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**The Labor Supply of Married Men:
A Switching Regressions Model**

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ABSTRACT

According to the family utility function approach, the labor supply functions of married men should differ according to whether or not their wives also work. In this paper I explicitly model the switching nature of labor supply while also accounting for the endogeneity of the labor force participation decision of the wife, using an endogenous switching regressions model based on the quadratic family utility function. The model is estimated from a cross-section of 1210 married couples from the Panel Study of Income Dynamics.

I. Introduction

A popular way to approach the analysis of family labor supply behavior is to postulate a utility function for the family which has as arguments the leisure time of husband and wife. For example, this underlies the work of Ashenfelter and Heckman (1974) and Wales and Woodland (1976). An important implication of this for the study of male labor supply is that men and working wives will have different labor supply functions than otherwise identical men whose wives do not work, since additional wife's leisure cannot be purchased by the latter group.¹ The magnitude of this effect is potentially very significant, since approximately half of all married women do not participate in the labor force.

While this issue has been largely ignored in empirical analyses of male labor supply behavior, two studies have addressed it, at least indirectly. Kniessner (1976) lays out the connection between the analysis of rationing and the issue of non-participation by the wife in a traditional family labor supply model. His study attempts to use the prior information of rationing theory to infer the sign of the cross-substitution between husband and wife leisure time by comparing the labor supply of men whose wives work with that of men whose wives do not work. Cogan (1978) is interested in directly estimating the labor supply functions of husbands, taking account of the different participation states of wives.

The approach of this paper is to specify a quadratic utility function which governs the family's consumption and labor supply decisions.

From this utility indicator it is possible to derive the husband labor supply functions that correspond to the two regimes of wife labor force status. Since the labor force participation decision of the wife is not independent of the husband's work decisions, an endogenous switching rule is specified to complete the model.

The supply functions of each regime share common parameters from the utility function. An interesting result of these cross-regime restrictions is that it is possible to identify all the parameters of the wife labor supply function, as well, even though the estimation derives from observations on the labor supply of the husbands only. That is, by comparing the response of men to changes in their wife's wage rate the labor supply of men whose wives do not work, it is possible to indirectly infer the labor supply function of wives, too.

The model is estimated on a cross-section of 1210 married couples from the 1977 survey of the Panel Study of Income Dynamics, using the maximum likelihood method.

The paper is organized as follows: Section II develops the econometric model. Section III discusses estimation and results. Section IV summarizes the contributions of this paper.

II. Development

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

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

is maximized subject to the budget constraint

$$X = w_M h_M + w_F h_F + Y ,$$

where T is the time available for work or leisure, h_M is the number of hours that the husband spends at market work, h_F measures the hours of work of the wife, Y is unearned income, and X is money income.

The wage rates, w_M and w_F , are measured in real after-tax terms, as is Y . For purposes here, it is convenient to express the family utility level in terms of hours of work only, as

$$(1) \quad U^* = U(T-h_M, T-h_F, w_M h_M + w_F h_F + Y) .$$

For any combination of h_F and h_w the net marginal utility of increasing hours of work can be expressed as

$$(2a) \quad m_1 = -U_1 + w_M U_3 = m_1(h_M, h_w) ;$$

$$(2b) \quad m_2 = -U_2 + w_F U_3 = m_2(h_M, h_w) .$$

An "interior" solution to this maximization problem is described by setting (2a) and (2b) equal to zero. The usual approach in studies of the labor supply of married men is to solve these first order conditions for a "reduced form," expressing h_M as a function of the exogenous variables of the system-- w_M , w_F and Y . Or rather, most studies begin with a reduced form specification of the labor supply function, thereby assuming an interior solution. However, if the family utility is higher with the wife not working, the first order (Kuhn-Tucker) conditions become

$$(3a) \quad m_1(h_M, 0) = 0 , \text{ and}$$

$$(3b) \quad m_2(h_M, 0) < 0 .$$

In this case, the labor supply function of the husband is implicitly

defined by (3a) alone, and will therefore have a different reduced form function than for the case in which the wife works. In particular, w_F will no longer enter into the labor supply function of the husband. Here I develop an empirical model which permits estimation of the common parameters that underly these regime-dependent functional forms. This approach is similar to the method presented by Wales and Woodland (1983) for analysis of consumption behavior with quantity constraints.

Quadratic Utility Model

The empirical model in this paper is based on a quadratic specification of the family utility function in equation (1):

$$U(Z) = \alpha Z - 1/2 Z' \beta Z ,$$

where α and Z are 3-element vectors and β is a 3x3 matrix of parameters. If α is positive and β is positive definite and symmetric, U will be concave. However, U is increasing only when $(\alpha - Z'\beta)$ is positive, thus U can be thought of as only a local approximation to an arbitrary utility function. The marginal utility functions (2a,b) for the quadratic specification are

$$\begin{aligned} m_1 = & -\alpha_1 + \alpha_3 w_M + \beta_{11}(T-h_M) - \beta_{33} w_1 (w_M h_M + w_F h_F + Y) \\ & + \beta_{12}(T-h_F) + \beta_{13} [(w_M h_M + w_F h_F + Y) - w_M(T-h_M)] \\ & - \beta_{23} w_M(T-h_F) , \end{aligned}$$

$$\begin{aligned} m_2 = & -\alpha_2 + \alpha_3 w_F + \beta_{22}(T-h_F) - \beta_{33} w_2 (w_M h_M + w_F h_F + Y) \\ & + \beta_{12}(T-h_M) + \beta_{23} [(w_M h_M + w_F h_F + Y) - w_F(T-h_F)] \\ & - \beta_{13} w_F(T-h_M) . \end{aligned}$$

By collecting constants and renaming the parameters, these equations can be written in more compact form as

$$(4a) \quad m_1 = \alpha^* + \alpha_3^* w_M - \beta_{11} h_M - \beta_{33} w_M (w_M h_M + w_F h_F + Y) \\ - \beta_{12} h_F + \beta_{13} (2w_M h_M + w_F h_F + Y) + \beta_{23} w_M h_F ;$$

$$(4b) \quad m_2 = \alpha_2^* + \alpha_3^* w_F - \beta_{22} h_F - \beta_{33} w_F (w_M h_M + w_F h_F + Y) \\ - \beta_{12} h_M + \beta_{13} w_F h_M + \beta_{23} (2w_F h_F + w_M h_M + Y) .$$

The starred parameters are functions of α , β and T .

Labor Supply Functions

Applying (4a,b) to the first order conditions described in (2a,b) and (3a,b) yields the labor supply functions for the two regimes. The labor supply function for husbands whose wives work is

$$(5) \quad h_1^w = [(-\beta_{33} w_M w_F - \beta_{12} + \beta_{13} w_F + \beta_{23} w_M)(\alpha_2^* + \alpha_3^* w_F - \beta_{33} w_F Y + \beta_{23} Y) \\ - (-\beta_{22} - \beta_{33} w_F^2 + 2\beta_{23} w_F)(\alpha_1^* + \alpha_3^* w_M - \beta_{33} w_M Y + \beta_{13} Y)] \cdot \frac{1}{D}$$

where

$$D = (-\beta_{11} - \beta_{33} w_M^2 + 2\beta_{13})(-\beta_{22} - \beta_{33} w_F^2 + 2\beta_{23} w_F) \\ - (-\beta_{33} w_M w_F - \beta_{12} + \beta_{13} w_F + \beta_{23} w_M)^2$$

For husbands with nonworking wives, the labor supply function is

$$(6) \quad h_1^n = -(\alpha_1^* + \alpha_3^* w_1 - \beta_{33} w_1 Y + \beta_{13} Y) / (-\beta_{11} - \beta_{33} w_1^2 + 2\beta_{13} w_1) .$$

Since the labor supply functions in both cases are invariant to monotone transformations of the utility function, some arbitrary standardization is required--in this case $\beta_{11} + \beta_{22} + \beta_{33} = 1$. Maximum likelihood estimates are invariant to the normalization that is chosen.

To permit the labor supply functions to vary with certain observable characteristics (in order to capture systematic differences in

tastes, or life-cycle effects), α_1^* and α_2^* are specified as linear functions of the characteristics. Specifically, these functions are

$$\alpha_{1i}^* = d_{10} + d_{11}RACE_i + d_{12}AGE_{1i} + d_{13}URB_i ,$$

$$\begin{aligned} \alpha_{2i}^* = & d_{20} + d_{21}RACE_i + d_{22}AGE_{2i} + d_{23}URB_i \\ & + d_{24}KIDS_i + d_{25}PRE_i \end{aligned}$$

where RACE is a dummy variable indicating whether or not the family is black, URB is a dummy for living in a metropolitan area, AGE_i is the age of the husband or wife, SCH_i is the number of years of schooling of the husband or wife, KIDS is the number of children (under age 18) in the family, and PRE is a dummy indicating the presence of preschool children in the household.² A desirable property of this specification is that characteristics shift the "tastes" (that is, marginal utility functions). The shifts in taste will have different effects on labor supply depending on the wage rates and participation status of the wife.

Stochastic Specification

A normal error structure is assumed for the model, with separate variances for the two regimes. Observed and predicted labor supply are thus related by the following equations:

$$(7) \quad h_{1i} = h_{1i}^w(\cdot) + U_{wi} \quad \text{if } I_i = 1 ;$$

$$(8) \quad h_{1i} = h_{1i}^N(\cdot) + U_{Ni} \quad \text{if } I_i = 0 ;$$

where $h_1^w(\cdot)$ and $h_1^N(\cdot)$ are defined in equations (5) and (6), U_{wi} and U_{Ni} are normal variates and I_i defined below is an index of the

work status of the wife. This does not complete the specification, however, since the wife's work decision is not independent of the hours of work chosen by the husband. The specification of this "switching rule" can be derived from (4a) and (4b), but depends on unobservable variables in a nonlinear way. Instead I specify a "reduced form" probit equation that contains all the exogenous variables that determine the market wage and reservation wage of the wife:

$$(9) \quad I_i = 0 \quad \text{if} \quad I_i^* \leq 0 ;$$

$$I_i = 1 \quad \text{if} \quad I_i^* > 0 ;$$

$$I_i^* = \Gamma' Z_i + U_{Pi} ,$$

where Γ is a vector of parameters and Z_i is a vector of variables. In particular, Z_i contains the pre-tax wage rate of the husband and the nonlabor income of the family as well as age, schooling and other family characteristics. (See Table 2 for a complete specification.) The error terms from (7), (8) and (9) are jointly normally distributed with zero mean and covariance Σ , with

$$\Sigma = \begin{bmatrix} \sigma_w^2 & \sigma_{WN} & \sigma_{WP} \\ \sigma_{WN} & \sigma_N^2 & \sigma_{NP} \\ \sigma_{WP} & \sigma_{NP} & 1 \end{bmatrix} .$$

This model is a nonlinear version of the endogenous switching regression discussed by Maddala (1983, pp. 225). The likelihood function can be written as

$$(10) \quad L = \Pi \left[\int_{-\infty}^{\Gamma' Z_i} f[h_{1i} - h_i^W(\cdot), v] dv \right]^{I_i} \\ \times \left[\int_{\Gamma' Z_i}^{\infty} g[h_{1i} - h_i^N(\cdot), v] dv \right]^{1-I_i}$$

where f and g are the bivariate normal density functions for (U_W, U_p) and (U_N, U_p) . Since we do not observe individuals in both regimes, σ_{WN} cannot be estimated.

III. Estimates and Results

Data

The model developed in the previous section was applied to a sample of 1,210 families taken from the 1976 interview of the Panel Study of Income Dynamics, Survey Research Center (1978). Some information is also taken from the 1976 survey. The PSID contains survey responses from several thousand households. Those selected for this sample were those families (both spouses present for the 1976 and 1977 interviews) with husband aged 30 to 50 years. In addition, if husbands or wives reported self-employment income, or worked on a pay basis other than wage or salary, the family was excluded. Other observations were dropped because of missing data for some of the variables. Table 1 reports descriptive statistics for data used in the estimation.

Wage rates for the husbands are the reported "usual" wage from the 1976 survey, deflated by the family's estimated marginal tax rate. The wage rate of wives is also the usual wage rate, but for wives who did

not report a wage rate in the 1976 interview, the wage was calculated by dividing pretax earnings by hours of work. This ratio is also deflated by the marginal tax rate. The wage rate of nonworking women does not enter into the estimation. For computational convenience, h_1 is measured in hundreds of hours per year. w_1 and w_2 are measured in dollars per hour, so Y is measured in hundreds of dollars per year. Unearned income is adjusted so that the after tax income of the family equals $w_1 h_1 + w_2 h_2 + Y$, where the wage rates are post-tax. This procedure is suggested by Hall (1973). The treatment, unfortunately, results in the right-hand-side variables being correlated with the error term of the equation. That is, men with unusually high hours of work will have lower wages (because taxes are progressive) and also higher "nonlabor" income. This suggests the estimated elasticities will be biased downward for the wage and upward for income. Some caution is also due in interpreting the reported standard errors. The nonlinear nature of the model precludes a simple solution to this problem. The pre-tax wage rate and actual non-labor income are used in the switching rule equation (9).

Estimates

Two versions of the model were estimated using the maximum likelihood method. The first version assumes an "exogenous switch"--that the error term in the participation equation is uncorrelated with the error term in either labor supply equation. The second version is the general endogenous switching regression model discussed above. The estimated

values of the parameters are reported in Table 2.

In the exogenous switching model, the estimation of the labor force participation equation, (9), is a simple probit. Comparing these probit estimates with the corresponding values of the endogenous switching model will give an idea of the importance of the simultaneity of the husband work decision and the participation decision of the wife. The parameter estimates are qualitatively similar in both specifications. However, the exogenous version estimates are of greater magnitude for AGE_F , $SCHOOL_F$ and $PRESCHL$; while they are of smaller magnitude for w_M and Y . In the endogenous version, the coefficient on income is significantly positive, indicating that leisure (non-work time) is not a normal good for married women.³ Furthermore, this result appears only after correcting for endogeneity between the participation decision of the wife and the labor supply of the husband.

As for the parameters of the utility function, once again they are differences in magnitude, but the estimates are qualitatively similar in both specifications. The elements of α_1^* are not measured with much precision. The same is true for the parameters in α_2^* . The other parameters, α_3^* and the β_{ij} , also differ somewhat between the two specifications. A likelihood ratio test strongly rejects the exogenous specification in favor of the more general model.

Using these estimated parameters, it is possible to evaluate the wage and income elasticities for each individual in the sample, conditional on the regime status of the family. The elasticity of labor supply depends on the exogenous variables in a nonlinear way, so the

distribution of these variables in the sample implies a distribution of elasticities also. This distribution is reported in Table 3 for the two versions of the model. The sample mean and the standard deviation of the elasticity are reported. (The standard deviation only reflects the distribution of exogenous variables in the sample, not the uncertainty associated with the parameter values.)

The labor supply curve is distinctly backward bending. The estimates suggest a labor supply elasticity of about negative 15 percent for men whose wives do not work, compared with about negative 5 percent for men with working wives. However, the variation in the sample is large relative to both of these values. The nonlabor income elasticities, while negative, are very small in magnitude. The cross-wage effect is essentially zero. In general, these wage elasticities are not much different from those reported by others, but the income elasticities are much smaller in magnitude than most. See Killingsworth (1983) for a survey of previous results.

As mentioned before, the construction of the wage, and nonlabor income (to treat progressive taxes) tends to bias the income elasticity upward and the wage elasticity downward. This is important because the small (negative) magnitude of the income elasticity and the large (negative) magnitude of the wage elasticity imply a substitution elasticity that is negative for typical individuals in this sample. In other words, the negative correlation between the wage rate and work hours is too large to be explained by utility maximization given the lack of correlation between income and work hours.⁴

There is also a difference between the elasticities of the two groups. The substitution elasticity is smaller for those with non-working wives. This difference is predicted in the theoretical discussion of constraints--when there are fewer goods to purchase, then the opportunity for substitution is smaller. Cogan (1978) and Kinessner (1976) both discuss this property.

Another issue is the relationship between the elasticities implied by the two versions of the model. Comparing these two columns of Table 3 suggests that ignoring the simultaneous nature of family labor supply biases the wage and substitution elasticities upward.

IV. Conclusions

In this paper I have presented an econometric model of the labor supply of married men based on a concept of family utility maximization, explicitly taking account of "spillovers" that result when the wife is constrained by the non-negativity of work hours. I also account for the simultaneity of the participation decision of the wife and the labor supply decision of the husband.

Since a high fraction of married women does not work, the empirical magnitude of misspecification error is potentially large. While I find a difference between the labor supply behaviors of men with working versus non-working wives, as theory predicts, the elasticities are small in both cases. A more interesting result suggests that ignoring the simultaneity between the husband's work hours and the wife's labor force participation results in estimates of wage elasticities that are biased upward.

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Footnotes

¹There exists a large body of literature that deals with the way that quantity constraints on the consumption of one good induce changes in the demands for other goods. See, for example, Tobin and Houthakker (1950-51) or Ashenfelter (1980).

²The variables in α_1^* are typical of those used in studies of male labor supply; those in α_2^* are typical of variables used in female labor supply studies. The parameters, α_1^* and α_2^* , are, however, parameters of the "family" utility function. Thus, there is no real theoretical reason for excluding wife's age from α_1^* , for example. Nevertheless, this approach is in harmony with most previous empirical work on the labor supply of men and women. In those studies, hours of work of the spouse are usually taken as fixed, and only those variables thought to influence individual tastes directly are included in the model.

³Non-market time is usually considered to be a normal good. The fact that transfer income is included in nonlabor income may partially explain this contrary result reported here. On the other hand, there is very little empirical work from family labor supply models with which to compare these findings.

⁴The negative substitution elasticity is not just an artifact of this estimation procedure. Simple linear regression gives estimated ε_s of $-.07$ and $-.004$ for the two subsamples of the data set.

Table 1*

Summary Statistics of Data Used in Estimation

Variable	Mean	Dev	Min	Max	Mean	Dev	Min	Max
h_M	22.05	5.02	2.10	54.96	21.82	5.55	0.16	43.00
w_M (Pre-Tax)	6.24	2.23	1.30	9.98	6.23	2.32	1.50	9.98
w_M (After-Tax)	4.49	1.37	1.05	7.78	4.83	1.46	1.50	9.98
w_F (Pre-Tax)	2.81	1.34	0.94	18.72	---	---	---	---
Y (Active)	32.75	69.32	-198.20	468.13	29.53	65.01	-145.75	476.66
Y (Adjusted)	54.67	62.94	-137.60	386.90	42.57	57.59	-87.55	392.80
RACE	0.26	0.44	0.00	1.00	0.29	0.46	0.00	1.00
AGE_M	40.92	6.23	30.00	50.00	40.56	5.95	30.00	50.00
AGE_F	38.18	6.97	18.00	54.00	37.97	7.16	18.00	57.00
$SCHOOL_M$	11.80	3.22	3.00	17.00	11.33	3.42	0.00	17.00
$SCHOOL_F$	12.07	2.25	5.00	17.00	11.14	2.46	0.00	17.00
NKIDS	2.11	1.56	0.00	8.00	2.76	1.74	0.00	10.00
PRESCHL	0.23	0.42	0.00	1.00	0.42	0.49	0.00	1.00
URBAN	0.68	0.47	0.00	1.00	0.72	0.45	0.00	1.00
Sample Size	N = 741				N = 469			

*Note that h_M is measured in hundreds of annual hours. Y is measured in hundreds of annual dollars. Wage rates are in dollars per hour. RACE, URBAN and PRESCHL are dummy variables.

Table 2

Parameter Estimates for Quadratic Family Utility Model

Variable	Exogenous Switch Model:		Endogenous Switch Model:	
	Parameter Value	Asymptotic Standard Error	Parameter Value	Asymptotic Standard Error
Elements of participation probit:				
Intercept	-.3082	.3886	.8044	.3432
RACE	.0354	.0954	-.0579	.0918
AGE _M	.0270	.0117	.0041	.0100
AGE _F	-.0242	.0104	.0088	.0088
SCHOOL _M	-.0087	.0165	-.0160	.0127
SCHOOL _F	.1362	.2140	.0631	.0166
NKIDS	-.0775	.0261	-.0702	.0247
PRESCHL	-.5540	.0974	-.4957	.0862
W _M (Pre-Tax)	-.0723	.0220	-.0977	.0202
Y(Non-Labor Income)	2.561×10^{-4}	5.90×10^{-4}	.0012	5.53×10^{-4}
Elements of α_1^*				
Intercept	15.5921	2.214	17.5778	2.8238
RACE	-1.6932	0.4064	-1.7792	0.4841
AGE _M	-0.0084	0.0205	-.0040	0.0229
URBAN	-0.3552	0.3216	-.1104	0.3369
Elements of α_2^*				
Intercept	0.4732	1.95219	6.7977	2.6417
RACE	-2.5581	1.396	-2.1931	1.1735
AGE _F	0.0328	0.049	.0716	0.0527
URBAN	-0.1871	0.776	.1278	0.7822
NKIDS	-0.0772	0.1747	.0578	0.1509
PRESCHL	1.1362	0.8004	3.1854	1.3351
Utility function constants				
α_3^*	.1151	0.1432	-0.2233	0.1766
β_{11}	.7964		.7022	
β_{22}	.1972	0.0572	.2945	0.0926
β_{33}	0.64	1.105×10^{-3}	.0033	8.07×10^{-4}
β_{12}	.1726	.0399	.2024	.0490
β_{13}	.0294	0.00575	.0159	0.0047
β_{23}	.0319	0.0062	.0176	0.0051
Variances/covariances				
σ_W^2	23.4070	1.2247	37.8640	2.7727
σ_N^2	30.4089	2.008	36.6015	4.7399
σ_{WP}	-----	-----	-5.3742	0.3123
σ_{NP}	-----	-----	-3.2547	0.9537
Log Likelihood	-4,431.00		-4,407.36	

Table 3*

Conditional Labor Supply Elasticities
Sample Averages and Standard Deviations

	<u>Exogenous Switch Model</u>	<u>Endogenous Switch Model</u>
Nonworking Wives Group (N=469)		
ϵ_{WM}	-.1194 (.4242)	-.185 (.3322)
ϵ_Y	-.0052 (.1358)	-.0005 (.0857)
ϵ_S	-.0896 (.3913)	-.1727 (.3149)
Working Wives Group (N=741)		
ϵ_{WM}	-.0214 (.1351)	-.0860 (.1252)
ϵ_Y	-.0187 (.0334)	-.0168 (.0310)
ϵ_S	.0163 (.1280)	-.0506 (.1143)
ϵ_{WF}	-.0273 (.0768)	.0007 (.0681)

* ϵ_{wi} is the labor supply elasticity with respect to w_i .

ϵ_Y is the labor supply elasticity with respect to nonlabor income.

ϵ_S is the pure substitution elasticity.