AN EMPIRICAL MODEL OF DISCRETE AND CONTINUOUS CHOICE IN FAMILY LABOR SUPPLY

Michael R. Ransom*

Abstract—Because of the interdependent nature of family labor supply decisions, the non-negativity constraint on women's hours of work will spill over into other consumption and labor supply decisions of the family. Here I develop an econometric model of family labor supply that captures this "spillover," while addressing the usual censoring issues as well. The model is based on a flexible direct utility function and permits unobservable differences in tastes. The model is estimated by the maximum likelihood method on a sample of about 1200 families from the Panel Study of Income Dynamics.

I. Introduction

PERHAPS the most important "fact" of family labor supply is that a large fraction of married women do not participate in the labor force. This presents two problems for empirical analysis. On the one hand, the non-negativity constraint on the wife's work, like any quantity constraint in an economic system, spills over into the other labor supply and consumption decisions of the family.[1] For example, we expect the labor supply functions of men to belong to different regimes, depending on whether their wives work.

On the other hand, the constraint obscures information about how the wife would like to respond to changes in wage rates or income. This "censoring" problem is very common in applied economics, and was first discussed by Tobin (1958). Rosett (1958) used Tobin's techniques to analyze labor supply problems, and numerous studies have followed, especially in the area of female labor supply.[2] For analysis of female labor supply in isolation, the utility maximizing implications of a quantity constraint are unimportant. To date only a few studies have attempted to address the "corner solution" problem in a model of joint husband–wife labor supply decision making.

The empirical literature dealing with the labor supply of married couples is surprisingly sparse, especially considering the dramatic changes in the labor force behavior of married women in the last 30 years relative to other groups. Of the few empirical studies of joint family labor supply, most have been based on samples restricted to households in which both spouses work.[3] Such an approach is strangely out of step with the importance placed on censoring issues in the female labor supply literature. Furthermore, estimation based on an endogenously selected sample will yield biased results.

Some recent work has taken a more sophisticated approach. For example, Blundell and Walker (1982) use a sample of only working couples, but correct for sample selection bias. This approach is not entirely satisfactory, since it ignores a large portion of the available data. Papers by Hausman and Ruud (1984) and by Kooreman and Kapteyn (1986) address the same issues as this paper. Both studies model family preferences using flexible functional forms, and impose the restrictions of the non-negativity constraint. However, their approaches require very restrictive assumptions about the stochastic structure of the models. The approach adopted by Hausman and Ruud (1984) does not permit stochastic differences in tastes. Any variability in hours among otherwise identical couples must be interpreted as "optimization error." Likewise, the method of Kooreman and Kapteyn (1986) is not strictly compatible with unobservable variation in tastes across observations, although they interpret their stochastic structure as an approximation of such.

In this paper I develop an econometric model of family labor supply based on a quadratic utility function. The specification permits unobservable differences in tastes and imposes the utility model consistently, regardless of the work status of the wife. The model takes the form of a simultaneous system of Tobit equations, similar to the models discussed by Amemiya (1974) and Wales and

Received for publication July 21, 1986. Revision accepted for publication March 6, 1987.

* University of Arizona.

[1] There is a large theoretical literature dealing with the effects of quantity constraints in demand systems. See, for example, Tobin and Houthakker (1950–51) or Ashenfelter (1980).

[2] For a survey of this literature, see Heckman and MaCurdy (1981) or Killingsworth (1981).

[3] This is true for all of the family labor supply studies based on micro data in the survey by Killingsworth (1981).

Woodland (1983). Estimation is by maximum likelihood.

II. Development of the Model

Consider a family that maximizes a utility function of three goods: husband's leisure, wife's leisure and money income. The family utility function

$$U = U(T - h_1, T - h_2, X),$$

is maximized subject to the constraints

$$X = w_1 h_1 + w_2 h_2 + Y,$$

and

$$h_1 \geq 0,\ h_2 \geq 0,$$

where T is the time available for work or leisure, h_1 is the number of hours that the husband spends at work, h_2 is the hours of work for the wife, Y is unearned income, and X is total money income. Thus w_1 and w_2, as well as Y, are measured in real terms. Since the budget constraint will be satisfied with equality, it is convenient to express the family utility in terms of hours of work only:

$$U^* = U(T - h_1, T - h_2, w_1 h_1 + w_2 h_2 + Y).$$

For any combination of h_1 and h_2, it is possible to define the marginal utility of increasing or decreasing hours of work as

$$m_1 = -U_1 + w_1 U_3 = m_1(h_1, h_2, w_1, w_2, Y), \tag{1a}$$

$$m_2 = -U_2 + w_2 U_3 = m_2(h_1, h_2, w_1, w_2, Y). \tag{1b}$$

These equations express the tradeoffs that a family makes in choosing hours of work.

In the absence of quantity constraints the first-order conditions for utility maximization require that

$$m_1(h_1, h_2, w_1, w_2, Y) = 0 \tag{2a}$$

and

$$m_2(h_1, h_2, w_1, w_2, Y) = 0. \tag{2b}$$

The usual approach in empirical studies of labor supply is to solve (2a, b) for the reduced form labor supply functions and estimate these directly. Most studies implicitly follow this course.

However, if the family utility is higher with the wife not working, the first-order conditions become

$$m_1(h_1, h_2, w_1, w_2, Y) = 0, \tag{3a}$$

and

$$m_2(h_1, h_2, w_1, w_2, Y) < 0. \tag{3b}$$

Condition (3b) simply states that family utility would decrease if the wife were to work. Utility is maximized when the remaining choice variable, h_1, satisfies (3a).

There is not a single reduced form, but two. Which labor supply regime the family belongs to is endogenously determined by the tastes and constraints that the family faces. An equivalent way of writing this system is to solve (2a) and (3a) for h_1 and (2b) and (3b) for h_2. This yields a simultaneous system of equations:

$$h_1 = h_1(h_2, w_1, w_2, Y)$$

$$h_2 = \begin{cases} h_2(h_1, w_1, w_2, Y) & \text{if } h_2(\ ) > 0, \\ 0 & \text{otherwise.} \end{cases}$$

The equation for h_2 has the form of the traditional limited dependent variable model, or Tobit. This expression emphasizes that the method proposed here is a generalization of the single equation techniques that are used extensively in empirical analyses of female labor supply.

Empirical Model

The empirical model estimated here is based on a quadratic utility function:

$$U(Z) = \alpha Z - \left(\frac{1}{2}\right) Z' \beta Z, \tag{4}$$

where Z is a vector with elements $Z_1 = T - h_1$, $Z_2 = T - h_2$ and $Z_3 = w_1 h_1 + w_2 h_2 + Y$, α is a vector of parameters and β is a matrix of parameters. The quadratic can be thought of as a second order approximation to an arbitrary utility function when β is positive definite.[4] Also, the marginal utility functions are linear in h_1 and h_2, which makes the quadratic function especially convenient for empirical applications. The marginal utility

[4] For a thorough discussion of the quadratic utility function in the context of demand theory, see Goldberger (1967).

unctions are

$$
\begin{aligned}
m_1 = & -\alpha_1 + \alpha_3 w_1 + \beta_{11}(T - h_1) \\
& -\beta_{33} w_1 (w_1 h_1 + w_2 h_2 + Y) \\
& +\beta_{12}(T - h_2) \\
& +\beta_{13}[(w_1 h_1 + w_2 h_2 + Y) \\
& \qquad -w_1(T - h_1)] \\
& -\beta_{23} w_1 (T - h_2), \\
m_2 = & -\alpha_2 + \alpha_3 w_2 + \beta_{22}(T - h_2) \\
& -\beta_{33} w_2 (w_1 h_1 + w_2 h_2 + Y) \\
& +\beta_{12}(T - h_1) \\
& +\beta_{23}[(w_1 h_1 + w_2 h_2 + Y) \\
& \qquad -w_2(T - h_2)] \\
& -\beta_{13} w_2 (T - h_1).
\end{aligned}
$$

By collecting the constants these equations can ɔe written as

$$
\begin{aligned}
m_1 = & \alpha_1^* + \alpha_3^* w_1 - \beta_{11} h_1 \\
& -\beta_{33} w_1 (w_1 h_1 + w_2 h_2 + Y) \\
& -\beta_{12} h_2 + \beta_{13}(2 w_1 h_1 + w_2 h_2 + Y) \\
& +\beta_{23} w_1 h_2; \qquad (5a) \\
m_2 = & \alpha_2^* + \alpha_3^* w_2 - \beta_{22} h_2 \\
& -\beta_{33} w_2 (w_1 h_1 + w_2 h_2 + Y) \\
& -\beta_{12} h_1 + \beta_{23}(2 w_2 h_2 + w_1 h_1 + Y) \\
& +\beta_{13} w_2 h_1. \qquad (5b)
\end{aligned}
$$

The starred parameters are functions of T, α and β, so there is no need to specify the time endowment in order to estimate the labor supply functions. (T, α and β are not all identified from the labor supply functions.)

Stochastic Specification

To allow for differences in tastes among families, I allow α_1 and α_2 in equation (4) to be normally distributed random variables. Furthermore, it is quite simple to permit tastes to vary with observable characteristics by specifying the means of α_1 and α_2 to be linear functions of measurable variables. Thus, α_1 and α_2 in (5a, b) become

$$\alpha_1^* = X_1 \Gamma_1 + \epsilon_1, \qquad (6a)$$

and

$$\alpha_2^* = X_2 \Gamma_2 + \epsilon_2, \qquad (6b)$$

where X_1 and X_2 are vectors of characteristics, Γ_1 and Γ_2 are parameter vectors to be estimated and ϵ_1 and ϵ_2 are normal disturbances with mean 0 and covariance matrix Σ. This is a convenient way to incorporate differences in demographic variables into the model. Taste variation enters only through shifts in the marginal utility functions, a rather restrictive approach.

The likelihood function can be derived from (5a, b) and (6a, b). There are two regimes in the model. In the first regime both husband and wife work, so the maximization conditions, from equation (2), are

$$
\begin{aligned}
& X_1 \Gamma_1 + \alpha_3^* w_1 - \beta_{11} h_1 \\
& \quad -\beta_{33} w_1 (w_1 h_1 + w_2 h_2 + Y) - \beta_{12} h_2 \\
& \quad +\beta_{13}(2 w_1 h_1 + w_2 h_2 + Y) \\
& \quad +\beta_{23} w_1 h_2 + \epsilon_1 = 0, \qquad (7a) \\
& X_2 \Gamma_2 + \alpha_3^* w_2 - \beta_{22} h_2 \\
& \quad -\beta_{33} w_2 (w_1 h_1 + w_2 h_2 + Y) - \beta_{12} h_1 \\
& \quad +\beta_{23}(2 w_2 h_2 + w_1 h_1 + Y) \\
& \quad +\beta_{13} w_2 h_1 + \epsilon_2 = 0. \qquad (7b)
\end{aligned}
$$

The joint density of h_1 and h_2 follows from the assumed distribution of ϵ_1 and ϵ_2:

$$f^*(h_1, h_2) = \mathrm{abs}(J) f(s_1, s_2),$$

where s_1 is defined from (7a) as

$$
\begin{aligned}
s_1 = & X_1 \Gamma_1 + \alpha_3^* w_1 - \beta_{11} h_1 \\
& -\beta_{33} w_1 (w_1 h_1 + w_2 h_2 + Y) - \beta_{12} h_2 \\
& +\beta_{13}(2 w_1 h_1 + w_2 h_2 + Y) + \beta_{23} w_1 h_2,
\end{aligned}
$$

s_2 is defined similarly from (7b) and where $f(\cdot)$ is the bivariate normal density. The Jacobian, J, has the form

$$
\begin{aligned}
J = & (-\beta_{11} - \beta_{33} w_1^2 + 2\beta_{13} w_1) \\
& \times(-\beta_{22} - \beta_{33} w_2^2 + 2\beta_{23} w_2) \\
& -(-\beta_{33} w_1 w_2 - \beta_{12} + \beta_{13} w_2 + \beta_{23} w_1)^2,
\end{aligned}
$$

illustrating the transformation of the problem from the unobservable ϵ's to the observable h's.

In the second regime the wife does not work. The marginal conditions are similar to those in (7), but the equality sign in (7b) becomes less than, and wherever h_2 appears is replaced by, 0. The contribution to the likelihood function from an observation in this regime is

$$\int_{-\infty}^{-s_2} \mathrm{abs}(K) f(s_1, \omega)\, d\omega,$$

where s_1 and s_2 are defined above, and K is of the form

$$K = \left(\beta_{11} + \beta_{33}w_1^2 - 2\beta_{13}w_1\right).$$

Therefore, the likelihood function for a sample containing observations from both regimes can be written as

$$L = \prod_{i \in I_1} \operatorname{abs}(J) f(t_1, t_2) \times \prod_{i \in I_2} \int_{-\infty}^{-s_2} \operatorname{abs}(K) f(s_1, \omega)\, d\omega, \qquad (8)$$

where I_1 is the set of families from the first (unconstrained) regime, and I_2 is the set of families from the second regime.

Internal Consistency

One additional feature of this model requires comment. Since this model is nonlinear, it is possible that there is no pair (h_1, h_2) that will satisfy both equations of the system. Or, there may be multiple solutions. It is useful to write the system in Amemiya's (1974) form, as

$$h_1 = \gamma_1 h_2 + v_1$$
$$h_2 = \begin{cases} \gamma_2 h_1 + v_2 & \text{if } \gamma_2 h_1 + v_2 > 0 \\ 0 & \text{otherwise} \end{cases}$$

where

$$\gamma_1 = \frac{\beta_{33}w_1w_2 + \beta_{12} - \beta_{13}w_2 - \beta_{23}w_1}{-\beta_{11} - \beta_{33}w_1^2 + 2\beta_{13}w_1},$$
$$\gamma_2 = \frac{\beta_{33}w_1w_2 + \beta_{12} - \beta_{13}w_2 - \beta_{23}w_1}{-\beta_{22} - \beta_{33}w_2^2 + 2\beta_{23}w_2},$$

and where v_1 and v_2 are functions of the exogenous variables and error terms. The existence and uniqueness of solutions for models of this type is called "internal consistency" or "coherency." Internal consistency requires that a unique reduced form exist for a given set of exogenous variables and error terms, i.e., that the system have a unique solution. Amemiya (1974, p. 1006) derives necessary and sufficient conditions for internal consistency. For this model, the conditions are satisfied if $1 - \gamma_1\gamma_2$ is positive. This can be rewritten as

$$\left(-\beta_{11} - \beta_{33}w_1^2 + 2\beta_{13}w_1\right) \times \left(-\beta_{22} - \beta_{33}w_2^2 + 2\beta_{23}w_2\right) - \left(-\beta_{33}w_1w_2 - \beta_{12} + \beta_{13}w_2 + \beta_{23}w_1\right)^2 > 0,$$

which is also one of the second order conditions that corresponds to the case where there is no corner solution. Thus, coherency is guaranteed under the usual assumptions for family utility maximization.[5] Ransom (forthcoming) shows the positive definiteness of β ensures internal consistency for a similar model. It is interesting to note that this condition also ensures that the Jacobian (J) of the transformation from ϵ_1 and ϵ_2 to h_1 and h_2 does not vanish.

III. Estimation and Results

Data

The model developed in the previous section was applied to a sample of 1,210 families taken from the Panel Study of Income Dynamics, Survey Research Center (1977). Data are responses to a retrospective survey administered in 1977, so most information refers to activities during 1976. The survey contains information on over five thousand households. I restricted the sample to households that satisfied the following criteria:

(1) Both spouses present in 1976 and 1977;
(2) Husband aged 30 to 50 years;
(3) No self-employment income for either spouse;
(4) Both spouses paid on a wage or salary basis, if working.

A few other families were excluded because of missing values for important variables. Descriptive statistics for the final sample appear in table 1.

Wage rates for the husbands, all of whom worked during the year, were the reported "usual" wage deflated by the estimated federal tax rate for the family.[6] For working wives, the wage is similarly defined. If no wage was reported, then average earnings were used. For those women who did not work, the after-tax wage was predicted using a wage equation estimated from the working subsample, correcting for selection bias. Hours are

[5] Schmidt (1981) suggests that the parameter restrictions required for internal consistency are arbitrary and questions the usefulness of simultaneous Tobit models. In this model the parameter restrictions are quite natural. For a rigorous and general treatment of internal consistency see Amemiya (1974) or Gourieroux, Laffont and Monfort (1980).

[6] The marginal tax rate is reported in the survey. It is estimated from information on the number of dependents and taxable income, assuming average deductions for income groups.

TABLE 1.—DESCRIPTIVE STATISTICS FOR DATA USED IN ESTIMATION

	Families with Working Wives $N = 741$		Families with Non-working Wives $N = 469$	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
h_1	22.05	5.02	21.83	5.55
h_2	13.76	6.72	—	—
w_1	4.49	1.37	4.83	1.46
w_2	2.81	1.34	2.47	0.55
Y	54.67	62.94	42.57	57.59
$RACE$	0.26	0.44	0.29	0.46
AGE_1	40.92	6.23	40.56	5.95
AGE_2	38.18	6.97	37.97	7.16
$SCHOOL_1$	11.80	3.22	11.33	3.42
$SCHOOL_2$	12.07	2.25	11.14	2.46
$NKIDS$	2.11	1.56	2.76	1.74
$PRESCHL$	0.23	0.42	0.42	0.49

Note: h_1 and h_2 are measured in *hundreds* of annual hours. Y is measured in *hundreds* of annual dollars. $RACE$ and $PRESCHL$ are binary variables. Others are measured in natural units.

measured in hundreds of hours per year. Non-labor income, Y, was adjusted so that the after-tax income of the family was equated to $w_1h_1 + w_2h_2 + Y$, where the wages are the after-tax wage rates, a procedure suggested by Hall (1973).

Because the tax system is progressive, the tax rate is endogenous with respect to work hours (or earnings). Therefore, the wage rate and the "virtual" non-labor income used in this analysis will be correlated with the error terms in the labor supply functions. This procedure will likely bias the wage elasticities downward and the income elasticities upward. It would be possible to incorporate more details of the tax system, along the lines of Burtless and Hausman (1978), since the parameters of the utility function are known.

In addition, the wage rate for non-working women is treated as if it were known with certainty, which clearly misspecifies the situation.[7] However, maximum likelihood estimation of a system with all wage rates endogenous is not practical for this problem because of the nonlinear way in which the wage rates enter the labor supply functions. Consistent instrumental variables techniques are not applicable for the same reason.

Results

The parameters of the model were estimated by numerically maximizing the likelihood function (8). Table 2 presents estimates of the parameters of the model with the associated asymptotic standard errors. The variables that shift the α_1^* and α_2^* parameters are race, years of schooling and age. (Race is a dummy variable set to unity for blacks.) Additionally, the number of children in the household ($NKID$) and a dummy variable indicating the presence of preschool children ($PRESCHL$) enter in the wife equation, α_2^*.

An arbitrary standardization of the utility function is required, since the labor supplies are invariant to monotonic increasing transformations of the utility function. In the tables below, β_{11} is set to 1. Maximum likelihood estimates are invariant to the particular normalization chosen.

The reduced form labor supply functions for each regime and the associated wage and income derivatives can be evaluated directly from the utility function parameters. Using these derivatives it is possible to assign to each working individual a value for the wage, income and substitution elasticities which are nonlinear functions of the family's characteristics. Table 3 shows summary statistics for these coefficients, which incorporate the underlying distribution of wage rates, income and hours of work. The standard deviations in table 3 reflect only the variability in individual characteristics in the sample, not sampling variability or other stochastic elements. The coefficients are conditional on the labor force status of the wife.

The average elasticities reported agree qualitatively with many of the previous studies of labor

[7] For example, Rosen (1976) uses this procedure.

TABLE 2.—ESTIMATED PARAMETER VALUES FOR QUADRATIC FAMILY UTILITY FUNCTION

Parameter	Value	Asymptotic Standard Error
Elements of α_1^*		
Intercept	19.839	1.567
$RACE_1$	−0.938	0.396
$SCHOOL_1$	0.287	0.059
AGE_1	0.006	0.026
Elements of α_2^*		
Intercept	2.232	0.966
$RACE_2$	0.073	0.122
$SCHOOL_2$	0.063	0.023
AGE_2	−0.015	6.69×10^{-3}
$NKID$	−0.092	0.032
$PRESCHL$	−0.521	0.158
α_3^*	0.597	0.123
β_{11}	1.000	—
β_{22}	0.105	0.027
β_{33}	1.61×10^{-3}	5.22×10^{-4}
β_{12}	0.107	0.038
β_{13}	6.32×10^{-3}	2.80×10^{-3}
β_{23}	-2.45×10^{-3}	1.31×10^{-3}
σ_1^2	32.24	1.936
σ_2^2	1.899	0.897
σ_{12}	5.129	1.646
Log likelihood	−6,262.72	
Sample size	1210	

supply of individual males or females.[8] The labor supply curve for the husbands is roughly vertical, while the wives' curve is moderately inelastic. The nonlabor income elasticities are also small, with the wives' being more elastic. There is slight negative cross-wage substitution. For men with non-working wives the wage elasticity is smaller, but in both cases very close to zero. The substitution elasticity for husbands in the non-working regime is smaller. For men, the estimated elasticities are compactly distributed across the sample, but for women, the estimates fall over a relatively large range. The distribution of the estimates is very skewed, however, so while the income elasticity is positive (indicating that leisure is inferior) for some of the observations, this is true for only a small fraction of the sample, even though the standard deviations are large relative to the averages.

The imposition of the concave, increasing utility function restricts the possible values that can be taken on by the wage and income derivatives of the labor supply functions. For example, the own-wage derivatives and elasticities must be positive, and the compensated cross-wage derivatives must be equal (though the corresponding elasticities will, of course, differ). However, the quadratic is not globally increasing, due to its "bliss-point" property. Because of this the own-wage elasticities are negative for a few of the observations in this sample. These "unacceptable" observations explain part of the large standard errors in table 3.

Goodness-of-Fit Measures

Since the model is nonlinear, and involves both discrete and continuous choices, it is difficult to tell how well the model fits the data. (The value of the likelihood function is not very informative without some alternative for comparison.) Do the restrictions of the model do violence to the data? Can the model in its restricted form reproduce the data in a convincing way? I examine these questions here.

One important feature of the model is the integration of the discrete participation of the wife with the "interior" labor supply decisions of the husband and wife. Here I examine how well the model predicts the labor force participation of the wife. Given the piecewise linear nature of the simultaneous system of equations developed above,

[8] See the survey by Killingsworth (1981) for a comprehensive summary of labor supply estimates.

TABLE 3.—WAGE AND INCOME ELASTICITIES BASED ON ESTIMATED MODEL

Coefficient	Families with Working Wives Mean	Families with Working Wives Standard Deviation	Families with Non-working Wives Mean	Families with Non-working Wives Standard Deviation
Husband own wage elasticity	−0.038	0.038	−0.035	0.067
Wife own wage elasticity	0.703	2.778		
Husband non-labor income elasticity	−0.031	0.036	−0.033	0.139
Wife non-labor income elasticity	−0.155	3.153		
Husband compensated own wage elasticity	0.037	0.025	0.028	0.056
Wife compensated own wage elasticity	0.733	2.743		
Husband compensated cross wage elasticity	−0.033	0.034		
Wife compensated cross wage elasticity	−0.210	0.638		

h_2 will have a reduced form of

$$h_2^* = \begin{cases} h_2^*(X, w_1, w_2, Y, \epsilon_1, \epsilon_2) & \text{if } h_2^*(\ ) > 0, \\ 0 & \text{otherwise.} \end{cases} \tag{9}$$

The probability that h_2 is greater than zero can be calculated with knowledge of the elements of equation (9). A simple goodness-of-fit test is to compare the actual participation status with the predicted status, based on whether the participation probability from (9) is greater than 1/2. Table 4 summarizes the results of this exercise. By this criterion, the model predicts a participation rate of about 85%, while only 59% of the sample actually works. The predictions tend to overstate the likelihood of a wife being in the labor force. The average probability of participation for the non-working subsample was predicted as 57%, 61% for the working subsample. However, the overall predicted probability is 58%, compared to the "true" participation rate of 59%. Thus, the participation prediction is unbiased, but does a poor job of differentiating between the workers and the non-workers.

Table 4 also presents predicted versus actual hours of work for those individuals who worked. The model overstates the hours of work of men by about 54 hours per year—roughly one week of full-time work. For the working sample, the model predicts that women will work only about half as many hours as they actually do. Thus, the model predicts that most women will work, but that the average hours of work will be quite small. However, we observe that a smaller fraction of the sample works (than predicted), while those who work choose many hours. This pattern is consistent with the presence of fixed costs of work. See Cogan (1980) for a discussion of this issue. The finding suggests that a model with fixed costs would be more appropriate for this sample.

TABLE 4.—PREDICTIVE ACCURACY OF MODEL

Participation of Wives			
Predicted	Actual: Participant	Actual: Non-Participant	Total
Participant	677	385	1060
Non-participant	64	86	150
Total	741	469	1210
Average Probability	.614	.565	
Average Hours of Work	Actual	Predicted	
Men	21.96	22.51	
Women	13.76	6.34	

IV. Summary

This paper proposes an econometric procedure that correctly incorporates the participation and the hours of work decision in estimation of a family labor supply model. The procedure is a generalization of the Tobit method to a system of decisions that explicitly takes account of the maximization "spillovers" that occur when there are quantity constraints. The method has several advantages over previous attempts to model the family labor supply decision: it utilizes information from all sample observations, regardless of work status of the wife, allows for unobservable differences in tastes between families, and can be adapted to situations with non-linear budget constraints, being based on the family utility function.

The empirical application of this method has led to a mixture of success and failure. On the one hand, the estimates of the structural utility function parameters are reasonably precise and their implications for labor supply behavior are consistent with previous research. On the other hand, imposing the family utility model on the husband–wife labor supply choice problem yields rather poor predictions of the wives' labor force participation and hours of work decisions.

REFERENCES

Amemiya, Takeshi, "Multivariate Regression and Simultaneous Equation Models when the Dependent Variables Are Truncated Normal," *Econometrica* 42 (Nov. 1974), 999–1012.

Ashenfelter, Orley, "Unemployment as Disequilibrium in a Model of Aggregate Labor Supply," *Econometrica* 48 (Apr. 1980), 547–564.

Blundell, Richard, and Ian Walker, "Modelling the Joint Determination of Household Labour Supplies and Commodity Demands," *The Economic Journal* 92 (June 1982), 351–364.

Burtless, Gary, and Jerry A. Hausman, "The Effect of Taxes on Labor Supply: Evaluating the Gary NIT Experiment," *Journal of Political Economy* 86 (Dec. 1978), 1103–1130.

Cogan, John, "Labor Supply with Time and Money Costs of Participation," J. P. Smith (ed.), *Female Labor Supply: Theory and Estimation* (Princeton, N.J.: Princeton University Press, 1980).

Goldberger, Arthur S., "Functional Form and Utility: A Review of Consumer Demand Theory," unpublished paper, University of Wisconsin, 1967.

Gourieroux, C., J. J. Laffont, and A. Monfort, "Coherency Conditions in Simultaneous Linear Models with Endogenous Switching Regimes," *Econometrica* 48 (Apr. 1980), 675–695.

Hall, Robert, "Wages, Income and Hours of Work in the U.S. Labor Force," in Glenn Cain and Harold Watts (eds.), *Income Maintenance and Labor Supply* (Chicago: Markham, 1973).

Hausman, Jerry, and Paul Ruud, "Family Labor Supply with Taxes," *American Economic Review* 74 (May 1984), 242–248.

Heckman, James, "Sample Selection Bias as a Specification Error with an Application to Estimation of Labor Supply Functions," in J. P. Smith (ed.), *Female Labor Supply: Theory and Estimation* (Princeton, NJ: Princeton University Press, 1980).

Heckman, James, and Thomas MaCurdy, "New Methods for Estimating Labor Supply Functions: A Survey," *Research in Labor Economics* 4 (1981), 65–102.

Killingsworth, Mark, "A Survey of Labor Supply Models: Theoretical Analyses and First-Generation Empirical Results," *Research in Labor Economics* 4 (1981), 1–64.

Kooreman, Peter, and Arie Kapteyn, "Estimation of Rationed and Unrationed Household Labor Supply Functions Using Flexible Functional Forms," *The Economic Journal* (June 1986), 398–412.

Ransom, Michael R., "A Comment on Consumer Demand Systems with Binding Non-negativity Constraints," *Journal of Econometrics* (forthcoming).

Rosen, Harvey, "Taxes in a Labor Supply Model with Joint Wage-Hours Determination," *Econometrica* 44 (May 1976), 485–507.

Rosett, Richard N., *Working Wives: An Econometric Study*, Cowles Foundation Paper No. 122 (1958).

Schmidt, Peter, "Constraints on the Parameters in Simultaneous Tobit and Probit Models," in C. F. Manski and D. McFadden (eds.), *Structural Analysis of Discrete Data with Economic Applications* (Cambridge: MIT Press, 1981).

Survey Research Center, *A Panel Study of Income Dynamics: Procedures and Tape Codes 1977 Interview Year* (Ann Arbor: Institute for Social Research, 1977).

Tobin, James, "Estimation of Relationships for Limited Dependent Variables," *Econometrica* 26 (Jan. 1958), 24–36.

Tobin, James, and H. S. Houthakker, "The Effect of Rationing on Demand Elasticities," *Review of Economic Studies* 18 (1950–51), 140–153.

Wales, Terence, and A. D. Woodland, "Estimation of Household Utility Functions and Labor Supply Response," *International Economic Review* 17 (June 1976), 397–410.

______, "Estimation of Consumer Demand Systems with Binding Non-negativity Constraints," *Journal of Econometrics* 21 (Apr. 1983), 263–285.