the Standard Estimation Model

Figure 6.1 shows the economic value of each hour of household production accomplished in the course of a typical year by the average presumably satisfactorily employed Missouri wife according to the standard version of the estimation model. These values were computed using the shadow price of home time function derived from the standard specification of the estimation model starting from a full home time allocation position (i.e. $M^{OBS} = 0$), and derogating from this full home time allocation position by adding increments of one hour of market work at a time until hours of paid market work perfectly match the observed number of hours the average employed wife devotes to home labor in a typical year (i.e. until $M^{OBS} = H^{OBS} = 1{,}721$). Doing so, 1,722 shadow price values (i.e. $H^{OBS} + 1$) were in fact calculated.

Looking at this figure from left to right, it is seen that the very first hour of home time devoted to household production activities in a typical year is worth $7.69531 to the average employed wife. Indeed, this is depicted by the value of the intercept on the vertical axis. As additional hours are put toward the production of household commodities, the monetary value of home labor declines at a decreasing rate until it reaches a minimum of $1.49987 for the last observed annual hour of home labor—that is, the monetary value which corresponds to the 1,721st hour of home time devoted to household production or, more specifically, the reservation wage of the average presumably satisfactorily employed wife. Obviously, household production time obeys the law of diminishing marginal returns to the average employed wife. Taking the sum of the shadow price values derived for each particular hour of home production, and dividing by 1,722 (i.e. by $H^{OBS} + 1$), it is found that the average shadow price of home labor time to the presumably satisfactorily employed wife is \$3.78919. Indeed, this average shadow price of home labor time is greater than the reservation wage value derived for this particular subsample of wives, but it is less than the actual after-tax market wage of \$8.95400 secured by the average employed Missouri wife.

Turning to the subsample of presumably satisfactorily nonemployed Missouri wives, Figure 6.2 illustrates the monetary value placed on each hour of household production accomplished during a typical year by the average nonemployed wife, based on the standard specification of the estimation model. As with the average employed wife, these values were calculated directly from the shadow price of home time function derived with the standard version of the recurrent estimation model, starting from a full home time-allocation equilibrium (i.e. $M^{OBS} = 0$), and adding increments of one hour of market work at a time until hours of market work coincide with the observed number of hours the average nonemployed wife devotes to home labor activities in a typical year (i.e. until $M^{OBS} = H^{OBS} = 2{,}759$). Accordingly, 2,760 shadow prices (i.e. $H^{OBS} + 1$) were computed.

Examination of Figure 6.2 shows that the first hour of household production in a typical year is valued at \$18.15938 by the average nonemployed wife. As hours of home labor increase, the economic value of this time declines at a decreasing rate until it achieves a minimum of \$1.32007 for the very last annual hour of home labor. As such, this lowest shadow price is the reservation wage of the average nonemployed wife according to the standard version of the estimation model, and corresponds to the economic value she places on her 2,759th hour of home labor. Taking the arithmetic mean of these 2,760 shadow prices, the average shadow price of household production time to the presumably satisfactorily nonemployed Missouri wives is found to be $6.42474. Obviously, this average shadow price is greater than her estimated reservation wage. Moreover, in contrast to the average shadow price of home labor computed for the subsample of employed wives, this average shadow price figure is also greater than the real market wage of $5.02013 the average housewife could normally secure in the labor market.

Performing similar analyses on the same subsamples of presumably satisfactorily employed and nonemployed wives, but using the shadow price of home time function derived from the first variant of the standard specification of the estimation model, Figures 6.3 and 6.4 illustrate the decreasing marginal returns to scale of home labor to the average employed and nonemployed wives, respectively.

Thus, looking to Figure 6.3, it is found that the first hour of household production in a typical year is valued at $8.74245 by the average employed Missouri wife. It is also seen that, as she allocates more and more hours to the production of home commodities, the monetary value of her home labor time falls at a decreasing rate until it attains a minimum of $3.02686 for her last annual hour of household labor. As such, this minimum is the reservation wage of the average employed wife according to the first variant of the standard model, and it denotes the economic value of the 1,721st hour of home labor to this average employed wife. Taking the mean of the 1,722 shadow price values which are portrayed in Figure 6.3, it is found that, based on the shadow price of home time function resulting from the first variant of the standard specification, the average shadow price of home time devoted to household production activities is \$5.38898 to the presumably satisfactorily employed wife. Consistent with the previous analysis performed on the same subsample of wives and using the shadow price of home time function derived from the standard formulation of the estimation model, while this average shadow price of home labor time is greater than the reservation wage derived for the average working wife, it is less than the real wage rate of \$8.95400 she actually commands in the paid labor market.

Figure 6.4 reveals that, to the average nonemployed Missouri wife presumed satisfied with her non-employment situation, the first hour of home time she devotes to household production activities in a typical year is worth \$15.38443. Yet, as she allocates additional hours toward the production of household goods and services the less productive, and thus valuable, becomes her time. Specifically, and as illustrated in Figure 6.4, to the nonemployed wife the economic value of household production time declines at a decreasing rate until it reaches a minimum of \$2.80938. Indeed, this minimum coincides with her very last annual hour of home labor—that is, her 2,759th hour—and denotes her reservation wage based on the first variant of the standard version of the estimation model. Taking the simple arithmetic mean of the 2,760 shadow price values delineated in Figure 6.4, it is found that, to the nonemployed Missouri wife, the average shadow price of home labor time is \$7.39600. Once again, as for the average shadow price derived from the standard version of the estimation model for the same subsample of nonemployed wives, it is seen that the average shadow price of time devoted to household production activities by the presumably satisfactorily nonemployed Missouri wife is not only greater than her reservation wage, but also greater than the potential market wage of \$6.51244 she could normally secure if she were to engage in paid market work.

Notice that, *under the assumption of no labor market constraints*, relative to the average shadow prices of home labor time derived from the standard version of the estimation model, those computed from the first variant of it are better estimates of the true average economic value employed and nonemployed Missouri wives place on their household production time. This is so because, as seen earlier, the additional regressors included in the first variant of the standard model (i.e. MLIM, SPMLIM, ATT2, SPATT2, HHTECH, and YADEQI) appreciably reduce the standard error of the estimates in the market wage and hours-of-work regressions. Indeed, by reducing the standard error of these regressions, it follows that the shadow price of home time function retrieved from these equations must provide for better (i.e. more consistent) estimates of the marginal value of household production time. Consequently, average shadow price values of household production time computed from the shadow price of home time function of the first variant of the standard estimation model must also be better estimates of the true average economic value of home labor time to the employed and nonemployed Missouri wives.

Utilizing the shadow price of home time function derived from the second and most refined variant of the standard specification of the estimation model—and thus, using desired annual hours of household production rather than observed hours as in the previous analyses based on the standard formulation of the estimation model and the first variant of it—Figures 6.5 and 6.6 illustrate the decreasing economic value of time allocated to home production activities for the subsamples of truly satisfactorily employed and nonemployed Missouri wives, respectively.

Examination of Figure 6.5 reveals that the first hour of home time allocated to the production of household goods and services is worth \$10.70783 to the average employed Missouri wife in her long-run (i.e. unconstrained) time-allocation equilibrium. Further, solving the shadow price of home time equation for each of the 1,764 subsequent hours of household work accomplished within a typical year by the average satisfactorily employed wife, it is seen that economic value of home labor falls at a decreasing rate until it reaches a minimum of \$2.09411 for the last desired hour of household production. To the average employed wife in her long-run time-allocation equilibrium, this minimum denotes the shadow value of her 1,764th hour of household production, and thus her reservation wage. Summing over the shadow price values derived for each particular hour of home labor, and dividing by 1,765 (i.e. H^{DES} + 1), the average shadow price of home labor time to the satisfactorily employed Missouri wife is found to be \$5.27915. Hence, to the truly satisfactorily employed wife in her long-run time-allocation equilibrium, the average shadow price of home labor is greater than her reservation wage, but yet less than the real market wage of \$8.94326 she secures in the labor force.

Now turning to Figure 6.6, it is seen that, to the average nonemployed Missouri wife in her long-run time-allocation equilibrium, the first hour of home labor accomplished in a typical year is valued at \$26.31695. Solving the shadow price of home time function for each of the 2,761 subsequent hours of home labor accomplished by the unconstrained housewife within a typical year, Figure 6.6 shows that the economic value of household production time declines at a decreasing rate until it finally attains a minimum of \$2.04636 for the last desired hour of home production. As such, this minimum denotes the reservation wage of the average sampled housewife in her long-run utility-maximizing equilibrium, and is the shadow price of her 2,761st hour of household labor. Taking the sum of the shadow price values derived for each hour of home labor accomplished within a year, and dividing by 2,762 (i.e. $H^{DES} + 1$), it is found that the average shadow price of household production time to the unconstrained housewife is \$9.50410. Therefore, it follows that, to the truly satisfactorily nonemployed wife, the average economic value of her household production time is not only greater than her reservation wage, but also it is greater than the net rate of pay of \$6.22795 she could potentially command in the paid labor force. Indeed, this result is fully consistent with those obtained from the previous analyses based on the shadow price of home time functions derived from the standard specification of the estimation model and the first variant of it.

As pointed out earlier, under the assumption of perfectly continuous budget lines (i.e. the standard assumption of no institutional labor market constraints), relative to the average shadow prices of home production time derived from the standard specification of the estimation model, those derived from the first variant of the standard specification are believed to better reflect the true average economic value of home labor time to employed and nonemployed Missouri wives. Yet, it is obvious that, once institutional labor market constraints are identified and appropriately controlled for in the formulation of the estimation model, average shadow prices of home labor time based on the results of such a more refined estimation model must necessarily be better estimates of the true average values of home production time to truly unconstrained employed and nonemployed wives. In due course, relative to the average shadow price figures obtained from the first variant of the standard version of the model, average shadow prices of home labor time computed from the shadow price function derived from the second variant of the standard specification of the estimation model are better estimates of the authentic average economic value employed and nonemployed Missouri wives place on their household production time.

Worth reporting is the fact that, regardless which specification of the estimation model is utilized to compute average shadow price values of home labor time, the average shadow price measure for the time devoted to household production activities by the employed wife is consistently above her estimated reservation wage, whereas it is always below her actual (after-tax) market wage. In contrast, while the average shadow price of home production time to the nonemployed wife is also always above her estimated reservation wage, it is consistently above her potential market wage as well.

Clearly, these results substantiate the fact that home production functions are not linearly homogeneous in time input as implicitly assumed in the standard application of the opportunity cost of time approach. Specifically, and as portrayed in Figures 6.1 through 6.6, home labor time is of decreasing returns to scale (i.e. DRS), and hence of decreasing marginal economic value to the individual. That home labor time obeys the law of diminishing marginal returns implies that the last hour of home production accomplished by any individual will always be the *least* valuable hour of home labor to that person.

Beyond doubt, since the reservation wage only provides for an opportunity cost measure of the last hour of household production time at full home time (i.e. when $M_i = 0$), it is obvious that taking the reservation wage of the nonemployed individual as the opportunity cost value for all her/his hours of household production seriously underestimates the true value of this time to that individual. Under these circumstances, that the average shadow price of home labor time to the nonemployed wife is substantially higher than her estimated reservation wage should not be surprising at all. In fact, the analyses performed on the nonemployed Missouri wives indicate that taking the reservation wage as the opportunity cost measure of home labor time to the nonemployed wife understates the true value of this time by as much as 79% when the standard specification of the estimation is used, 62% when the first variant of it is used, and 78% when the second and most refined variant of it is utilized. Unquestionably, the standard implicit assumption of linearly homogeneous home production functions leads to enormous biases in the opportunity cost measures one might derive for the time nonemployed individuals devote to home production activities.

In another order of ideas, recall that, incongruent with standard economic theory, it was found earlier that the estimated reservation wage of the average nonemployed wife was below the estimated market wage she could potentially secure in the paid labor force regardless which version of the estimation model was used to derive market and reservation wage figures. In the face of such a troubling outcome, it was pointed out that this anomalous result could possibly be caused by the requirement imposed on the market wage concept within the recurrent estimation model. Specifically, it was noted that, because the market wage is required to be invariant to hours of market work at the estimation level, it could hardly be contrasted to the estimated reservation wage to justify (or predict) the extensive margin of the labor supply decision. Here the rationale was that the monetary value of the last hour of home time devoted to household production activities to the nonemployed individual (i.e. her/his reservation wage) is very likely to be substantially lower than a market wage which purports to reflect the *average* monetary value of the individual's decreasing marginal productivity over some lengthy periods of time devoted to paid market employment. Accordingly, based on this rationale, it would be natural that the estimated reservation wage of the nonemployed person be less than the wage she/he may potentially secure in the labor market. Yet, if the market wage the nonemployed person may potentially secure in the labor force represents an average monetary value for the decreasing returns to scale of her/his market time input, then it would be reasonable to believe that his/her reluctance to participate in the paid labor market might simply be explained by the greater average monetary value she/he places on her/his home labor time. Interestingly enough, this seems to be the case with nonemployed Missouri wives. In fact, no matter which specification of the estimation is used, the previous analyses reveal that the average shadow price the nonemployed wife places on her home labor time exceeds the wage rate she can potentially secure in the labor force.

To the employed individual, the standard opportunity cost measure for her/his home labor time is not her/his reservation wage, but her/his actual market wage. Theoretically, in her/his long-run time-allocation equilibrium, the net market wage of the employed individual should be at least equal to the shadow price of her/his *last* hour of household production. Hence, inasmuch as home production functions are of decreasing returns to scale in labor time input, it follows that taking the market wage of the employed person as the opportunity cost measure for all the hours she/he devotes to household production activities should understate the true economic value of this time to the employed individual. Yet, the results of the previous analyses show the opposite. Specifically, it is found that the average shadow price of home labor to the employed Missouri wife is substantially lower than the real market wage she/he actually secures in the labor force. For instance, when the shadow price of home time function derived from the standard specification of the estimation model is used the compute the average shadow value of the time the employed wife devotes to household production activities, it is found that her actual after-tax market wage overestimates the average shadow price of her home labor time by as much as 136%. Likewise, using the shadow price of home time function obtained from the first variant of the standard specification, it is found that the actual market wage of the employed wife overstates the average monetary value she places on her home production time by 66%, whereas the results from the second and most refined variant of the standard specification of the estimation model reveal that her market wage overstates the average shadow price of her home labor time by 69%. Consequently, what these results suggest is simply the fact that, to the employed wife in her long-run time-allocation equilibrium, the average monetary value she places on her home labor time is less than the average monetary value of her time devoted to the paid labor market.

In due course, inasmuch as the average shadow price of home labor time denotes the average economic value of household production time as perceived by the individual, it is strongly argued that it is a more sensible opportunity cost measure for the time devoted to household production activities, regardless whether the individual is employed in the market or not. Indeed, at a conceptual level, the use of the average shadow price of home labor time as an opportunity cost measure for the time devoted to household production activities represents an important extension of the opportunity cost approach to assessing the economic value of household production time.

The Annual Value of Missouri Wives' Household Production Time

In the last section of this chapter, the annual monetary value of household production time for the subsamples of employed and nonemployed Missouri wives is derived using the different opportunity cost measures obtained from each of the three particular specifications of the estimation model utilized in this study. Specifically, the after-tax market wage, the estimated reservation wage, and the average shadow price of home labor time are used alternatively to calculate the yearly monetary value of the time allocated by employed and nonemployed sampled Missouri wives to household production processes. The resulting figures from this last analysis are presented in Table 6.19 which follows.

Table 6.19 The Annual Value of Household Production Time for the Sampled Missouri Wives using Three Different Opportunity Cost Measures Derived from the Standard Specification of the Estimation Model and the Two Particular Variants of it

Standard Specification of the Estimation Model

Particular Subsample of Wives	Observed Hours of Home Labor (H^{OBS})[a]	After-Tax Market Wage (W)	Value of H^{OBS} using W	Reservation Wage ($S\|_{M^{OBS}=0}$)	Value of H^{OBS} using $S\|_{M^{OBS}=0}$	Average Shadow Price of H^{OBS} ($\bar{S}$)[b]	Value of H^{OBS} using $\bar{S}$
Presumably Satisfactorily Employed Wives (n=617)	1,721	$ 8.95400	$15,409.83	$ 1.49987	$ 2,581.28	$ 3.78919	$ 6,521.20
Presumably Satisfactorily NonEmployed Wives (n=240)	2,759	$ 5.02013	$13,850.54	$ 1.32007	$ 3,642.07	$ 6.42474	$17,725.86

First Variant of the Standard Specification

Particular Subsample of Wives	Observed Hours of Home Labor (H^{OBS})[a]	After-Tax Market Wage (W)	Value of H^{OBS} using W	Reservation Wage ($S\|_{M^{OBS}=0}$)	Value of H^{OBS} using $S\|_{M^{OBS}=0}$	Average Shadow Price of H^{OBS} ($\bar{S}$)[b]	Value of H^{OBS} using $\bar{S}$
Presumably Satisfactorily Employed Wives (n=617)	1,721	$ 8.95400	$15,409.83	$ 3.02686	$ 5,209.23	$ 5.38898	$ 9,274.43
Presumably Satisfactorily NonEmployed Wives (n=240)	2,759	$ 6.51244	$17,967.82	$ 2.80938	$ 7,751.08	$ 7.39600	$20,405.56

Table 6.19 (continued)

Second Variant of the Standard Specification

Particular Subsample of Wives	Desired Hours of Home Labor (H^{DES})[c]	After-Tax Market Wage (W)	Value of H^{DES} using W	Reservation Wage ($S\|_{M^{DES}=0}$)	Value of H^{DES} using $S\|_{M^{DES}=0}$	Average Shadow Price of H^{DES} ($\bar{S}$)[d]	Value of H^{DES} using $\bar{S}$
Truly Satisfactorily Employed Wives (n=632)	1,764	$ 8.94326	$15,775.91	$ 2.09411	$ 3,694.01	$ 5.27915	$ 9,312.42
Truly Satisfactorily NonEmployed Wives (n=225)	2,761	$ 6.22795	$17,195.37	$ 2.04636	$ 5,650.00	$ 9.50410	$26,240.82

[a] For the Standard Specification of the estimation model and the First Variant of it, *observed* (i.e. reported) hours of home labor per year, H^{OBS}, were used to derive the annual monetary values of household production time. H^{OBS} were rounded for the computations.

[b] For the Standard Specification of the estimation model and the First Variant of it, Average Shadow Prices of Home Labor were computed using the following

simple formula: $\bar{S} = \dfrac{\sum_{j=0}^{H^{OBS}} S|_{M^{OBS}=j}}{H^{OBS}+1}$.

[c] For the Second Variant of the Standard Specification of the estimation model, *desired* annual hours of home labor, H^{DES}, were estimated from the subsample of employed wives identified as *satisfactorily employed* prior to the control of labor market constraints (n=196). H^{DES} were rounded for the computations.

[d] For the Second Variant of the Standard Specification of the estimation model, Average Shadow Prices of Home Labor were computed using the following

simple formula: $\bar{S} = \dfrac{\sum_{j=0}^{H^{DES}} S|_{M^{DES}=j}}{H^{DES}+1}$.

Examination of Table 6.19 shows that, according to the standard specification of the recurrent estimation model, the annual monetary value of home production time for the typical employed Missouri wife is $15,409.83 when her after-tax market wage is used to price this time. If her reservation wage were to be used as the opportunity cost measure, then the annual monetary value of her home labor time would only be $2,581.28. Indeed, using the reservation wage of the employed wife as the monetary value for all her hours of home labor would understate the true economic value of this time since this opportunity cost measure is only valid for her last annual hour of home labor at full non-market time (i.e. at $M^{OBS} = 0$). Yet, another problem also arises with the use of the market wage as the opportunity cost measure for her household production time. Specifically, the market wage of the employed wife denotes the average hourly value of her market production time, and not the average hourly value of her home production time. Accordingly, when the average shadow price of her home labor time is computed and used as the opportunity cost measure, it is found that the annual value of household production time to the employed Missouri wife is $6,521.20. Indeed, inasmuch as this last figure is derived from an opportunity cost measure which gives the *average* hourly value of the time she allocates to the production of household commodities, it follows that this figure must be a more valid estimate of the true annual value of home labor time to the employed Missouri wife.

For the average nonemployed Missouri wife, Table 6.19 indicates that, based on the standard version of the estimation model, the annual monetary value of her household production time would be $13,850.54 if her potential market wage were used to price this time. Yet, according to economic theory, the opportunity cost measure of home labor time to the nonemployed individual is her/his reservation wage, not her/his market wage. Hence, using the estimated reservation wage of the nonemployed Missouri wife, the annual monetary value of her home labor time is found to be $3,642.07. An obvious problem with the use of the reservation wage as the opportunity cost measure of home production time for the nonemployed wife is that it only provides for the monetary value of her last annual hour of home labor. In fact, because home production functions are of decreasing returns to scale, it is clear that using the reservation wage of the nonemployed wife as representing the opportunity cost value for all her hours of household production would necessarily understate the true economic value of this time. In due course, when the average shadow price of her home labor time is computed and utilized as the opportunity cost measure, it is found that the annual value of her household production time is $17,725.86. Since this last figure is derived from an opportunity cost measure which gives the *average* hourly value of the time she allocates to the production of household commodities—rather than the marginal value given by her reservation wage—it must be the case that this figure is a more sensible estimate of the true annual value of household production time to the nonemployed Missouri wife.

Turning to the estimates computed from the first variant of the standard specification, Table 6.19 reveals that the annual monetary value of home production time for the average employed Missouri wife is $15,409.83 when her actual after-tax market wage is used as the opportunity cost measure for this time, whereas it is $5,209.23 when her estimated reservation wage is used, and $9,274.43 when the average shadow price of her home labor time is utilized to assess the value this time. In contrast, for the average nonemployed Missouri wife, the annual value of household production time is $17,967.82 when her potential market wage is used as the opportunity cost measure for this time, whereas it is $7,751.08 when her reservation wage is used, and $20,405.56 when the average shadow price of her home labor time is utilized.

As with the standard formulation of the estimation model, it is suggested here that the figures computed using the average shadow price of home labor time are better estimates of the true annual monetary value of household production time than those derived using the standard opportunity cost measures. More specifically, since the average shadow price of home labor reflects the average economic value of home production time to the employed wife, whereas her market wage denotes the average economic value of her market time, it must be the case that the annual value of home production time computed utilizing the average shadow price of her home labor time is more appropriate than the annual value computed using her after-tax market wage. Likewise, because the average shadow price of home labor gives the average economic value of home production time to the nonemployed wife, whereas her reservation wage can only be used to price her last annual hour of home labor, it must be the case that the annual value of household production time computed with the average shadow price of her home labor time is a more sensible figure than the annual value computed with her reservation wage.

Finally, based on the second and most refined variant of the standard specification of the estimation model, Table 6.19 shows that, for the average satisfactorily employed Missouri wife in her long-run time-allocation equilibrium, the annual value of her home production time is $15,775.91 when her market wage is used as the opportunity cost measure for this time, whereas it is $3,694.01 when her reservation wage is used, and $9,312.42 when the average shadow price of her home labor time is used. In contrast, for the average satisfactorily nonemployed wife, the annual monetary value of her home production time is $17,195.37 when her potential market wage is used as the opportunity cost measure for this time, $5,650.00 when her reservation wage is used, and $26,240.82 when the average shadow price of her home labor time is utilized to assess the economic value of this time.

Like the figures previously derived from the standard specification of the estimation model and the first variant of it, the annual monetary values of household production time computed using the average shadow price of home labor time must be closer to reality than the figures computed with the standard opportunity cost measures. This is so because, to the satisfactorily employed wife, the average shadow price of her home labor time represents the average economic value she places on this time, whereas her market wage reflects the average economic value of the time she devotes to paid market employment. Similarly, inasmuch as, to the satisfactorily nonemployed wife, the average shadow price of home labor time reflects the average monetary value of her household labor time, whereas her reservation wage is only a valid opportunity cost measure for her last annual hour of household production, it is evident that the annual value of home production time computed using the average shadow price of her home labor time is a better estimate of the true monetary value of this time to the satisfactorily nonemployed wife than the annual value computed using her reservation wage.

CHAPTER 7

SUMMARY, LIMITATIONS, AND RECOMMENDATIONS

For many years home and family economists have been grappling with the issue of how to accurately assign a monetary value to the time devoted to household production activities. Although a variety of techniques have evolved to meet this end, one particular approach, notably, the opportunity cost of time approach, has been growing in popularity since the mid-1980s. Based on the precept that the cost of any choice made by the household should be valued in terms of its best—most valuable—forgone alternative, and that household members allocate their time across all competing activities so as to equate their productivity in each activity at the margin, this approach has been particularly appealing to researchers interested in deriving the economic value of home labor time from a household perspective. However, while appealing on theoretical grounds, many researchers have rightfully criticized certain oversimplifying premises upon which this approach is based.

Addressing important conceptual and empirical problems associated with the standard opportunity cost approach to assessing the economic value of household production time, this study used the fundamentals of time-allocation theory (Becker, 1965) in conjunction with the two-stage recurrent estimation model proposed by Heckman (1976) to develop and test practical solutions that enable derivation of opportunity cost measures which provide for a more valid assessment of the authentic value of this time from an individual (i.e. household) perspective.

Specifically, the usual assumption of perfectly continuous budget lines (i.e. the assumption that individuals are fully free to allocate as much or as little of their time to both market and home activities—or, more precisely, that there are no institutional labor market constraints affecting their time-allocation behavior), and the implicit assumption of linearly homogeneous (i.e. CRS) home production functions, which characterize the standard application of the opportunity cost methodology to valuing home production time, are shown to be incongruent with reality, and thus to introduce important biases in opportunity cost measures derived under such assumptions. Consequently, in an effort to reconcile the opportunity cost methodology with reality, and hence alleviate the biases resulting from such unrealistic assumptions, simple conceptual refinements are suggested, implemented, and empirically tested in this study.

As such, inasmuch as it guarantees that all sampled individuals are analyzed in their long-run time-allocation equilibria, the use of desired (i.e. truly unconstrained) rather than observed (i.e. potentially constrained) labor supply behavior in the formulation of Heckman's two-stage recurrent estimation model is proposed as an efficient solution to control for the adverse effects of labor market constraints on the opportunity cost measures derived for the valuation of home labor time. Likewise, utilizing the full flexibility of the recurrent estimation model, a simple procedure is developed for the derivation of an *average* shadow price of home labor time that provides for an opportunity cost measure which, in contrast to standard measures such as market and reservation wages, fully accounts for the decreasing returns to scale of home production time. Also, aside from the conceptual refinements introduced in this study, it is empirically demonstrated that Heckman's correction procedure for sample selection bias—which procedure is normally needed to ensure consistent estimates of opportunity cost measures from the recurrent system of equations for individuals who do not participate in paid market employment—may not be required when certain important non-standard labor supply regressors are incorporated along with the standard regressors commonly considered by home and family economists in the econometric formulation of the recurrent estimation model.

Essentially, using a random sample of 857 Missouri wives surveyed in the Summer of 1996, three different versions of the general econometric model developed by Heckman (1976) were utilized and compared in terms of their estimation results in this study. While the first version of the estimation model only reiterated the usual and currently standard specification of the recurrent system of equations used by home and family economists to derive opportunity cost measures for home labor time, the two other formulations of the model improved on this standard version by refining its econometric specification. For instance, the first variant of the standard specification of the model included additional regressors generally missing from the usual specification, but believed to be of significant consequences in the determination of opportunity cost measures—particularly in the determination of reservation wages—as well as on the very issue of sample selection bias. These new regressors considered in the first variant of the standard specification were the wife's gender-role attitudinal orientation with respect to what she views as the proper role of women in the family and in society, her husband's attitude on the very same gender-role construct, her state of health, her husband's state of health, an index denoting her view vis-à-vis the adequacy of her available home technology, and an index denoting her perception with respect to the adequacy of her household's overall income. In addition to these new and presumably important regressors, the second variant of the standard specification was further refined by replacing the wives' observed labor supply behavior with their desired (i.e. truly unconstrained) behavior to control for labor market constraints which, from the economic theory of time allocation, are known to generate biases in the estimated opportunity cost measures of household production time—notably in reservation wages.

In order to assess the impact of these refinements, the goodness of fit of each particular specification of the estimation model was investigated. Particularly, while distinct pseudo R-square statistics were calculated and used to evaluate the discriminatory power of the first stage Probit analysis of the wives' labor-force participation behavior, the adjusted R-square and standard error of the estimates were both utilized to gauge the explanatory strength of the second stage OLS analysis of the offered wage and hours of market work regressions. Also, reservation and market wages as standard opportunity cost measures for home production time were derived from each particular specification of the recurrent model, for both employed and nonemployed Missouri wives. While comparisons between the figures obtained from the standard formulation of the model and the first variant of it permitted to assess the biases resulting from the omission of important labor supply determinants in the recurrent system of equations used to derive the standard opportunity measures, direct comparisons between the figures obtained from the first variant of the standard specification and the second variant of it enabled evaluation of the biases due to institutional labor market restraints in the opportunity cost of time estimates. Moreover, for both employed and nonemployed wives, 'average' shadow prices of household production time were computed from each particular specification of the recurrent estimation model, and contrasted to the reservation and market wage figures in order to assess the biases introduced by the standard implicit assumption of linearly homogeneous (i.e. CRS) home production functions.

Summary of the Results

The results obtained from the standard version of the estimation model revealed that the personal and socio-demographic characteristics usually considered by home and family economists in specifying the recurrent system of equations used to derive the value of home production time do not enable consistently distinguishing employed from nonemployed wives. Not surprisingly, lambda, the sample-selection correction variable derived from the labor-force participation Probit analysis, was found statistically significant in the OLS market wage regression based on the standard specification. That the coefficient of lambda was statistically different from zero indicates that important differences in the personal characteristics of working and non-working sampled wives were simply not captured by the regressors commonly utilized to specify the recurrent estimation model. In fact, the explanatory power of the labor-force participation Probit regression based on the standard regressors was fairly weak. For instance, using the residual sum of squares between actual and predicted labor force participation of the 857 sampled wives, Efron's pseudo R-square statistic indicated that merely 30% of the variance in the Probit model was explained by the standard set of regressors. Based on the Probit likelihood ratio, McFadden's and Cragg-Uhler's measures of fit—0.2645 and 0.3876, respectively—also corroborated that important labor supply determinants were missing from the standard specification of the model. Thus, according to the most optimistic pseudo R-square statistic, at least 61% of the variation in the labor-force participation Probit model was not explained by the standard regressors.

Given the weakness of the standard regressors to adequately distinguish between working and non-working wives—and thus, to accurately explain the censoring of the sample—it can be said that the inclusion of the sample-selection correction instrument, lambda, in the wage and hours-of-work regressions seems necessary when the recurrent estimation model is specified with the standard set of regressors. In fact, lambda is needed to capture important omitted labor supply determinants which, if included in the recurrent system of equations, would make it possible to distinguish the wives who choose to work in the market from those who do not. In other words, without the correction for sample selection bias, the results obtained from the standard formulation of the recurrent estimation model would only be valid for the subsample of employed wives inasmuch as nonemployed wives have personal and socio-demographic characteristics which differ in ways that are obviously not captured by the standard set of regressors. Of course, this is not to say that the standard regressors do not capture anything at all in terms of existing important differences which distinguish employed from nonemployed wives, but only that these standard regressors do not capture enough of these important differences to consistently predict the labor-force participation status of the sampled wives.

As such, among the standard characteristics considered in the labor-force participation Probit analysis, the results of this study indicates that, consistent with similar analyses, the likelihood of market participation for the sampled wives was significantly reduced by the presence of preschool children and children between six and 16 years of age in the home. Everything else equal, the presence of teenagers and young adult children in the household was found to have the opposite significant effect. Wives with spouses commanding higher wages from market employment were also found significantly less likely to engage in paid market work, ceteris paribus. Likewise, wives living in households with higher unearned income were significantly less likely to be working in the market. Compared to the wives without a high school diploma, those with a graduate or professional college degree were significantly more likely to engage in market employment, ceteris paribus. Similarly, wives with more market work experience were also found significantly more likely to be observed participating in the labor force.

Indeed, these results are indicative that some of the important distinguishing characteristics between working and non-working wives were effectively captured by certain regressors included in the standard model. Nonetheless, that lambda was statistically significant in the OLS wage regression implies that, as a whole, the set of standard regressors does not capture sufficient important differences between employed and nonemployed wives to adequately explain the censoring of the sample. In due course, because the recurrent system of equations is estimated on the characteristics of employed wives, without the inclusion of lambda in the wage and hours of market work equations used to derive the shadow price of home time function, generalization of the estimation results to nonemployed wives would not be sensible, else any opportunity cost measure derived for these housewives would be plagued by sample selection bias.

Aside from lambda which was significant in the OLS market wage regression, the results from the standard estimation model reveal that the stock of human capital embodied in a wife significantly affects the hourly wage rate commanded in the labor market. In fact, relative to the employed wives without a high school diploma, those with a technical school diploma, an undergraduate college degree, or a graduate or professional college degree, were found to secure significantly higher wages from market employment. Likewise, working wives with extra-curricular credentials (e.g. special licenses or certifications) were found to obtain significantly higher wages, ceteris paribus. Other factors constant, the wives with more work experience were found to earn significantly more from paid employment than those with less experience. The last standard regressor found to significantly affect the wives' market wages was the population size in the county of residence. As such, regression of the market wage on the standard characteristics of the employed wives indicated that those living in more highly populated counties were commanding higher wages than those residing in less populated counties, ceteris paribus.

Only two standard regressors were statistically significant in the OLS annual hours of market work regression. Specifically, relative to the wives who had not graduated from high school, those with a technical school diploma were found devoting significantly fewer hours per year to labor market activities, ceteris paribus. Conversely, everything else constant, the wives with more market work experience were found to supply significantly more hours to paid employment. In contrast to the estimation results obtained from the market wage regression, lambda was not found statistically significant in the hours-of-work regression based on the standard set of regressors, a result consistent with many similar analyses[1].

Based on the standard personal and socio-demographic characteristics of the sampled wives participating in the labor market, the adjusted R-squares for the sample-selection-corrected wage and hours of market work regressions were 0.3365 and 0.2319, respectively, and the standard errors of the estimates corrected for selection bias were assessed at 0.3854 in the estimated log of the market wage, and 533.0005 in the estimated annual hours of market work.

Using the coefficient on work experience in the sample-selection-corrected market wage and hours-of-work regressions to identify the coefficient on hours of market work in the shadow price of home time function, the coefficients of this latter function were solved following the usual procedure. Except for two characteristics found to derogate from theoretical expectations, all other standard personal and socio-demographic variables considered in the shadow price of home time function were found to align with expectations. Specifically, it was found that the economic value sampled wives place on their home time was increasing at a declining rate with their age. Also, the shadow value

[1] Review of previous work (e.g. Gronau, 1974; Ferber & Green, 1985; Puang & Metzen, 1993) suggests that sample selection bias is an important problem particularly in estimating the wage functions of married females, but not in estimating their labor supply functions.

of home time to the wives was found to be an increasing function of their human capital. As such, other factors constant, relative to the wives without a high school diploma, those with a high school diploma, a technical school diploma, an undergraduate college degree, or a graduate or professional college degree, were all found to place a greater value on home time. Likewise, wives with extra-curricular credentials were found to confer a greater value to this time as well. Ceteris paribus, the same was also found to be true for Caucasian wives relative to those of other racial designations. While the wives residing in more populated counties were found to place a greater value on home time, those living in counties with higher levels of unemployment seemed to assign a lower economic value to this time. So far as the composition of the household is concerned, wives with preschool children and/or children between six and 16 years of age were found to place a greater economic value on their non-market time. In contrast, adult relatives and friends permanently living in the household were found to have the opposite effect on the wives' shadow value of home time, ceteris paribus. Other factors constant, the wives who reported having been married for longer periods of time were found to assign a lower value to home time. In contrast, home ownership was found to increase the shadow price of home time, ceteris paribus. Similarly, the larger the home—as proxied by its number of bedrooms—the greater was found the wives' shadow value of non-market time. Likewise, the larger the size of the household's yard, the greater the economic value assigned to home time, ceteris paribus. Everything else fixed, sampled wives with husbands commanding higher wages from market employment were found to place a greater economic value on their non-market time. Moreover, hours of market work were found to be positively associated with the wives' shadow price of home time. The two characteristics found inconsistent with expectations were the number of young adult children (i.e. children of age 16 and over) living in the home and the unearned income of the household. In fact, while a negative relationship was expected between the presence of young adult children and the wives' shadow price of home time, the opposite relationship was found. In contrast, while a positive association was posited between the unearned income of the household and the shadow price of non-market time, the converse relationship was shown to prevail.

Based on the standard specification of the model, the reservation wages of the average employed and nonemployed sampled wives were estimated at \$1.50 and \$1.32, respectively. In contrast, the actual (i.e. prevailing) market wage of the average employed wife was \$8.95, whereas the potential market wage of the average nonemployed wife was estimated at \$5.02.

Turning to the results obtained from the first variant of the standard model, this study clearly shows that the addition of non-standard regressors such as the wife's gender-role attitude, her husband's gender-role attitude, her state of health, her husband's state of health, her home technology, and her perceived household's overall income adequacy, to the set of standard regressors importantly contributes to distinguish employed from nonemployed wives. In fact, when these characteristics were included along with the standard regressors in the recurrent system of equations, the explanatory power of the labor-force participation Probit analysis improved considerably. While an increase of nearly 45% was recorded in explanatory power of the Probit regression according to

Efron's goodness-of-fit statistic, increases in the order of 39% and as much as 50% were found according to Cragg-Uhler's and McFadden's pseudo R-square statistics.

Among the new characteristics considered in the labor-force participation Probit analysis, only the wife's gender-role attitude and state of health were found significantly related to the likelihood of labor market participation, though. Everything else equal, it was found that the sampled wives with a more traditional gender-role attitude were significantly less likely to be observed participating in market work activities. Likewise, the wives with poorer health were also found significantly less likely to engage in paid employment, ceteris paribus. Hence, under these circumstances, it can be said that these two particular non-standard regressors are very likely to have accounted for most of the increase in the explanatory power of the labor-force participation Probit regression.

Obviously, the wife's state of health and gender-role attitude are characteristics that enable capturing important differences between working and non-working wives, which differences are simply not captured when the recurrent estimation model is specified strictly in terms of the standard regressors. Of course, by raising the explanatory power of the Probit analysis, the 'chances' that lambda be found statistically significant in the OLS market wage and hours-of-work regressions must necessarily diminish. This was in fact confirmed by the results of the first variant of the standard model. As such, lambda—the sample-selection correction instrument—which was statistically significant in the wage regression of the standard version of the model, ceased to be significant once the non-standard characteristics were incorporated in the recurrent system of equations.

That it ceased to be significant once the non-standard characteristics were included in the model implies that, as a whole, the combined set of standard and non-standard characteristics permitted elucidation of enough important differences to adequately distinguish working from non-working wives, and to ensure that, even without Heckman's correction for sample selection bias, consistent estimates would be achieved by the improved specification. As such, this suggests that the estimated wage and hours of market work functions, as well as the shadow price of home time equation retrieved from these functions, could be generalized to nonemployed wives regardless whether lambda is used to instrument the recurrent system of equations or not.

For the first variant of the standard specification, the OLS results of the market wage regression revealed that, similar to those obtained with the standard version of the model, the stock of human capital embodied in a wife, her work experience, and the size of the population in her county of residence, were the standard determinants of her market wage. Further, her state of health—the only non-standard regressor included in the wage function—was also found as an important determinant of her wage. Specifically, other factors constant, relative to the wives without a high school diploma, those with a technical diploma, an undergraduate degree, or a graduate or professional degree, were found to command significantly higher wages from market employment. The holding of extra-curricular credentials was found to significantly raise the wives' market wages as well. Ceteris paribus, the wives with more work experience were found to secure significantly higher wages from employment. Also, employed wives living in more populated counties were found to command significantly higher wages than those in less populated counties. Lastly, everything else equal, less healthy wives were found securing significantly lower wages than healthier wives.

The OLS results of the observed annual hours of market work regression performed on both standard and non-standard characteristics revealed that, relative to the wives who had not graduated from high school, those with a technical diploma were working significantly fewer hours on their market jobs. Conversely, the wives with extra-curricular credentials were found to supply significantly more hours per year to paid employment compared to those without such credentials. Wives with more work experience were found to devote significantly more hours to paid employment, ceteris paribus. Everything else equal, the wives whose spouses' wage rates were greater were found to supply significantly less hours to market work activities. Surprisingly, only one non-standard characteristic was found to have a significant impact on the wives' intensity of market work. Specifically, and contrary to expectations, it was found that the wives reporting a better adequacy of their household's income were supplying significantly more hours to market employment than those perceiving a deficiency in their household's income. Indeed, one would have expected that, as in the labor-force participation Probit analysis, a wife's gender-role attitude and state of health be significantly related to her observed hours of paid work. Yet, this was not found. In due course, it can be said that, although these particular non-standard characteristics are important determinants of the extensive margin of a Missouri wife's labor supply decision, once the decision of participating in the market has been made, her gender-role attitude and state of health do not significantly affect the *observed* intensity of her labor supply decision.

Relative to the fit improvement induced in the labor-force participation Probit regression, the inclusion of the non-standard regressors in the recurrent estimation model did only little in the way of increasing the explanatory power of the wage and hours-of-work regressions. While according to the standard version of the model the adjusted R-square statistics for the wage and hours-of-work regressions were 0.3365 and 0.2319, respectively, these were 0.3341 and 0.2639 after the inclusion of the non-standard regressors. Indeed, this similarity in the adjusted R-squares of the standard specification and the first variant of it supports the instrumental purpose of lambda. In contrast, although the adjusted R-squares remained practically unchanged, it was found that the standard errors of the estimates from the wage and hours-of-work regressions decreased appreciably once the new characteristics were incorporated in the model. In fact, after the inclusion of the non-standard regressors, the standard error of the estimates was assessed at 0.3556 in the estimated log market wage, whereas it was 0.3854 prior to the inclusion of these characteristics. Likewise, after the inclusion of the non-standard characteristics, the standard error of the estimates was assessed at 484.1173 in the estimated annual hours of market work, whereas it was 533.0005 prior to the inclusion of these non-standard characteristics. Thus, from a statistical standpoint, inasmuch as the standard error of the estimates portrays the average size of the regression residuals, these results clearly show that the addition of the non-standard characteristics increased the precision—and hence, the predictive power—of the estimates derived from the recurrent system of equations.

As with the standard model, the shadow price of home time function for the first variant was retrieved using the coefficient on market experience obtained from the wage and hours-of-work regressions. Among the non-standard characteristics included in the first variant of the standard model, it was found that, other factors constant, the wives with a more traditional gender-role attitude were placing a greater economic value on home time. Likewise, the wives whose husbands' gender-role attitudes were more traditional placed a greater value on non-market time, ceteris paribus. Conversely, less healthy wives were found to assign a lower monetary value to home time, whereas those living with less healthy spouses appeared to place a greater economic value on this time, ceteris paribus. Household technology was found positively related to the wives' shadow value of home time. Specifically, everything else held constant, the wives who indicated a better adequacy of their home technology were found to accord a greater economic value to home time. Contrary to expectations, the wives reporting a more adequate household income were found to place a lower value on their non-market time, ceteris paribus.

Based upon the first variant of the standard specification, the reservation wages of the average employed and nonemployed sampled wives were estimated at $3.03 and $2.81, respectively. Comparisons of these reservation wage figures with those obtained from the standard version of the model revealed that, while the estimated reservation wage of the average employed wife was downward biased by 50% as a result of omitting the non-standard characteristics from the recurrent system of equations, the reservation wage of the average nonemployed wife was downward biased by 53% due to this omission. In contrast, while the actual market wages of employed wives are not affected by the specification of the estimation model, potential (i.e. estimated) market wages of nonemployed wives were found to be downward biased by 23% on average due to the omission of the non-standard characteristics from the estimation model. In fact, the market wage the average sampled housewife could potentially secure in the labor market was estimated at \$6.51 after the non-standard characteristics were added in the model, whereas it had been estimated at \$5.02 prior to their inclusion.

The last variant of the standard estimation model differed from the first variant only by the use of desired (i.e. truly unconstrained) labor supply behavior in its specification. Rather than relying on the assumption of no labor market constraints (i.e. the standard assumption of perfectly continuous budget lines)—which unrealistic assumption was maintained in the standard version of the model and the first variant of it—and because it guarantees that every wife is analyzed in her long-run time-allocation equilibrium, the use of desired labor supply behavior was implemented as a practical solution to control for the market constraints faced by a large proportion of sampled wives.

Using the discrepancies between observed and desired hours of market work, of the 857 sampled Missouri wives, 436 (≈51%) were found to face a market constraint at the time of the survey. In fact, examination of the differences between desired and observed hours of work permitted identification of 108 underemployed wives, 313 overemployed wives, and 15 unemployed wives. Indeed, under the standard assumption of perfectly continuous budget lines, these constrained wives were wrongly assumed unconstrained. Yet, with the use of desired labor supply behavior, these wives could be 'observed', and hence analyzed, in their unconstrained long-run time-allocation equilibria.

Unlike the underemployed and overemployed wives, the 15 unemployed wives were not only constrained with respect to the intensive margin of their labor supply decision (i.e. their hours-of-work decision) at the time of the survey, but also with regard to the extensive margin of their labor supply decision (i.e. their participation decision). Consequently, being constrained with respect to their participation decision, it follows that the results of the Probit analysis obtained from the standard version of the estimation model and the first variant of it must have been biased by considering these 15 wives as voluntarily nonemployed. This is so because, in absence of market constraints, these unemployed wives would have been employed in the labor force, and thus must be more likely to have characteristics that resemble those of employed wives, not those of nonemployed wives. Under such circumstances, when desired labor supply behavior is used to control for the market constraints, it is reasonable to expect that the explanatory power of the labor-force participation Probit analysis should increase as a result of 'freeing' these normally employed wives from their current unemployment situation.

The results of the desired labor-force participation Probit regression obtained from the second variant of the standard model were found to confirm this expectation. Although modest, relative to the goodness-of-fit measures obtained for the Probit analysis performed for the first variant of the standard model, the explanatory power of the labor-force participation Probit analysis increased by 1.30% according to Efron's pseudo R-square statistic whereas it increased by 2.41% and 1.13%, respectively, according to McFadden's and Cragg-Uhler's pseudo R-square measures of fit. That the explanatory power of the Probit regression increased—although only modestly—indicates that these unemployed wives have characteristics which, overall, resemble more those of employed than nonemployed wives.

For the second variant of the standard model, the OLS wage regression revealed very similar results to those obtained from the first variant. As such, lambda remained statistically non-significant after the control of labor market constraints and, among the standard regressors, the stock of human capital embodied in a wife, her market experience, and the size of the population in her county of residence, were found to be significant determinants of her offered wage. Likewise, her state of health—the only non-standard characteristic included in the wage regression—was also found as an important determinant of the wage she commands in her long-run time-allocation equilibrium. Precisely, in their long-run time-allocation equilibria, compared to the wives without a high school diploma, those with a technical diploma, an undergraduate degree, or a graduate degree, were found to secure significantly higher wages from market work. Similarly, the holding of extra-curricular credentials was found to significantly raise the wives' market wages. Ceteris paribus, the wives with more work experience were found to command significantly higher wages from paid employment. Also, employed wives residing in more populated counties were found to command significantly higher wages than those living in less populated counties. Finally, less healthy wives were found to secure significantly lower wages than healthier wives, ceteris paribus.

The OLS results of the desired annual hours of market work regression performed on both standard and non-standard characteristics of the employed wives indicated that, in their long-run time-allocation equilibria, relative to the wives who had not graduated from high school, those with a high school diploma, a technical school diploma, an undergraduate college degree, or a graduate or professional degree, were all working significantly fewer hours per year in the market, ceteris paribus. Conversely, other factors constant, in their long-run time-allocation equilibria, employed wives with more market work experience were found to devote significantly more hours to paid employment. In their unconstrained time-allocation equilibria, employed wives with preschool children were found to supply significantly fewer hours to market employment, ceteris paribus. Among the non-standard regressors, the results of the desired hours-of-work regression revealed that, in their long-run equilibria, the wives with a more traditional gender-role attitude were supplying significantly fewer hours to market employment than those with a more egalitarian attitude, ceteris paribus. Lastly, other characteristics being equal, in their desired time-allocation equilibria, employed wives whose spouses were less healthy were found to work significantly more hours in the market than those with healthier spouses.

As measured by the adjusted R-squares, the explanatory power of the OLS wage and hours of market work regressions was found to be very similar prior to and after the control of institutional labor market constraints. As such, while according to the first variant of the standard model, the adjusted R-square statistics for the wage and hours of market work regressions were 0.3341 and 0.2639, respectively, these were 0.3392 and 0.2419 after controlling for the constraints. Interestingly, although the adjusted R-squares remained relatively similar prior to and after the use of desired labor supply behavior, it was found that the standard error of the estimates from the hours of market work regression had substantially decreased after desired labor supply behavior was substituted for observed behavior in the estimation model. Specifically, even though the standard error of the estimates from the wage regression was practically unchanged as a result of using the wives' desired labor supply behavior (i.e. 0.3551 versus 0.3556), the standard error of the estimates was evaluated at 408.9985 in the estimated *desired* annual hours-of-work, whereas it was assessed at 484.1173 in the estimated *observed* annual hours of market work. Therefore, from a statistical perspective, these results clearly suggest that the use of desired labor supply behavior importantly contributed to the precision of the estimates derived from the recurrent system of equations.

As with the standard version of the estimation model and the first variant of it, the shadow price of home time function for the second variant was identified using the coefficient on market work experience obtained from the wage and hours-of-work OLS regressions. Abstracting from the changes in the magnitude of the coefficients, in terms of the relationships between the shadow price of home time and the characteristics considered in the second variant of the standard model, certain noticeable changes occurred as a result of using the wives' desired labor supply behavior. Specifically, while, contrary to expectations, the household's unearned income and the perceived adequacy of the household's overall income had been found inversely related to a wife's shadow price of home time prior to the control of market constraints, the signs on these characteristics were found positive as hypothesized after controlling for the constraints. That is, in their long-run time-allocation equilibria, the wives living in households with larger unearned income were found to assign a greater economic value to home time.

Likewise, in their unconstrained time-allocation equilibria, the wives reporting a better perceived adequacy of their household's income were found to place a greater price on their home time, ceteris paribus.

Based on the second and most refined variant of the standard estimation model, in their long-run unconstrained time-allocation equilibria, the average employed and nonemployed Missouri wives were found to have reservation wages of $2.09 and $2.05, respectively. Additionally, while the market wage of the average satisfactorily employed wife was found to be $8.94, it was estimated at $6.23 for the average satisfactorily nonemployed wife. Contrasting these figures to those derived from the first variant of the standard model, it is clear that the assumption of no labor market constraints (i.e. the standard assumption of perfectly continuous budget lines) leads to important biases in the opportunity cost of time measures, notably in reservation wage estimates. Specifically, without controlling for the market constraints imposed on 436 sampled wives, the reservation wage estimates of the employed wives were found to be upward biased by nearly 45%, whereas those of nonemployed wives were found upward biased by 37%, on average. To a much lesser extent, without the appropriate control of these constraints, the estimated market wages of the nonemployed wives were found to overstate their true wage offer by 5% on average, whereas this true wage offer was only slightly overstated by 0.1% for the employed wives.

According to economic theory, it should be the case that, in their long-run time-allocation equilibria, employed wives have market wages which outweigh their reservation wages.

In contrast, it should be the case that the reservation wages of nonemployed wives outweigh the wages they could potentially command in the labor market. Yet, in this study, although it was found that the mean estimated market wage for the employed wife outweighed her mean estimated reservation wage, the mean estimated reservation wage for the nonemployed wife was found substantially below her mean estimated market wage. In fact, regardless the specification of the model utilized to derive these estimates, for the nonemployed as well as for the employed wives, the mean estimated reservation wages were consistently found well below the mean market wages. Here a logical explanation was advanced to justify these results. Essentially, these results were rationalized by pointing to the fact that, as implemented in the general recurrent estimation model, the market wage represents an *average* monetary value for the decreasing returns to scale of some predetermined lengthy periods of time devoted to market production, while, in contrast, the reservation wage conveys the *marginal* value of the *least* valuable hour of home time in complete absence of market work (i.e. prior to labor market entry). Thus, inasmuch as the reservation wage conceptually denotes the value placed on the very last annual hour of home time at full non-market time, it should be natural that the estimated reservation wages were found to be very low relative to the market wage figures. Indeed, under the assumption of linearly homogeneous (i.e. CRS) home production function, this rationale would be meaningless since reservation wages would unrealistically be regarded as average monetary values in much the same way as market wages. However, when the assumption of linearly homogeneous home production function is relaxed, and *average* shadow prices of home time devoted to household production activities are computed, this rationale is seen to make perfect sense.

As such, using the shadow price of home time function retrieved from each particular specification of the recurrent estimation model, the *average* shadow price of home labor time to the average nonemployed wife was found to be \$6.42 according to the standard version of the model, \$7.40 according to its first variant, and \$9.50 according to its second and most refined variant. Likewise, the *average* shadow price of home labor time to the average employed Missouri wife was found to be \$3.79 according to the standard formulation of the model, \$5.39 according to its first variant, and \$5.28 according to its second variant. Unsurprisingly, these average shadow price values are all greater than the reservation wage figures obtained from each particular specification of the estimation model. That these average shadow price values were found to be greater than the estimated reservation wages illustrates the decreasing returns to scale of home labor time. Further, that the average shadow prices computed for the subsample of nonemployed wives were found to exceed their estimated potential market wages sheds light on the rationale at the basis of their non-employment choice. Similarly, that the average shadow prices derived for the subsample of employed wives were found to be below their actual market wages delineates the foundation of their employment choice.

Based on the most refined variant of the standard estimation model (i.e. the second variant), it is seen that if the reservation wage of the nonemployed Missouri wife were taken as the opportunity cost measure for all her hours of household work as commonly done by home and family economists, then the true economic value of this time to this nonemployed wife would be understated by 78%, on average. Likewise, if the market wage of the employed Missouri wife were used as the opportunity cost measure for all her hours of home production, then the true value of this time to this employed wife would be overstated by as much as 69%, on average.

Thus, as evidenced by the results of this study, it shall be clear that a wife's state of health and gender-role attitude may represent a sensible alternative to Heckman's lambda in deriving opportunity cost measures for household production time. Additionally, if the opportunity cost approach is to enable derivation of the authentic monetary value of home production time from an individual (i.e. household) perspective, then the conceptual refinements developed and implemented in this study are indispensable to ensure the validity of the opportunity cost measures one obtains for this productive time. Beyond doubt, the results emerging from this study suggest that it is imperative that the reality of institutional labor market constraints and decreasing returns to scale of household production time be effectively modeled through the opportunity cost methodology, else substantial biases will continue to plague estimates of the economic value of home production time, and hence obscure the (our) understanding of household members' time-allocation.

Limitations of the Study

In its pristine form, the market wage measure which should be used in the recurrent system of equations must theoretically reflect the real return to paid employment, and thus include all fringe benefits and be net of taxes and other costs that are generally associated with market work. Indubitably, a first important limitation of this study lies in the fact that, although federal and Missouri state income taxes were imputed from the wage measure, fringe benefits (e.g. employer's contribution to a pension plan, health and/or disability insurance, life insurance, dental insurance, childcare accommodations, etc.), as well as money costs (e.g. transportation expenditures, childcare expenditures, clothing expenditures, meal expenditures, etc.) and time costs (e.g. commuting time, and other time 'expenditures' such as personal appearance grooming) related to paid employment were not accounted for in the market wage measure. Consequently, it is recognized that, without the proper accounting of fringe benefits and employment-related costs, the market wage measure employed in this study represents an imperfect assessment of the real return to paid employment. Hence, this imperfect assessment of the real return to market work may have importantly distorted the opportunity cost of time measures obtained in this study.

A second limitation of the present study is linked to the overall accuracy of reported household production time. In fact, inasmuch as sampled wives were asked to 'recall' their average weekly time devoted to three general categories of household production activities (e.g. home and yard work, household resource management and shopping, and care of children and other household members), it seems very likely that some of them may have simply under-reported this time whereas others possibly over-reported it. Under such circumstances, it should be obvious that any bias in the measurement of household production time would have distorted the estimated annual value of this time, regardless whether reservation or market wages were used in the computations. Moreover, these potential biases in the reporting of home production hours necessarily contaminate the average shadow price values derived for this time. For instance, in cases where this time was under-reported, the averaging procedure developed in this study would have produced underestimates of the true average economic value of this time, whereas, in cases where home labor time was over-reported, the averaging procedure would have yielded overestimates of the average monetary value of this time.

Another potentially important limitation of this study is related to the fact that, for the sampled wives identified as constrained with respect to their time-allocation behavior prior to the control of labor market restraints, desired annual hours of household production were imputed from the results of an hours of household work regression analysis performed on the personal and socio-demographic characteristics of wives whose observed time-allocation behavior had been found unconstrained prior to the control implemented for labor market constraints. Although theoretically sound, it shall be recognized that, from an econometric perspective, this imputation procedure may not have produced consistent estimates. As such, for the very same reason which led Heckman to develop his sample-selection correction procedure, in the event that constrained wives have unobserved characteristics that importantly differ from those of unconstrained wives, then desired annual hours of home production imputed for the constrained wives based on the results of a regression analysis performed on unconstrained wives are likely impeded by sample selection bias.

A last limitation of this work relates to the potentiality of its results for being generalized to the entire population of Missouri wives aged 20 or more, but less than 65, and living in intact households. In fact, by restricting the sample upon which the different analyses were conducted to the wives who had no more than one market job at the time of the survey, it is obvious that generalization of the results to multiple job-holders is hardly possible. Likewise, given the amazingly large proportion of sampled wives who reported living in homes owned by their household (i.e. roughly 96%), and the large proportion of wives reporting being Caucasian (i.e. roughly 97%), there are reasons to believe that the technique utilized by the sampling firm (i.e. Best Mailing Lists, Inc.) has led to an over-sampling of homeowners and white households. Therefore, caution should be exercised in the generalization of the results of this study.

Implications of the Findings and Recommendations for Further Research

Many researchers have rightfully criticized the pertinence of certain oversimplifying premises on which relies the standard opportunity cost of time methodology to assessing the monetary value of time devoted to home production activities. Until now, very little had been done in the way of improving on the shortcomings of the opportunity cost approach, however. Thus, given the scarcity of studies that have attempted to deal with the serious shortcomings of the standard opportunity cost of time methodology, it follows that the refinements introduced in this study shall be regarded as a significant advancement toward the reconciliation of the opportunity cost approach to valuing household production time with the reality of labor market restraints and decreasing returns to scale of this time. Also, since it is hoped that this study will spawn incentives in the field to pursue research along the lines explored in this work, it seems essential that certain guidelines be formulated for future studies in the area of home production time valuation.

One of the greatest challenge faced by home and family economists in the area of household production time valuation is related to the availability of suitable data sets. Although an abundance of data collections are available nowadays, very few lend themselves to the purpose of valuing the economic value of home production time within the opportunity cost of time framework. For instance, the findings of this study suggest that researchers are generally forced to recourse to Heckman's sample-selection correction procedure because the personal and socio-demographic characteristics usually found in these available data sets do not provide sufficient information with regard to critical labor-force participation determinants. Likewise, while most relevant data collections offer appropriate information about actual (i.e. observed) labor supply behavior, data on desired (i.e. unconstrained) behavior are rarely available to the analyst. Unquestionably, efforts should be orchestrated from within the profession, and in concert with the diverse local and national data-gathering agencies, to rectify this situation.

In the same vein, and as pointed out in the preceding section, an important limitation of the present study was the imperfect measure of the real return to paid market employment which is likely to have generated important biases in the different opportunity cost measures derived for the valuation of household production time. In due course, future research should account not only for federal and state income taxes, but also for all fringe benefits and costs (i.e. money and time costs) associated with paid market work.

Additionally, rather than relying on the recall technique, research designs that incorporate time diaries, and thus which provide the respondents with accounting sheets for the tabulation of their time inputs, should be utilized in order to ensure the highest possible level of accuracy in the reporting of household production time. In fact, since it is prone to lack in accuracy, the recall technique should only be used as an option of last resort when it comes to assess the monetary value of home production time.

Although tempting, it would be precarious to conclude with certitude that the inclusion of the wife's state of health and gender-role attitude—along with the characteristics usually considered in the recurrent estimation model from which opportunity cost measures are derived—enables circumvention of Heckman's correction procedure for sample selection bias. Indeed, further analyses need to be conducted with different samples before such a conclusion can be reached. For the time being, and until enough evidence is accumulated, Heckman's lambda should be considered as an insurance policy against sample selection bias, and thus should continue to instrument the recurrent system of equations from which opportunity cost of time measures are derived.

POSTSCRIPT

"It's the same each time with progress. First they ignore you, then they say you're mad, then dangerous, then there's a pause and then you can't find anyone who disagrees with you."

Tony Benn (1925), British Labour Politician.
Quoted in: ***Observer*** (London, 6 Oct. 1991).

APPENDIX A

SPECIMENS OF THE FINAL VERSION OF THE SURVEY INSTRUMENTS USED TO COLLECT THE DATA

Survey Instrument

SPECIMEN

(FORM A)

College of Human Environmental Sciences

Department of Consumer and Family Economics

239 Stanley Hall
Columbia, Missouri 65211
Telephone (573) 882-7836

UNIVERSITY OF MISSOURI-COLUMBIA

May, 1996

COVER PAGE Used for the FIRST MAILING

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Sincerely Yours,

Jean Robitaille	Edward J. Metzen
Research Associate	Professor and Department Chair

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If you have already completed and returned the first set of questionnaires we sent to you, please simply ignore this additional mailing and discard (or better, recycle) these.

Please do keep in mind that for the study results to provide a representative picture of how Missouri couples allocate their time in today's conditions, it is crucial that both spouses in each household in the sample complete a questionnaire. We will therefore very much appreciate your doing so and returning them, hopefully within the next two weeks. You and your spouse should complete the questionnaires independently, but return them together in the enclosed pre-stamped envelope.

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Sincerely Yours,

Jean Robitaille
Research Associate

Edward J. Metzen
Professor and Department Chair

FORM A

STUDY OF TIME USE IN PAID MARKET WORK & HOUSEHOLD WORK

The quality of this research depends on your willingness to complete this questionnaire as fully as possible. Remember, your answers are strictly confidential and will **NEVER** be connected with your name.

SECTION 1:

Q1: Please fill in the table below the information requested at the top of each column for **EVERY PERSON** living in your household, including persons not related to you.

	Relationship to You?	Gender? (Circle Number)	Present Age?	Licensed Driver? (Circle Number)
Person 1	*Yourself*	1 female 2 male		1 no 2 yes
Person 2	*Your Spouse*	1 female 2 male		1 no 2 yes
Person 3		1 female 2 male		1 no 2 yes
Person 4		1 female 2 male		1 no 2 yes
Person 5		1 female 2 male		1 no 2 yes
Person 6		1 female 2 male		1 no 2 yes
Person 7		1 female 2 male		1 no 2 yes
Person 8		1 female 2 male		1 no 2 yes
Person 9		1 female 2 male		1 no 2 yes

Q2: How long have you been **MARRIED** to your **CURRENT** spouse? ______ years and ______ months

Q3: What is the **HIGHEST** level of formal education you **COMPLETED**? (Circle only **ONE** number)

1 No Formal Schooling
2 Some Grade (elementary) School
3 Completed Grade School (8^{th} Grade)
4 Some High School
5 Completed High School, GED or Equivalent (12^{th} Grade)
6 Some Technical School (but no degree)
7 Completed Technical School
8 Some College (but no degree)
9 Earned Associate's or similar Degree
10 Earned Bachelor's Degree
11 Some Graduate or Professional Study
12 Earned a Graduate or Professional Degree

Q4: If you have any kind of **certifications, credentials**, or **licenses** that you **earned OUTSIDE** the formal education system, please briefly describe these below. (Write "NONE" if you do not have any.)

____

____

____

Q5: Are you a native of the U.S.? (Circle number)

1 No → How long have you been living in the U.S.? ________ years and ________ months
2 Yes

Q6: What is your race? (Circle number)

1 Caucasian (White)
2 African-American (Black)
3 Hispanic
4 American Indian, Aleutian, Inuit
5 Asian or Pacific Islander
6 Other, please specify: ______________________________

Q7: Do you **OWN, or are you currently buying**, your home? (Circle number)

1 No
2 Yes

Q8: How many BEDROOMS, BATHROOMS, and OTHER ROOMS does your current residence have?

________ bedrooms ________ bathrooms ________ other rooms

Q9: Is **your household** responsible for the maintenance of the yard where you live? (Circle number)

1 No → If "No", go to question Q11.
2 Yes

Q10: Approximately how large is your yard where you currently live? (Circle number)

1 MODEST SIZE YARD (less than 1/8 acre or 75 x 75 feet)
2 SMALL SIZE YARD (1/8 acre or more but less than 1/4 acre or 100 x 100 feet)
3 MEDIUM SIZE YARD (1/4 acre or more but less than 1/2 acre or 150 x 150 feet)
4 LARGE SIZE YARD (1/2 acre or more but less than 1 acre or 200 x 200 feet)
5 VERY LARGE YARD (more than 1 acre or 200 x 200 feet)

Q11: Do you have a **motorized** transportation vehicle such as a car, truck, or motorcycle that you personally can use **WHENEVER** you need it? (Circle number)

1 No
2 Yes

Q12: To what extent do you think your home equipment and tools are enough to carry out the work **YOU USUALLY DO** or **WANT TO DO** in and around the house? (Circle number)

1 lack of equipment makes most of the work I want to do difficult
2 some shortage of equipment which often limits the work I could do
3 plenty of equipment to do almost all the work I want to do

Q13: To what degree, if any, do you have a health problem or disability that limits the type or amount of work you can do **AT HOME**? (Circle number)

1 NO health problem or disability limiting the type/amount of work I can do at home
2 health problem or disability SLIGHTLY limiting the type/amount of work I can do at home
3 health problem or disability IMPORTANTLY limiting the type/amount of work I can do at home
4 health problem or disability TOTALLY preventing me from doing any type of work at home

Q14: To what degree, if any, do you have a health problem or disability that limits the type or amount of work you can do in **PAID EMPLOYMENT**? (Circle number)

1 NO health problem or disability limiting the type/amount of paid work I can do
2 health problem or disability SLIGHTLY limiting the type/amount of paid work I can do
3 health problem or disability IMPORTANTLY limiting the type/amount of paid work I can do
4 health problem or disability TOTALLY preventing me from doing any type of paid work

Q15: How many other persons, children or adults, **CURRENTLY LIVING** with you have a **PERMANENT** health problem or disability which limits the type or amount of activities **THEY** can do? (Enter "0" if none.)

____

Q16: Please indicate the extent to which you agree or disagree with **EACH** of the following statements. **CIRCLE** your choice using the following scale:

1 = ***STRONGLY DISAGREE***
2 = ***DISAGREE***
3 = ***AGREE***
4 = ***STRONGLY AGREE***

a) A man can make long range plans for his life, but a woman has to take things as they come.	1 2 3 4
b) A pre-school child is likely to suffer if his/her mother works.	1 2 3 4
c) A working mother can establish just as warm and secure a relationship with her children as a mother who does not work.	1 2 3 4
d) It is much better for everyone involved if the man is the achiever outside the home and the woman takes care of the home and family.	1 2 3 4
e) A woman should have exactly the same job opportunities as a man.	1 2 3 4
f) Men should share the work around the house with women such as doing dishes, cleaning, and so forth.	1 2 3 4
g) A woman should not let bearing and rearing children stand in the way of a career.	1 2 3 4
h) On the job, men should not refuse to work for women.	1 2 3 4
i) Women are much happier if they stay at home and take care of their children.	1 2 3 4
j) Young girls are entitled to as much independence as young boys.	1 2 3 4
k) Men and women should be paid the same money if they do the same work.	1 2 3 4
l) Women should be considered as seriously as men for jobs as executives or politicians or even President.	1 2 3 4
m) If anything happened to one of the children while the mother was working, she could never forgive herself.	1 2 3 4
n) A woman's job should be kept for her when she is having a baby.	1 2 3 4
o) You usually find that the happiest families are those with a large number of children.	1 2 3 4
p) There should be free or very low price childcare centers so that women could take jobs.	1 2 3 4

SECTION 2:

Q17: Considering **ALL** jobs you have had since your 16th BIRTHDAY, please indicate approximately how many **YEARS** you have worked for pay or profit:

9 months or more, 35 hours or more MOST of the weeks: (enter "0" if none) ________ years

9 months or more, less than 35 hours MOST of the weeks: (enter "0" if none) ________ years

less than 9 months, 35 hours or more MOST of the weeks: (enter "0" if none) ________ years

less than 9 months, less than 35 hours MOST of the weeks: (enter "0" if none) ________ years

Q18: Are you **CURRENTLY** working for PAY or PROFIT? (Circle number)

1 No → If "No", go directly to **PART B** on page 7
2 Yes → If "Yes", answer the questions in **PART A**

PART A: ***Please answer the questions of this part ONLY IF you are CURRENTLY WORKING for pay or profit.***

Q19: How many **PAYING** jobs or self-employments do you **CURRENTLY** have? ________

Q20: Did you have **ANY OTHER** job in 1995 that you **NO LONGER** have today? (Circle number)

1 No → If "No", go to question Q22.
2 Yes

Q21: For **ONLY** the job(s) you had in **1995**, but **NO LONGER HAVE** today, please indicate approximately how much **GROSS** (Before Taxes) income you earned on that (those) job(s) in 1995.

$__________________________ in 1995

Q22: For **EACH** of your **CURRENT** jobs, indicate whether you are EMPLOYED or SELF-EMPLOYED. (Circle number)

	EMPLOYED	SELF-EMPLOYED
PRIMARY JOB:	1	2
SECOND JOB:	1	2
THIRD JOB:	1	2

Q23: Please briefly describe the nature of your occupation for **EACH** of your **CURRENT** paying jobs.

PRIMARY JOB: ____

SECOND JOB: ____

THIRD JOB: ____

Q24: How long have you been employed on **EACH** job you currently have?

PRIMARY JOB: ________ years and ________ months
SECOND JOB: ________ years and ________ months
THIRD JOB: ________ years and ________ months

Q25: Please indicate how many **HOURS PER WEEK** you spend, **on average**, working on **EACH** job.

PRIMARY JOB: _______ hours per week
SECOND JOB: _______ hours per week
THIRD JOB: _______ hours per week

Q26: For **EACH** job you currently have, indicate how many **WEEKS** you spent working on this job in **1995**. [**DO NOT** include any *paid* or *unpaid* week(s) of vacation, leave, sickness or disability.]

PRIMARY JOB: _______ weeks of work in 1995
SECOND JOB: _______ weeks of work in 1995
THIRD JOB: _______ weeks of work in 1995

Q27: Please indicate how many **WEEKS** of **PAID VACATION or LEAVE** you had in **1995** for **EACH** job you currently have. (Enter "0" if none.)

PRIMARY JOB: _______ weeks of PAID vacation or leave in 1995
SECOND JOB: _______ weeks of PAID vacation or leave in 1995
THIRD JOB: _______ weeks of PAID vacation or leave in 1995

Q28: If you could work as much or as little as you wanted on your **CURRENT** job(s), **at your REGULAR pay rate(s)**, how many **HOURS PER WEEK** and **WEEKS PER YEAR** would you chose to work in **EACH** of your jobs?

PRIMARY JOB: _______ hours per week _______ weeks per year
SECOND JOB: _______ hours per week _______ weeks per year
THIRD JOB: _______ hours per week _______ weeks per year

Q29: For **EACH** job you **CURRENTLY** have, please indicate your **GROSS** (Before Taxes) rate of pay, and **CIRCLE** the time period for which this rate of pay applies.

PRIMARY JOB: $_______________ hourly / weekly / every 2 weeks / twice monthly / monthly
SECOND JOB: $_______________ hourly / weekly / every 2 weeks / twice monthly / monthly
THIRD JOB: $_______________ hourly / weekly / every 2 weeks / twice monthly / monthly

Q30: For whatever reason, assume that tomorrow you were to lose **ALL** of your current jobs. What is the **LOWEST GROSS** (Before Taxes) **HOURLY** pay rate you would be willing to accept to take any particular job?

$____________ per hour

Q31: Assuming that you take a job at the **LOWEST GROSS** (Before Taxes) **HOURLY** pay rate you just reported above, how many **HOURS PER WEEK** and **WEEKS PER YEAR** would you be willing to work on this job?

________ hours per week

________ weeks per year

Please go to <u>SECTION 3</u> on page 11

<u>PART B</u>: ***Please answer the questions of this part <u>ONLY IF</u> you are <u>NOT</u> CURRENTLY WORKING for pay or profit. Otherwise, go directly to SECTION 3 on page 11.***

Q32: Although you may not be currently working in the market, were you working for PAY or PROFIT anytime since **<u>JANUARY 1995</u>**? (Circle number)

1 No → If "No", go to **<u>PART C</u>** on page 10

2 Yes → If "Yes", please answer the rest of the questions in this part.

Q33: How many **PAID** jobs or self-employments did you have since **<u>JANUARY 1995</u>**? _______

Q34: For **ALL** the jobs you have had since **<u>JANUARY 1995</u>**, please indicate approximately how much **GROSS** (Before Taxes) income you earned from those jobs **in 1995**.

$__________________________ in 1995

Q35: In which **MONTH** and **YEAR** did you stop working on your **<u>LAST</u>** paying job? ______________

Q36: On your LAST (most recent) **PAYING** job, were you working as EMPLOYED or SELF-EMPLOYED? (Circle number)

1 Employed
2 Self-Employed

Q37: Please briefly describe the nature of your LAST (most recent) paying job.

____

____

Q38: How long were you employed on your LAST (most recent) job? ______ years and ______ months.

Q39: What is the **MAIN** reason or event that caused you to stop working on that job? (Circle **ONE** number)

1 I became ill, disabled, or unable to work.
2 I decided to go back to school.
3 My job is seasonal and no work can be done during this time of the year.
4 I became pregnant and I am currently on a pregnancy or maternity leave.
5 I decided to leave my employer in order to find a better job.
6 I was laid off by my employer.
7 My employer went out of business.
8 I had to terminate business.
9 I stopped working on my job to take care of the home and/or the children.
10 I retired from the labor market.
11 Other, please briefly specify: ______________________________________

____

Q40: On average, how many **HOURS PER WEEK** were you working on your LAST (most recent) job?

________ hours per week

Q41: On average, how many **WEEKS PER YEAR** were you working on your LAST (most recent) paying job? [**DO NOT** include any *paid* or *unpaid* week(s) of vacation, leave, sickness or disability.]

________ weeks of work per year

Q42: Please indicate how many weeks of **PAID** vacation or leave per year you typically had in your LAST (most recent) market job. (Enter "0" if none.)

________ weeks of PAID vacation or leave per year

Q43: Please indicate what was your **GROSS** (Before Taxes) rate of pay on your **<u>LAST</u>** (most recent) job, and **CIRCLE** the time period for which this rate of pay applied.

$__________________ hourly / weekly / every 2 weeks / twice monthly / monthly / annually

Q44: Are you **CURRENTLY** looking for a job? (Circle number)

1 No → If "No", go to question Q47.
2 Yes

Q45: If it were possible, would you take back your **<u>LAST</u>** (most recent) job at the **SAME PAY RATE** and **WORKING CONDITIONS** you had prior you stopped working on this job? (Circle number)

1 No → If "No", go to question Q47.
2 Yes

Q46: If you could take back your **<u>LAST</u>** (most recent) job, how many **HOURS PER WEEK** and **WEEKS PER YEAR** would you chose to work at the **<u>REGULAR</u> pay rate** you were earning on this job?

________ hours per week
________ weeks per year

Q47: Whether or not you are currently looking for a job, please indicate the **LOWEST GROSS** (Before Taxes) **HOURLY** pay rate you would be willing to accept to take any particular job.

$___________ per hour

Q48: Assuming that you take a job at the **LOWEST GROSS** (Before Taxes) **HOURLY pay rate** you just reported above, how many **HOURS PER WEEK** and **WEEKS PER YEAR** would you be willing to work on this job?

________ hours per week
________ weeks per year

Please go to <u>SECTION 3</u> on page 11

PART C: ***Please answer the questions of this part ONLY IF you have NOT WORKED AT ALL for pay or profit since JANUARY 1995. Otherwise, go to SECTION 3 on page 11.***

Q49: What is the **MAIN** reason that kept you from working for pay or profit since **JANUARY 1995**? (Circle only **ONE** number.)

1 I was ill, disabled, or unable to work.
2 I was going to school.
3 I was taking care of the home and/or the children.
4 I could not find a suitable job.
5 I could not find any job at all.
6 I was retired from the labor market.
7 Other, please briefly specify: ______________________________

____

Q50: When did you stop working on your **LAST** (most recent) job? (Write both the MONTH and YEAR.)

____

Q51: Are you **CURRENTLY LOOKING** for a paid market job? (Circle number)

1 No
2 Yes

Q52: Whether or not you are currently looking for a job, please indicate the **LOWEST GROSS** (Before Taxes) **HOURLY pay rate** you would be willing to accept to take any particular job.

$____________ per hour

Q53: Assuming that you take a job at the **LOWEST GROSS** (Before Taxes) **HOURLY pay rate** you just reported above, how many **HOURS PER WEEK** and **WEEKS PER YEAR** would you be willing to work on this job?

________ hours per week

________ weeks per year

SECTION 3:

Q54: Various household work activities are carried out by household members. Below are three categories of such activities. Please place a check (√) in the box next to **EACH** activity **YOU typically perform** in your household.

CATEGORY 1: HOUSEHOLD AND YARD WORK

[ ] Indoor cleaning and maintenance
[ ] Household laundry and ironing
[ ] Repairs and alterations to clothing
[ ] Sewing and/or knitting home goods
[ ] Preparing meals for the household
[ ] Washing dishes, cookware, etc.
[ ] Indoor and/or outdoor home repairs
[ ] Yard and/or garden maintenance
[ ] Auto care and maintenance

What is your '***best***' **estimate** of how much total time you spend per **AVERAGE WEEK** on **ALL** the activities contained in **CATEGORY 1**? (Enter "0" if none.) _______ hours and _______ minutes

CATEGORY 2: HOUSEHOLD RESOURCE MANAGEMENT AND SHOPPING

[ ] Preparing household budget or spending plan
[ ] Managing routine finances (keeping bills and records)
[ ] Managing household investments and savings
[ ] Preparing shopping and grocery lists
[ ] Shopping for the needs of the household

What is your '***best***' **estimate** of how much total time you spend per **AVERAGE WEEK** on **ALL** the activities contained in **CATEGORY 2**? (Enter "0" if none.) _______ hours and _______ minutes

CATEGORY 3: CARE OF CHILDREN AND OTHER HOUSEHOLD MEMBERS

[ ] Active care to children, at home or away (attending needs, helping with school work, reading to them, transportation to school and recreational activities, etc.)

[ ] Active care to other household members, at home or away.

What is your '***best***' **estimate** of how much total time you spend per **AVERAGE WEEK** on the activities contained in **CATEGORY 3**? **DO NOT** include time just '***being there***' for supervision. (Enter "0" if none.) _______ hours and _______ minutes

Q55: Please give your **BEST estimate** of how much total time you spend per **AVERAGE WEEK** on **EACH** category of activities represented below. (Enter "0" if none.)

Sleep and Rest:	_______ hours and _______ minutes
Leisure Activities, Exercise, and Socializing:	_______ hours and _______ minutes
Studying or Reading for Educational Purposes:	_______ hours and _______ minutes
Unpaid Training or Practice Related to Employment:	_______ hours and _______ minutes
Volunteer Work for the Community or the Church:	_______ hours and _______ minutes

SECTION 4:

Q56: Considering **both** yours and your spouse's incomes, indicate approximately what was your **GROSS** (before taxes) **TOTAL COMBINED INCOME** from **ALL** sources (including personal earnings, investment income, net profits from business or rental property, pensions, social security, etc.) **in 1995**.

$______________________________

Q57: To what extent do you think that this income **was enough** for your family to live on **in 1995**? (Circle number)

1 not at all adequate
2 could meet necessities only
3 could afford some of the things we wanted but not everything
4 could afford about everything we wanted
5 could afford about everything we wanted and still save money

Q58: **IN TOTAL**, how many **EXEMPTIONS** for dependents could **YOU** and **YOUR SPOUSE** claim for your **1995 income tax return**? (Enter "0" if none.) _______

Q59: **In 1995**, approximately how much did **YOU** and **YOUR SPOUSE** spend on childcare services **DUE TO PAID EMPLOYMENT**? (Enter "0" if none.) $__________.__

SECTION 5:

Q60: Overall, considering **ALL** aspects of your life, how **satisfied or dissatisfied** are you with the quality of **YOUR** life? (Circle number)

1 Extremely Dissatisfied
2 Dissatisfied
3 Somewhat Dissatisfied
4 Somewhat Satisfied
5 Satisfied
6 Extremely Satisfied

Thank You Very Much For Your Participation !

Survey Instrument
SPECIMEN
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Research Associate

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Professor and Department Chair

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If you have already completed and returned the first set of questionnaires we sent to you, please simply ignore this additional mailing and discard (or better, recycle) these.

Please do keep in mind that for the study results to provide a representative picture of how Missouri couples allocate their time in today's conditions, it is crucial that both spouses in each household in the sample complete a questionnaire. We will therefore very much appreciate your doing so and returning them, hopefully within the next two weeks. You and your spouse should complete the questionnaires independently, but return them together in the enclosed pre-stamped envelope.

We can guarantee you that the information you provide will remain strictly confidential and anonymous. We have set up a special system for processing the questionnaires so that not even we will be able to connect you with your responses. The study has been approved by the appropriate review process at the University of Missouri. We thank you very much for your understanding and your help in our efforts to be responsible to the citizens of Missouri by studying family circumstances and how families function in these times.

Sincerely Yours,

Jean Robitaille
Research Associate

Edward J. Metzen
Professor and Department Chair

FORM B

STUDY OF TIME USE IN PAID MARKET WORK & HOUSEHOLD WORK

The quality of this research depends on your willingness to complete this questionnaire as fully as possible. Remember, your answers are strictly confidential and will NEVER be connected with your name.

SECTION 1:

Q1: What is the **HIGHEST** level of formal education you **COMPLETED**? (Circle only **ONE** number)

1 No Formal Schooling
2 Some Grade (elementary) School
3 Completed Grade School (8th Grade)
4 Some High School
5 Completed High School, GED or Equivalent (12th Grade)
6 Some Technical School (but no degree)
7 Completed Technical School
8 Some College (but no degree)
9 Earned Associate's or similar Degree
10 Earned Bachelor's Degree
11 Some Graduate or Professional Study
12 Earned a Graduate or Professional Degree

Q2: If you have any kind of **certifications, credentials,** or **licenses** that you **earned OUTSIDE** the formal education system, please briefly describe these below. (Write "NONE" if you do not have any.)

____

____

____

Q3: Are you a native of the U.S.? (Circle number)

1 No → How long have you been living in the U.S.? _______ years and _______ months
2 Yes

Q4: What is your race? (Circle number)

1 Caucasian (White)
2 African-American (Black)
3 Hispanic
4 American Indian, Aleutian, Inuit
5 Asian or Pacific Islander
6 Other, please specify: ________________________________

Q5: Do you have a **motorized** transportation vehicle such as a car, truck, or motorcycle that **you** personally can use **WHENEVER** you need it? (Circle number)

1 No
2 Yes

Q6: To what extent do you think your home equipment and tools are enough to carry out the work **YOU USUALLY DO** or **WANT TO DO** in and around the house? (Circle number)

1 lack of equipment makes most of the work I want to do difficult
2 some shortage of equipment which often limits the work I could do
3 plenty of equipment to do almost all the work I want to do

Q7: To what degree, if any, do you have a health problem or disability that limits the type or amount of work you can do **AT HOME**? (Circle number)

1 NO health problem or disability limiting the type/amount of work I can do at home
2 health problem or disability SLIGHTLY limiting the type/amount of work I can do at home
3 health problem or disability IMPORTANTLY limiting the type/amount of work I can do at home
4 health problem or disability TOTALLY preventing me from doing any type of work at home

Q8: To what degree, if any, do you have a health problem or disability that limits the type or amount of work you can do in **PAID EMPLOYMENT**? (Circle number)

1 NO health problem or disability limiting the type/amount of paid work I can do
2 health problem or disability SLIGHTLY limiting the type/amount of paid work I can do
3 health problem or disability IMPORTANTLY limiting the type/amount of paid work I can do
4 health problem or disability TOTALLY preventing me from doing any type of paid work

Q9: How many other persons, children or adults, **CURRENTLY LIVING** with you have a **PERMANENT** health problem or disability which limits the type or amount of activities **THEY** can do? (Enter "0" if none.)

____

Q10: **EXCLUDING YOU** and **YOUR SPOUSE**, how many other persons, children and adults, are **CURRENTLY** living in your household? (Enter "0" if none.) ________

Q11: Please indicate the extent to which you agree or disagree with **EACH** of the following statements. **CIRCLE** your choice using the following scale:

1 = ***STRONGLY DISAGREE***
2 = ***DISAGREE***
3 = ***AGREE***
4 = ***STRONGLY AGREE***

a) A man can make long range plans for his life, but a woman has to take things as they come.	1 2 3 4
b) A pre-school child is likely to suffer if his/her mother works.	1 2 3 4
c) A working mother can establish just as warm and secure a relationship with her children as a mother who does not work.	1 2 3 4
d) It is much better for everyone involved if the man is the achiever outside the home and the woman takes care of the home and family.	1 2 3 4
e) A woman should have exactly the same job opportunities as a man.	1 2 3 4
f) Men should share the work around the house with women such as doing dishes, cleaning, and so forth.	1 2 3 4
g) A woman should not let bearing and rearing children stand in the way of a career.	1 2 3 4
h) On the job, men should not refuse to work for women.	1 2 3 4
i) Women are much happier if they stay at home and take care of their children.	1 2 3 4
j) Young girls are entitled to as much independence as young boys.	1 2 3 4
k) Men and women should be paid the same money if they do the same work.	1 2 3 4
l) Women should be considered as seriously as men for jobs as executives or politicians or even President.	1 2 3 4
m) If anything happened to one of the children while the mother was working, she could never forgive herself.	1 2 3 4
n) A woman's job should be kept for her when she is having a baby.	1 2 3 4
o) You usually find that the happiest families are those with a large number of children.	1 2 3 4
p) There should be free or very low price childcare centers so that women could take jobs.	1 2 3 4

SECTION 2:

Q12: Considering **ALL** jobs you have had since your **16th BIRTHDAY**, please indicate approximately how many **YEARS** you have worked for pay or profit:

9 months or more, 35 hours or more MOST of the weeks: (enter "0" if none) ________ years

9 months or more, less than 35 hours MOST of the weeks: (enter "0" if none) ________ years

less than 9 months, 35 hours or more MOST of the weeks: (enter "0" if none) ________ years

less than 9 months, less than 35 hours MOST of the weeks: (enter "0" if none) ________ years

Q13: Are you **CURRENTLY** working for PAY or PROFIT? (Circle number)

1 No → If "No", go directly to **PART B** on page 6
2 Yes → If "Yes", answer the questions in **PART A**

PART A: ***Please answer the questions of this part ONLY IF you are CURRENTLY WORKING for pay or profit.***

Q14: How many **PAYING** jobs or self-employments do you **CURRENTLY** have? ________

Q15: Did you have **ANY OTHER** job in 1995 that you **NO LONGER** have today? (Circle number)

1 No → If "No", go to question Q17.
2 Yes

Q16: For **ONLY** the job(s) you had **in 1995**, but **NO LONGER** have today, please indicate approximately how much **GROSS** (Before Taxes) income you earned on that (those) job(s) in 1995.

$________________________ in 1995

Q17: For **EACH** of your **CURRENT** jobs, indicate whether you are EMPLOYED or SELF-EMPLOYED. (Circle number)

	EMPLOYED	SELF-EMPLOYED
PRIMARY JOB:	1	2
SECOND JOB:	1	2
THIRD JOB:	1	2

Q18: Please briefly describe the nature of your occupation for **EACH** of your **CURRENT** paying jobs.

PRIMARY JOB: ____

SECOND JOB: ____

THIRD JOB: ____

Q19: How long have you been employed on **EACH** job you currently have?

PRIMARY JOB: _________ years and _________ months
SECOND JOB: _________ years and _________ months
THIRD JOB: _________ years and _________ months

Q20: Please indicate how many **HOURS PER WEEK** you spend, **on average**, working on **EACH** job.

PRIMARY JOB: ________ hours per week
SECOND JOB: ________ hours per week
THIRD JOB: ________ hours per week

Q21: For **EACH** job you currently have, indicate how many **WEEKS** you spent working on this job **in 1995**. [**DO NOT** include any *paid* or *unpaid* week(s) of vacation, leave, sickness or disability.]

PRIMARY JOB: ________ weeks of work in 1995
SECOND JOB: ________ weeks of work in 1995
THIRD JOB: ________ weeks of work in 1995

Q22: Please indicate how many **WEEKS** of **PAID VACATION** or **LEAVE** you had **in 1995** for **EACH** job you currently have. (Enter "0" if none.)

PRIMARY JOB: ________ weeks of PAID vacation or leave in 1995
SECOND JOB: ________ weeks of PAID vacation or leave in 1995
THIRD JOB: ________ weeks of PAID vacation or leave in 1995

Q23: If you could work as much or as little as you wanted on your **CURRENT** job(s), at your **REGULAR pay rate(s)**, how many **HOURS PER WEEK** and **WEEKS PER YEAR** would you chose to work in **EACH** of your jobs?

PRIMARY JOB: ________ hours per week ________ weeks per year
SECOND JOB: ________ hours per week ________ weeks per year
THIRD JOB: ________ hours per week ________ weeks per year

Q24: For **EACH** job you **CURRENTLY** have, please indicate your **GROSS** (Before Taxes) rate of pay, and **CIRCLE** the time period for which this rate of pay applies.

PRIMARY JOB: $________________ hourly / weekly / every 2 weeks / twice monthly / monthly
SECOND JOB: $________________ hourly / weekly / every 2 weeks / twice monthly / monthly
THIRD JOB: $________________ hourly / weekly / every 2 weeks / twice monthly / monthly

Q25: For whatever reason, assume that tomorrow you were to lose **ALL** of your current jobs. What is the **LOWEST GROSS** (Before Taxes) **HOURLY pay rate** you would be willing to accept to take any particular job?

$__________ per hour

Q26: Assuming that you take a job at the **LOWEST GROSS** (Before Taxes) **HOURLY pay rate** you just reported above, how many **HOURS PER WEEK** and **WEEKS PER YEAR** would you be willing to work on this job?

_______ hours per week

_______ weeks per year

Please go to SECTION 3 on page 10

PART B: ***Please answer the questions of this part ONLY IF you are NOT CURRENTLY WORKING for pay or profit. Otherwise, go directly to SECTION 3 on page 10.***

Q27: Although you may not be currently working in the market, were you working for PAY or PROFIT anytime since **JANUARY 1995**? (Circle number)

1 No → If "No", go to **PART C** on page 9

2 Yes → If "Yes", please answer the rest of the questions in this part.

Q28: How many **PAID** jobs or self-employments did you have since **JANUARY 1995**? ______

Q29: For **ALL** the jobs you have had **since JANUARY 1995**, please indicate approximately how much **GROSS** (Before Taxes) income you earned from those jobs **in 1995**.

$____________________ in 1995

Q30: In which **MONTH** and **YEAR** did you stop working on your **LAST** paying job? ____________

Q31: On your __LAST__ (most recent) **PAYING** job, were you working as EMPLOYED or SELF-EMPLOYED? (Circle number)

1 Employed
2 Self-Employed

Q32: Please briefly describe the nature of your __LAST__ (most recent) paying job.

____

____

Q33: How long were you employed on your __LAST__ (most recent) job? ______ years and ______ months.

Q34: What is the __MAIN__ reason or event that caused you to stop working on that job? (Circle **ONE** number)

1 I became ill, disabled, or unable to work.
2 I decided to go back to school.
3 My job is seasonal and no work can be done during this time of the year.
4 I became pregnant and I am currently on a pregnancy or maternity leave.
5 I decided to leave my employer in order to find a better job.
6 I was laid off by my employer.
7 My employer went out of business.
8 I had to terminate business.
9 I stopped working on my job to take care of the home and/or the children.
10 I retired from the labor market.
11 Other, please briefly specify: ____

____

Q35: On __average__, how many **HOURS PER WEEK** were you working on your __LAST__ (most recent) job?

________ hours per week

Q36: On __average__, how many **WEEKS PER YEAR** were you working on your __LAST__ (most recent) paying job? [**DO NOT** include any *paid* or *unpaid* week(s) of vacation, leave, sickness or disability.]

________ weeks of work per year

Q37: Please indicate how many weeks of PAID vacation or leave per year you typically had in your __LAST__ (most recent) market job. (Enter "0" if none.)

________ weeks of PAID vacation or leave per year

Q38: Please indicate what was your **GROSS** (Before Taxes) rate of pay on your **<u>LAST</u>** (most recent) job, and **CIRCLE** the time period for which this rate of pay applied.

$____________________ hourly / weekly / every 2 weeks / twice monthly / monthly / annually

Q39: Are you **CURRENTLY** looking for a job? (Circle number)

1 No → If "No", go to question Q42.
2 Yes

Q40: If it were possible, would you take back your **<u>LAST</u>** (most recent) job **at the SAME PAY RATE** and **WORKING CONDITIONS** you had prior you stopped working on this job? (Circle number)

1 No → If "No", go to question Q42.
2 Yes

Q41: If you could take back your **<u>LAST</u>** (most recent) job, how many **HOURS PER WEEK** and **WEEKS PER YEAR** would you chose to work at the **<u>REGULAR</u> pay rate** you were earning on this job?

________ hours per week
________ weeks per year

Q42: Whether or not you are currently looking for a job, please indicate the **LOWEST GROSS** (Before Taxes) **HOURLY pay rate** you would be willing to accept to take any particular job.

$____________ per hour

Q43: Assuming that you take a job at the **LOWEST GROSS** (Before Taxes) **HOURLY pay rate** you just reported above, how many **HOURS PER WEEK** and **WEEKS PER YEAR** would you be willing to work on this job?

________ hours per week
________ weeks per year

Please go to <u>SECTION 3</u> on page 10

PART C: ***Please answer the questions of this part ONLY IF you have NOT WORKED AT ALL for pay or profit since JANUARY 1995. Otherwise, go to SECTION 3 on page 10.***

Q44: What is the **MAIN** reason that kept you from working for pay or profit since **JANUARY 1995**? (Circle only **ONE** number.)

1 I was ill, disabled, or unable to work.
2 I was going to school.
3 I was taking care of the home and/or the children.
4 I could not find a suitable job.
5 I could not find any job at all.
6 I was retired from the labor market.
7 Other, please briefly specify: ____

____

Q45: When did you stop working on your **LAST** (most recent) job? (Write both the **MONTH** and **YEAR**.)

____

Q46: Are you **CURRENTLY LOOKING** for a paid market job? (Circle number)

1 No
2 Yes

Q47: Whether or not you are currently looking for a job, please indicate the **LOWEST GROSS** (Before Taxes) **HOURLY pay rate** you would be willing to accept to take any particular job.

$____________ per hour

Q48: Assuming that you take a job at the **LOWEST GROSS** (Before Taxes) **HOURLY pay rate** you just reported above, how many **HOURS PER WEEK** and **WEEKS PER YEAR** would you be willing to work on this job?

________ hours per week

________ weeks per year

SECTION 3:

Q49: Various household work activities are carried out by household members. Below are three categories of such activities. Please place a check (√) in the box next to **EACH** activity **YOU typically perform** in your household.

CATEGORY 1: HOUSEHOLD AND YARD WORK

[ ] Indoor cleaning and maintenance
[ ] Household laundry and ironing
[ ] Repairs and alterations to clothing
[ ] Sewing and/or knitting home goods
[ ] Preparing meals for the household
[ ] Washing dishes, cookware, etc.
[ ] Indoor and/or outdoor home repairs
[ ] Yard and/or garden maintenance
[ ] Auto care and maintenance

What is your *'best'* **estimate** of how much total time you spend per **AVERAGE WEEK** on **ALL** the activities contained in **CATEGORY 1**? (Enter "0" if none.) ________ hours and ________ minutes

CATEGORY 2: HOUSEHOLD RESOURCE MANAGEMENT AND SHOPPING

[ ] Preparing household budget or spending plan
[ ] Managing routine finances (keeping bills and records)
[ ] Managing household investments and savings
[ ] Preparing shopping and grocery lists
[ ] Shopping for the needs of the household

What is your *'best'* **estimate** of how much total time you spend per **AVERAGE WEEK** on **ALL** the activities contained in **CATEGORY 2**? (Enter "0" if none.) ________ hours and ________ minutes

CATEGORY 3: CARE OF CHILDREN AND OTHER HOUSEHOLD MEMBERS

[ ] Active care to children, at home or away (attending needs, helping with school work, reading to them, transportation to school and recreational activities, etc.)

[ ] Active care to other household members, at home or away.

What is your *'best'* **estimate** of how much total time you spend per **AVERAGE WEEK** on the activities contained in **CATEGORY 3? DO NOT** include time just *'being there'* for supervision. (Enter "0" if none.) ________ hours and ________ minutes

Q50: Please give your **BEST estimate** of how much total time you spend per **AVERAGE WEEK** on **EACH** category of activities represented below. (Enter "0" if none.)

Sleep and Rest:	_______ hours and _______ minutes
Leisure Activities, Exercise, and Socializing:	_______ hours and _______ minutes
Studying or Reading for Educational Purposes:	_______ hours and _______ minutes
Unpaid Training or Practice Related to Employment:	_______ hours and _______ minutes
Volunteer Work for the Community or the Church:	_______ hours and _______ minutes

SECTION 4:

Q51: Considering **both** yours and your spouse's incomes, indicate approximately what was your **GROSS** (before taxes) **TOTAL COMBINED INCOME** from **ALL** sources (including personal earnings, investment income, net profits from business or rental property, pensions, social security, etc.) **in 1995**.

$________________________________

Q52: To what extent do you think that this income **was enough** for your family to live on **in 1995**? (Circle number)

1 not at all adequate
2 could meet necessities only
3 could afford some of the things we wanted but not everything
4 could afford about everything we wanted
5 could afford about everything we wanted and still save money

SECTION 5:

Q53: Overall, considering **ALL** aspects of your life, how **satisfied or dissatisfied** are you with the quality of **YOUR** life? (Circle number)

1 Extremely Dissatisfied
2 Dissatisfied
3 Somewhat Dissatisfied
4 Somewhat Satisfied
5 Satisfied
6 Extremely Satisfied

Thank You Very Much For Your Participation !

APPENDIX B

SPECIMENS OF THE POST-CARD REMINDERS

Post-Card Reminder

SPECIMEN

College of Human Environmental Sciences

Department of Consumer & Family Economics

239 Stanley Hall
Columbia, Missouri 65211
Telephone (573) 882-7836

UNIVERSITY OF MISSOURI-COLUMBIA

June, 1996

Sent out Two Weeks after the FIRST MAILING of the Survey Instruments

Dear Fellow Missourians:

About a week ago we mailed you two questionnaires as part of a survey on family time use in market work and at home. This is just a gentle reminder for you to complete the questionnaires as soon as possible and return them to us—hopefully within the next week. Please do keep in mind that the information you provide is strictly confidential and will never be connected with your name. Thanks for your participation in this Missouri study.

Sincerely Yours,

Jean Robitaille Research Associate	Edward J. Metzen Professor & Department Chair

Post-Card Reminder

SPECIMEN

College of Human Environmental Sciences

Department of Consumer & Family Economics

239 Stanley Hall
Columbia, Missouri 65211
Telephone (573) 882-7836

UNIVERSITY OF MISSOURI-COLUMBIA

July, 1996

Sent out Two Weeks after the SECOND MAILING of the Survey Instruments

Dear Fellow Missourians:

About a week ago we mailed you a second set of questionnaires as part of a survey on family time use in market work and at home. This is just a gentle reminder for you to complete the questionnaires as soon as possible and return them to us—hopefully within the next week. Please remember that the information you provide is strictly confidential and will never be connected with your name. Thank you for your participation in this Missouri study.

Sincerely Yours,

Jean Robitaille Research Associate	Edward J. Metzen Professor & Department Chair

APPENDIX C

PROCEDURE USED TO IMPUTE FEDERAL AND STATE INCOME TAXES FROM PERSONAL EARNINGS, NONLABOR INCOME, AND HOUSEHOLD INCOME FIGURES

As pointed out earlier, both market wage and shadow price of home time functions are expressed in terms of after-tax figures. Specifically, after-tax estimates are needed since, to the individual, the opportunity cost of home production time (i.e. the cost of engaging in unpaid home production activities rather than working for pay in the labor market) must be at least equal to her/his current or potential disposable (i.e. after-tax) return to paid employment at the margin. Hence, this appendix describes the procedure adopted to impute both Federal and Missouri State taxes from any reported and derived income- or earnings-related figures used in this study. Because of the 'quasi-investment' components of Social Security and Medicare coverage, FICA withholdings, although compulsory, were not imputed from income-related figures[1]. Also, inasmuch as the data used in this study were collected between June and July 1996, and income figures were reported for the year of 1995, the imputation procedure described here is based on the 1995 Income Tax Guides published by the Federal and the Missouri State governments.

For practical purposes, it is assumed that the sampled married-couple households jointly fill their tax returns and claim deductions and credits in conformity with this particular filing status. Also for practical reasons, and because both spouses were asked in the survey to report the total gross combined income of their household for 1995, the mean of these reported combined income figures for each married couple is taken as being their household's Adjusted Gross (joint) Income for 1995.

---

[1] To a large extent, FICA tax represents a form of *forced* investment in terms of added security and financial stability at retirement. As such, the assumption made in this study is that FICA withholdings are regarded by individuals in much the same way as the premiums they must pay in order to purchase private health or life insurance coverage.

Federal Income Tax

The first step of the procedure was to impute the Federal tax from the combined (joint) gross 1995 income figures reported by the surveyed married-couple households. In the 1995 Federal tax code, a married couple filing jointly could claim a Standard Deduction of $6,550, and personal exemptions were $2,500 per qualifying person in the household[2]. Accordingly, and because it was not possible to obtain the actual deductions claimed by the sampled households in 1995, Taxable Income figures were derived by subtracting both the Standard Deduction of $6,550 and the allowable total dollar amount for personal exemptions from reported combined income figures. Once Taxable Income figures for 1995 were obtained, the tax liability for each of the sampled households was determined using the Federal Tax Schedule Y-1 reproduced in Table C.1.

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[2] In 1995, the allowable total dollar amount for personal exemptions was reduced if the married-couple household had a joint Adjusted Gross Income exceeding the threshold amount of $172,050. Those personal exemptions were completely phased out if the joint Adjusted Gross Income exceeded $294,550. Hence, for those households which reported a total combined gross 1995 income of $172,050 or less, the dollar amount for personal exemptions was computed by simply multiplying the number of qualifying family members by $2,500. However, when the reported total combined gross income for 1995 was over the $172,050 threshold, the potential dollar value for personal exemptions was calculated from the worksheet presented below.

<u>Exemption Reduction Worksheet</u>

1. Multiply $2,500 by the number qualifying family members	(1) $_______
2. Compute the amount of gross combined income exceeding the $172,050 threshold	(2) $_______
3. Divide line (2) by $2,500 and round up to the next higher integer	(3) _____
4. Multiply the number on line (3) by 2 %	(4) _____
5. Multiply line (1) by line (4)	(5) $_______
6. Subtract line (5) from line (1). This was the dollar amount for personal exemptions the household could deduct in 1995 if its (joint) adjusted gross income exceeded the $172,050 threshold.	(6) $_______

Table C.1 Schedule Y-1 used to impute the 1995 Federal Income Tax

If the Joint Taxable Income for 1995 was:			
Over –	**but Not Over –**	**The Tax Was –**	**of the Amount Over –**
$ 0	$ 39,000	15%	$ 0
$ 39,000	$ 94,250	$ 5,850 + 28%	$ 39,000
$ 94,250	$143,600	$21,320 + 31%	$ 94,250
$143,600	$256,500	$36,618.50 + 36%	$143,600
$256,500	$ ——	$77,262.50 + 39%	$256,500

When appropriate, the credit for childcare expenses was computed and applied against the Federal tax liability of the household. In 1995 the allowable tax credit for childcare expenses ranged from 20 to 30 percent of up to $2,400 of care expenses for one qualifying dependent and up to $4,800 of expenses for two or more qualifying dependents. In this study, to qualify as "dependent" for the tax credit a child must have been under the age of 13 at the time the household was surveyed. The allowable credit was calculated from Table C.2.

Table C.2 Allowable Federal Tax Credit for 1995 Childcare Expenses

	MAXIMUM CREDIT		
Gross (Joint) Income of the Household in 1995	Credit Percentage	One Qualifying Dependent	Two or More Qualifying Dependents
$10,000 or Less	30%	$ 720	$1,440
$10,001 - $12,000	29%	$ 696	$1,392
$12,001 - $14,000	28%	$ 672	$1,344
$14,001 - $16,000	27%	$ 648	$1,296
$16,001 - $18,000	26%	$ 624	$1,248
$18,001 - $20,000	25%	$ 600	$1,200
$20,001 - $22,000	24%	$ 576	$1,152
$22,001 - $24,000	23%	$ 552	$1,104
$24,001 - $26,000	22%	$ 528	$1,056
$26,001 - $28,000	21%	$ 504	$1,008
$28,001 and Over	20%	$ 480	$ 960

To obtain the post-Federal income tax figure for each sampled household, the Federal tax liability—minus the credit for childcare expenses (when applicable)—was deducted from the reported joint income figures.

Missouri State Income Tax

Indeed, households not only have to pay income tax to the Federal government, but also to the State. Consequently, the second step of the procedure described in this appendix deals precisely with the imputation of the Missouri State tax from the joint gross 1995 income figures reported by the sampled married couples in this study. As with the Federal income tax, the Missouri Standard Deduction for married couples filing jointly in 1995 was $6,550. Additionally, for joint filing the Federal Income Tax Deduction was limited to a maximum of $10,000 in 1995, and the personal exemption was $2,400. Finally, in 1995, a $400 exemption per dependent (excluding both spouses) was allowed. Accordingly, Taxable Income figures for the sampled married-couple households were derived by subtracting the Standard Deduction of $6,550, the deduction for Federal Income Tax (up to $10,000), and the total dollar amount allowable for exemptions from the gross combined 1995 income figures reported by the households. Once Taxable Income figures were properly derived, the Missouri income tax liability for each household was assessed from the abridged tax schedule contained in Table C.3. As with the Federal income tax liability, the Missouri State income tax liability was simply deducted from the gross combined 1995 income reported by each of the sampled households to arrive at disposable income.

Table C.3 Schedule used to impute the 1995 Missouri State Income Tax

If the Joint Taxable Income for 1995 was:			
Over –	**but Not Over –**	**The Tax Was –**	**of the Amount Over –**
$0	$1,000	1.5%	$0
$1,000	$2,000	$ 15 + 2.0%	$1,000
$2,000	$3,000	$ 35 + 2.5%	$2,000
$3,000	$4,000	$ 60 + 3.0%	$3,000
$4,000	$5,000	$ 90 + 3.5%	$4,000
$5,000	$6,000	$125 + 4.0%	$5,000
$6,000	$7,000	$165 + 4.5%	$6,000
$7,000	$8,000	$210 + 5.0%	$7,000
$8,000	$9,000	$260 + 5.5%	$8,000
$9,000	$ ----	$315 + 6.0%	$9,000

Derivation of an After-tax Hourly Market Wage

Inasmuch as both Federal and State income taxes could be estimated and then imputed from the gross joint income figures reported by the surveyed households, it was possible to compute an average income tax rate for each married-couple household in this study. This average income tax rate was then utilized to derive after-tax hourly earnings figures for any working spouse in each sampled household. It was equally used in the calculation of the nonlabor (i.e. unearned) portion of the household's income. The average income tax rate for each household was calculated according to the following simple formula:

$$\boxed{\text{Average Income Tax Rate} = (\text{Federal} + \text{State Tax Liability}) \,/\, \text{Gross Combined Income} \;,}$$

For example, if a particular household had an average income tax rate of 20% and the wife was, at the time of the survey, working in the labor market at a gross wage of $12 per hour, then her net hourly return to paid employment was simply $12*(1–20%) = $9.60. In the very same way, if her husband's gross market wage was $18 per hour, then his net hourly return to paid employment was $18*(1–20%) = $14.40 at the time of the survey.

Carefully notice here that the household's average income tax rate was employed to obtained after-tax hourly market wage figures. Contrasting with the marginal tax rate, which provides the tax rate that applies only to the last (marginal) dollars of earnings, the average tax rate can be uniformly applied to the totality of the household's earnings. For this reason, the use of the average income tax rate was preferred to the marginal tax rate for the imputation procedure.

APPENDIX D

PRINCIPAL FACTOR ANALYSIS OF THE GENDER-ROLE ATTITUDES SCALE

As mentioned earlier while describing the independent variables considered in the diverse specifications of the estimation model, attitudinal variables related to the respondents' gender-role orientation were included in both the first and second variants of the standard specification. This was possible since both the wife and husband in each sampled household were, among other things, also asked to complete a gender-role attitudes scale as a part of the mail survey. (The scale appears in both forms of the questionnaire reproduced in Appendix A. In Form A, the scale is contained in Question 16 while, in Form B, Question 11 presents the very same scale.)

The gender-role attitudes scale used in this study is a modified version of the scale utilized in the *1970 National Fertility Study* conducted by the Office of Population Research at Princeton University. This particular scale was selected mainly because one of the underlying attitudinal dimensions or constructs this scale permits to measure has been found of substantial relevance in predicting the employment status of married women. For instance, a thorough analysis conducted by Thornton and Camburn (1979) on fertility, sex-role attitudes, and labor force participation of married women concluded that one particular dimension of this gender-role attitudes instrument, labeled "*Home Orientation*" by the authors, was intimately related to women's commitment to market work and to their current employment status.

Given the very nature of the present study, it was thought appropriate to employ this scale as the basic pointer for the gender-role attitude measures to be included as independent variables in the labor supply equation (and hence the shadow price of home time equation) of both the first and second variants of the standard specification of the estimation model.

In its original form, this attitudes scale contains 18 gender-role statements (i.e. items) for which respondents are asked to indicate the degree of their agreement or disagreement with each statement on a five point likert-type scale. Possible responses range from "Strongly Agree" to "Strongly Disagree" with a neutral point taking a value of three and denoting that the respondent is simply *indifferent* (i.e. "Undecided") with respect to the gender-role attitude conveyed by the particular statement. Figure D.1 reproduces the original gender-role attitudes scale used in the *1970 National Fertility Study*.

Do you *Strongly Agree*, *Agree*, *Disagree*, or *Strongly Disagree* with each of the following statements?

1 = *Strongly Agree*
2 = *Agree*
3 = *Undecided or Don't Know*
4 = *Disagree*
5 = *Strongly Disagree*

1. A man can make long range plans for his life, but a woman has to take things as they come.	1 2 3 4 5
2. A pre-school child is likely to suffer if his/her mother works.	1 2 3 4 5
3. A working mother can establish just as warm and secure a relationship with her children as a mother who does not work.	1 2 3 4 5
4. It is much better for everyone involved if the man is the achiever outside the home and the woman takes care of the home and family.	1 2 3 4 5
5. A woman should have exactly the same job opportunities as a man.	1 2 3 4 5
6. Men should share the work around the house with women such as doing dishes, cleaning, and so forth.	1 2 3 4 5
7. A woman should not let bearing and rearing children stand in the way of a career if she wants it.	1 2 3 4 5
8. On the job, men should not refuse to work under women.	1 2 3 4 5
9. Women are much happier if they stay at home and take care of their children.	1 2 3 4 5
10. Young girls are entitled to as much independence as young boys.	1 2 3 4 5
11. Men and women should be paid the same money if they do the same work.	1 2 3 4 5
12. Women should be considered as seriously as men for jobs as executives or politicians or even President.	1 2 3 4 5
13. If anything happened to one of the children while the mother was working, she could never forgive herself.	1 2 3 4 5
14. A woman's job should be kept for her when she is having a baby.	1 2 3 4 5
15. You usually find that the happiest families are those with a large number of children.	1 2 3 4 5
16. Many of those in women's rights organizations today seem to be unhappy misfits.	1 2 3 4 5
17. There should be free childcare centers so that women could take jobs.	1 2 3 4 5
18. Sex seems to exist mainly for the man's pleasure.	1 2 3 4 5

Figure D.1 Original Gender-Role Attitudes Scale used in the *1970 National Fertility Study*

In this study the original scale was reduced to 16 statements, however. More precisely, items 16 and 18 were excluded from the gender-role attitudes scale because the pilot phase of the survey instruments seemed to reveal a general misunderstanding and/or a certain reticence with regard to the nature and/or content of these two specific statements. Further, two items of the original scale were slightly rephrased. For instance, the expression "under women" in the original statement 8 was replaced by "for women" because, as pointed out by some participants during the pilot phase of the questionnaires, the semantic associated with the word '*under*' was somewhat disturbing. The other original statement that was modified is statement 17. Given today's highly organized and privatized childcare service industry, it was felt that the adjective "free" was semantically extreme when used alone in the statement. Accordingly, statement 17 was reformulated to soften the concept it underlies (i.e. affordable childcare services that ease women's access to the paid labor market). In fact, statement 17 was rephrased as follows: 'There should be free *or very low cost* childcare centers so that women could take jobs.' Finally, rather than using the original five-point scale developed in the *1970 National Fertility Study*, a four-point scale was retained for the present study. Precisely, for each of the 16 statements contained in the gender-role attitudes scale, possible responses range from "Strongly Disagree" to "Strongly Agree" with no explicit *neutral* (i.e. 'Undecided') point. Indeed, where necessary, categories were reordered for analysis so that for all 16 statements a low score indicates an egalitarian or non-traditional response[1]. The idea behind the removal of the neutral point was to somehow force the respondents to express the strength of their agreement or

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[1] Precisely, the response categories related to statements c, e, f, g, h, j, k, l, n, and p were reordered so that a low score to those items reflects a non-traditional or egalitarian response.

disagreement on the scale. Although neutral attitudes are conceivable in theory, it is believed that in practice most people assume a non-neutral position on the agreement-disagreement continuum; however, because choosing sides could at times be mentally laborious, people often seem to have the spontaneous and unfortunate tendency to *hide* behind a neutral position when such 'neutrality' is an offered option. Hence, the removal of the neutral point from the original scale was essentially to minimize such deplorable tendency[2].

Correlations among the 16 gender-role items for both sampled married women and men exhibited different degrees of relationships among the several measures which were expected to cluster on theoretical grounds[3]. For both the wives and husbands the standardized Cronbach's alpha is 0.83, confirming the excellent reliability (i.e. internal consistency) of the gender-role attitudes scale as a whole. Further, for each gender, Kaiser's overall measure of sampling adequacy is around 0.87, indicating that, from a statistical standpoint, the gender-role attitudes scale used in this study should be regarded as a sound and well-balanced instrument for the construction of robust summary indices. In order to construct summary indices from the scale, principal factor analysis was conducted separately for both the sampled wives and husbands. Table D.1 presents the factor analysis for the sampled wives and a similar analysis for the husbands is reported in Table D.2.

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[2] A score of 2.5 was given to those few respondents whose answers to some attitudinal statements were either positioned in between the "disagree" and "agree" categories or missing.

[3] Inter-item correlation matrices for both sampled wives and husbands are available upon written request to the author.

Table D.1 Wives' Gender-role Attitude Measures: Primary Factor Loadings[a] (n=857)

Gender-role Attitude Measures[b]	Factor 1	Factor 2
a. Men can make long range plans/Women can't	0.176	0.207
b. Mother works/Kids likely to suffer	0.048	**0.789**[c]
c. Working moms/Same relationship with kids	0.122	**0.731**
d. Men should work but women shouldn't	**0.320**	**0.611**
e. Men & Women/Equal Opportunities	**0.612**	0.189
f. Men should share housework with women	**0.562**	0.172
g. Women's career/More important than kids	0.110	**0.592**
h. Men should not refuse to work for women	**0.603**	0.112
i. For women happiness is found in the home	**0.301**	**0.515**
j. Girls/Boys should get same independence	**0.453**	0.173
k. Men/Women—equal pay for equal work	**0.706**	0.107
l. Women as executives should be acceptable	**0.714**	0.184
m. Working moms are responsible if kids hurt	0.127	**0.352**
n. Pregnant women are entitled to keep their job	**0.456**	0.162
o. Large number of kids equals happy family	0.253	0.296
p. Need low-cost childcare for working women	0.219	0.183

[a] Factor loadings resulted from orthogonal (i.e. Varimax) rotations.

[b] See Appendix A, Question 16 in Form A or Question 11 in Form B for the exact wording of each of the gender-role attitude measures.

[c] Bolded loadings indicate that the specific gender-role attitude measure was found statistically satisfactory to cluster under a particular factor.

For the wives as well as for the husbands, two factors were extracted using orthogonal rotations (i.e. Varimax). Oblique rotations (i.e. Promax) were also performed and comparable results were obtained. As customarily employed in psychometric analyses, a

Table D.2 Husbands' Gender-role Attitude Measures: Primary Factor Loadings[a] (n=857)

Gender-role Attitude Measures[b]	Factor 1	Factor 2
a. Men can make long range plans/Women can't	**0.309**	0.130
b. Mother works/Kids likely to suffer	−0.014	**0.695**[c]
c. Working moms/Same relationship with kids	0.127	**0.641**
d. Men should work but women shouldn't	0.249	**0.619**
e. Men & Women/Equal Opportunities	**0.585**	0.258
f. Men should share housework with women	**0.478**	0.171
g. Women's career/More important than kids	0.159	**0.542**
h. Men should not refuse work for women	**0.536**	0.170
i. For women happiness is found in the home	0.249	**0.584**
j. Girls/Boys should get same independence	**0.520**	0.132
k. Men/Women—equal pay for equal work	**0.721**	0.082
l. Women as executives should be acceptable	**0.736**	0.164
m. Working moms are responsible if kids hurt	0.182	**0.329**
n. Pregnant women are entitled to keep their job	**0.458**	0.194
o. Large number of kids equals happy family	0.181	**0.321**
p. Need low-cost childcare for working women	0.129	0.261

[a] Factor loadings resulted from orthogonal (i.e. Varimax) rotations.

[b] See Appendix A, Question 16 in Form A or Question 11 in Form B for the exact wording of each of the gender-role attitude measures.

[c] Bolded loadings indicate that the specific gender-role attitude measure was found statistically satisfactory to cluster under a particular factor.

minimum loading criterion of .30 was considered as *statistically* satisfactory for any gender-role item to cluster under a particular index (i.e. factor). In interpreting the results of the factor analyses theoretical considerations took precedence in determining the true attitudinal dimensions embodied in the scale, however.

For the sampled wives, nine items demonstrated communality with the first factor extracted (i.e. items d, e, f, h, i, j, k, l, and n). However, because items d ("Men should work but women shouldn't") and i ("For women happiness is found in the home") showed much stronger interdependence with the second factor, these items were not regarded as theoretically valid for inclusion under the first factor. The seven remaining items (i.e. items e, f, h, j, k, l, and n) appear to align theoretically, since all measure, to a certain degree, the extent to which married women in the sample perceive the necessity of gender equity in the paid labor force and in the home. Accordingly, these seven items were combined and the resulting index was labeled "*Equity of Privileges Between Genders*", indicating the extent to which the wife feels that there should be equitable opportunities and privileges between genders.

Also from Table D.1, it is seen that six items correlated with the second factor extracted from the entire scale (i.e. items b, c, d, g, i, and m). These six items appear to be very similar with respect to the theoretical construct they measure. Simply put, they all measure the extent to which the wife views her proper role as being primarily a homemaker and the extent to which market work activities may cause distress and difficulty in the home. Consequently, these six items were consolidated under an index similarly labeled in the Thornton & Camburn study (1979) as "*Home Orientation*". This resulting index indicates that respondents scoring high on that particular dimension of the gender-role attitudes scale believe that, for a woman, a homemaking role is both more appropriate and more valuable than a market role, and that she should receive greater satisfaction from engaging in such a role.

Now turning to the sampled husbands, Table D.2 shows that eight items (i.e. items a, e, f, h, j, k, l, and n) shared communality with the first factor previously labeled "*Equity of Privileges Between Genders*". With the exception of item a ("Men can make long range plans/Women can't"), the other items are the very same that clustered under this first factor in the analysis performed for the wives. Although item a appears to share a certain communality with the other items that loaded under the first factor for the husbands, its degree of correspondence with this particular dimension of the gender-role attitudes scale is statistically weak (i.e. .309) compared to the seven other items, and also very close to the established minimum of .30 for reliable clustering. Hence, mainly for precautionary reasons, item a was dismissed from the first summary index. As for the wives, the seven remaining items align theoretically inasmuch as all appear to indicate, to some degree, the extent to which sampled married men perceive the need for gender equity in the paid labor market as well as in the home.

Also related to the sampled husbands, the data presented in Table D.2 allow to distinguish seven items which statistically clustered under the second factor previously defined as "*Home Orientation*" (i.e. items b, c, d, g, i, m, and o). With the exception of item o ("Large number of kids equals happy family"), the six other items are identical to those found clustering on this particular factor for the wives. In contrast to the other gender-role items defining this second factor, although item o is found to exhibit a certain statistical degree of communality with the other items, because it is a fertility norm measure, it does not appear to concord theoretically with the attitudinal dimension measured by the other six items. More specifically, while items b, c, d, g, i, and m all measure the extent to which the husband perceives the role of women as being primarily homemakers and the extent to which market work may cause distress or difficulty in the home, item o—a fertility norm variable—was considered theoretically disconnected from the gender-role attitudinal dimension underlying the second factor. For this reason, item o was eliminated from the "*Home Orientation*" index. As in the case of the wives, the resulting index indicates that husbands scoring high on that particular dimension of the scale believe that, for a woman, a homemaking role is more appropriate, more valuable, and also more rewarding than a market role in terms of personal gratification.

Establishing a parallel with the factor analysis conducted by Thornton and Camburn in 1979 with a national sample of married wives on the original version of this gender-role attitudes scale, it should be noted that the two distinct factors extracted from the modified version of the scale used in this study are remarkably consistent with Thornton's and Camburn's previous findings. Using the very same minimum loading criterion of .30 for inclusion under a particular factor, the only real difference between the two analyses is related to item f. Specifically, while item f (i.e. "Men should share housework with women") was not found to present sufficient statistical communality with either the first or second dimension extracted from the original gender-role attitudes scale used in their analysis, the current factor analyses conducted on both sampled married women and men clearly show that this particular item theoretically harmonizes with the other attitudinal measures which define the first dimension (i.e. *Equity of Privileges Between Genders*) of this slightly modified version of the original gender-role attitudes scale. Indeed, that the very same items (except for item f) loaded under similar theoretical dimensions (i.e. constructs) in an analysis performed on data collected over two decades ago should be seen, to a large extent, as a very good indication of the construct validity inherent to the gender-role attitudes scale employed in this study.

Given the theoretical nature underlying the "*Home Orientation*" index, and also because only this particular dimension of the gender-role attitudes scale was found to be a significant determinant in predicting married women's employment status and commitment to the paid labor force (see Thornton & Camburn, 1979), both the wives' and husbands' gender-role attitude scores to this specific index were used as regressors in the first and second variants of the standard model commonly used to derive the value of home production time for married women.

APPENDIX E

RESULTS OF THE OLS REGRESSION ANALYSIS USED FOR THE ESTIMATION OF DESIRED ANNUAL HOURS OF HOME LABOR

In order to derive the desired (i.e. unconstrained) hours of home labor for the subsamples of constrained wives, an OLS regression analysis of the yearly hours of home labor was performed over the subsample of employed wives whose time-allocation behavior were not afflicted by institutional labor market constraints at the time of the survey (n=196). Indeed, since these employed wives were fully maximizing utility in their long-run time-allocation equilibria prior to the control of labor market constraints implemented in the second variant of the standard estimation model, it follows that, as with their reported (i.e. observed) hours of market work, their reported hours of household labor were in fact their desired hours (i.e. $M^{OBS} = M^{DES}$ and $H^{OBS} = H^{DES}$). Thus, in principle, it was possible to estimate a desired hours of home labor function based on the personal and socio-demographic characteristics of these particular wives. Further, once estimated, this function was utilized to derive an estimate of the desired hours of home labor for any particular subsample of wives whose time-allocation behavior were constrained in the labor market—and hence in the home—prior to the control of labor market restraints.

Accordingly, the desired hours of home labor function reproduced below was estimated on the following characteristics of the unconstrained working wives (n=196):

$$\begin{aligned} H_i^{DES} = {} & \beta_{H0} + \beta_{H1}AGE_i + \beta_{H2}AGESQ_i + \beta_{H3}ED1_i + \beta_{H4}ED2_i + \beta_{H5}ED3_i + \beta_{H6}ED4_i + \beta_{H7}CRED_i + \\ & \beta_{H8}RACE_i + \beta_{H9}CNSIZE_i + \beta_{H10}KDSLT6_i + \beta_{H11}KDS6\text{~}16_i + \beta_{H12}KDSGE16_i + \\ & \beta_{H13}OTHGE16_i + \beta_{H14}YMARRIED_i + \beta_{H15}OWN_i + \beta_{H16}BEDROOMS_i + \beta_{H17}SIZEYRD_i + \\ & \beta_{H18}SPWAGE_i + \beta_{H19}UNEARN_i + \beta_{H20}MLIM_i + \beta_{H21}SPMLIM_i + \beta_{H22}ATT2_i + \\ & \beta_{H23}SPATT2_i + \beta_{H24}HHTECH_i + \beta_{H25}YADEQ_i + U_{Hi} \end{aligned}$$

where

H_i^{DES} = the desired (i.e. unconstrained) annual hours of home labor for the satisfactorily employed wives ;

AGE_i = the age of the wife in years ;

$AGESQ_i$ = the age of the wife squared ;

$ED1_i$ = 1 if the wife's highest education level is a High School diploma, 0 if otherwise ;

$ED2_i$ = 1 if the wife's highest education level is a Technical School diploma, 0 if otherwise ;

$ED3_i$ = 1 if the wife's highest education level is an Undergraduate College degree, 0 if otherwise ;

$ED4_i$ = 1 if the wife's highest education level is a Graduate/Professional College degree, 0 if otherwise ;

$CRED_i$ = 1 if the wife possesses any extra-curricular credential such as a special license, certification, etc., 0 if otherwise ;

$RACE_i$ = 1 if the wife is Caucasian (White), 0 if otherwise ;

$CNSIZE_i$ = the size of the population expressed in 100,000s of inhabitants in the wife's county of residence (as published by the U.S. Census Bureau on March 1996, series CB96-32) ;

$KDSLT6_i$ = the number of children under 6 years of age living in the household ;

$KDS6{\sim}16_i$ = the number of children aged 6 and over, but less than 16 years old living in the household ;

$KDSGE16_i$ = the number of children aged 16 and over living in the household ;

$OTHGE16_i$ = the number of relatives (excluding immediate family members) and/or friends aged 16 and over living in the household ;

$YMARRIED_i$ = the number of years the wife had been married with her current spouse at the time of the survey ;

$$OWN_i = \begin{cases} 1 \text{ if the wife's household owns or is buying its current residence,} \\ 0 \text{ if otherwise ;} \end{cases}$$

$BEDROOMS_i$ = the number of bedrooms in the wife's current residence ;

$SIZEYRD_i$ = the size of the yard the household must care for where the wife resides[1] ;

$SPWAGE_i$ = the after-tax market wage of the wife's spouse on his primary job. Considering both Federal and Missouri State income taxes, one minus the household's 1995 average income tax rate was used to convert the husband's gross market wage into an after-tax figure[2] ;

$UNEARN_i$ = the after-tax total household income for 1995 in thousands of dollars minus husband's and wife's earnings from paid employment. Taking into account both Federal and Missouri State income taxes, one minus the household's 1995 average income tax rate was used to convert the gross unearned income into an after-tax figure[3] ;

$MLIM_i$ = an index representing the extent to which the wife is limited with respect to the type or amount of work she can possibly accomplish due to a health condition or disability[4] ;

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[1] The household's yard size variable, SIZEYRD, was scaled as follows:

- '1' if the household had *no yard* to care for or only a *modest yard* (i.e. less than 1/8 acre or 75 x 75 feet) to maintain at the time of the survey ;
- '2' if the household had a *small yard* (i.e. 1/8 acre or more but less than 1/4 acre or 100 x 100 feet) to maintain at the time of the survey ;
- '3' if the household had a *medium yard* (i.e. 1/4 acre or more but less than 1/2 acre or 150 x 150 feet) to maintain at the time of the survey ;
- '4' if the household had a *large yard* (i.e. 1/2 acre or more but less than 1 acre or 200 x 200 feet) to maintain at the time of the survey ;
- '5' if the household had a *very large yard* (i.e. 1 acre or more) to maintain at the time of the survey .

[2] See Appendix C for the details on how the household's average income tax rate for 1995 was estimated.

[3] See Appendix C for the details on how the household's average income tax rate for 1995 was estimated.

[4] The MLIM variable was scaled as follows:

- '1' if the wife reported ***no health-related limitation*** on the amount or type of work she could do ;
- '2' if she reported ***a slight health-related limitation*** on the amount or type of work she could do ;
- '3' if she reported ***an important health-related limitation*** on the amount or type of work she could do ;
- '4' if she reported ***a total health-related limitation*** on the amount or type of work she could do .

$SPMLIM_i$ = an index representing the extent to which the wife's spouse is limited with respect to the type or amount of work he can possibly accomplish due to a health condition or disability[5] ;

$ATT2_i$ = the wife's score at a 'Home Orientation' attitudinal index denoting what she views as the proper role of women in the family and in society in general, and the extent to which she perceives market work to generate difficulty in the home[6]. (A low score to this index indicates a more egalitarian attitude, while a high score reflects a more traditional attitude.) ;

$SPATT2_i$ = the husband's score at a 'Home Orientation' attitudinal index denoting what he views as the proper role of women in the family and in society in general, and the extent to which he perceives women's involvement in the paid labor force to generate difficulty in the home[7] . (Again, a low score to this index indicates a more egalitarian attitude, while a high score reflects a more traditional attitude.) ;

$HHTECH_i$ = the wife's score at a Household-Technology Adequacy Index conveying her perception vis-à-vis the degree of adequacy of her available home tools and equipment at the time of the survey[8] ;

and

$YADEQI_i$ = the wife's score at an Income Adequacy Index conveying her perception with respect to the overall capacity of her household's money income to meet the wants of her family unit[9] .

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[5] The SPMLIM variable was coded using the very same scale as for MLIM, except that it is expressed in terms of the husbands' data instead of the wives' data.

[6] Refer to Appendix D for the details on how the 'Home Orientation' attitudinal index was elaborated.

[7] Refer to Appendix D for the details on how the 'Home Orientation' attitudinal index was elaborated.

[8] A three-point scale was used to generate the wife's household-technology adequacy index, HHTECH. This scale is reproduced as follows:

'1' if the wife reported an *important shortage* (i.e. "a lack") of equipment at the time of the survey ;
'2' if the wife reported only *some shortage* of equipment at the time of the survey ;
'3' if the wife reported *no shortage* (i.e. "plenty") of equipment at the time of the survey .

[9] The household (money) income adequacy index, YADEQI, was generated from the wife's response to the five-point scale reproduced below.

1 = not at all adequate ;
2 = could meet necessities only ;
3 = could meet some of the things we wanted but not everything ;
4 = could afford about everything we wanted ;
5 = could afford about everything we wanted and still save money .

Table E.1 OLS Regression Results for the Desired Yearly Hours of Home Labor, H^{DES}, Based on the Characteristics of the Sampled Wives Identified as Satisfactorily Employed Prior to the Control of Labor Market Constraints (n=196)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
INTERCEPT	218.960982 (2035.8493)	0.000000
AGE (in years)	−9.066916 (89.1654)	−0.072680
AGESQ	0.086272 (0.9706)	0.062684
ED1 (High School diploma/Base: < than ED1)	−265.633123 (318.9876)	−0.115699
ED2 (Technical School diploma/Base: < than ED1)	54.272591 (469.3818)	0.010029
ED3 (Undergraduate College degree/Base: < than ED1)	−189.600124 (346.2556)	−0.075658
ED4 (Grad. or Prof. College degree/Base: < than ED1)	−377.922557 (415.6754)	−0.083006
CRED (Base: 'no credentials')	−201.357444 (186.9018)	−0.072729
RACE (Base: 'non-white')	−233.050562 (405.8515)	−0.038189
CNSIZE (in 100,000s of population)	−35.195175 (20.5223)	−0.119396
KDSLT6	953.171499 *** (168.7339)	0.424589 ***
KDS6~16	629.098447 *** (94.6463)	0.490801 ***
KDSGE16	149.049787 (102.1471)	0.103684
OTHGE16	253.888527 (748.3987)	0.022538
YMARRIED (in years)	7.581549 (11.9800)	0.068564
OWN (Base: 'non-homeowner')	589.296206 (534.4339)	0.073588
BEDROOMS	−133.812946 (119.7920)	−0.082665
SIZEYRD	10.280885 (66.4977)	0.010767

Table E.1 (continued)

Independent Variables	Parameter Estimates	
	Unstandardized[a]	Standardized[b]
SPWAGE (in after-tax dollars)	13.304640 (11.3497)	0.087570
UNEARN (in 1,000s of after-tax dollars)	8.508967 (11.3884)	0.052024
MLIM	225.754696 (186.7385)	0.080241
SPMLIM	28.617365 (133.4355)	0.015368
ATT2 (a high score=traditional gender-role attitude)	19.982429 (27.6846)	0.056197
SPATT2 (a high score=traditional gender-role attitude)	25.657940 (27.4320)	0.074148
HHTECH	219.559761 (189.0625)	0.079633
YADEQI	−81.192935 (72.8435)	−0.077958

ADJ. R^2 = 0.2807, F (25, 195) = 3.965 ***, SE of ESTIMATE = 975.1014

[a] Standard errors in parentheses.

[b] The standardized parameter estimates were computed by dividing the unstandardized estimates by their respective ratios of the sample standard deviation of the dependent variable to the sample standard deviation of the particular independent variable.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results of this desired hours of home labor regression are reported in Table E.1. Using the personal characteristics of the subsamples of wives who were constrained with respect to their time-allocation behavior prior to the control of institutional labor market constraints (i.e. the subsamples of wives who were involuntarily unemployed, underemployed, and overemployed, respectively), this estimated desired hours of home labor function was utilized to derive the estimates of H^{DES} reported in Table 6.18.

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VITA

Jean Robitaille was born September 6th, 1965, in Québec city, Canada where he still permanently resides. His high school education was completed in Charlesbourg, Québec, where he graduated in 1982. From 1982 to 1984, Mr. Robitaille attended the college of Limoilou, Québec, where he received his general and vocational degree in Human Sciences.

He enrolled at Laval University, a French university in Québec, in 1985, where he first completed a Bachelor Degree in Consumer Sciences (i.e. "Sciences de la Consommation") in May 1988, and a Master Degree in Measurement & Evaluation (i.e. "Mesure & Evaluation") in June 1991. While working on his Master Degree at Laval, he served both as teaching and research assistant for the department of Measurement & Evaluation. He also worked as an independent researcher in Measurement & Evaluation on several governmental and private projects.

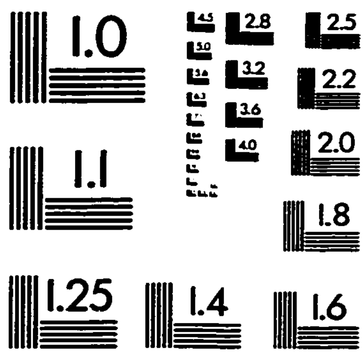
His tremendous interest for the field of Consumer Economics, his overall academic performance, and his eagerness for new cultural and professional experiences provided him with the opportunity of being recruited by Laval University as faculty member for the

Department of "Economie Agroalimentaire et Sciences de la Consommation" upon acquisition of a fully funded doctoral degree in the field of interest in the United States. Thenceforth, in August 1991, Mr. Robitaille migrated to the Midwestern state of Missouri, where he first perfected his English during the course of a semester at the Intensive English Program (IEP) at the University of Missouri-Columbia. In June 1992, he then became a doctoral student in Consumer & Family Economics at the same university. He became a Ph.D. candidate in March 1995. He received the Superior Graduate Achievement Award for 1997 from the Graduate Student Association, which association he presided for the entire academic year in 1994. Further, Mr. Robitaille has been granted additional funding from Laval University in order to engage in post-doctoral work until his debut as faculty member.

Including among his principal research interests are the economic valuation of household production time, the interrelationships of market work and the family, the economic analysis of fertility and human capital development, and the intergenerational granting among families.

Mr. Robitaille is currently engaged to Ms. Sylvie Guenette, and plans for a marital union should be carried out in the Spring following his graduation from the University of Missouri-Columbia.

IMAGE EVALUATION TEST TARGET (QA-3)



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