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Estimation of Husband and Wife Home Labor Supply Functions

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Abstract. The main objective of this paper is to explain the noticeable changes in the American family's use of time and to test the mutual causation hypothesis that the American husband's and wife's home labor supply are jointly dependent and each stimulates the other.

The paper developes a simultaneous equations model and presents an application to the theory of family allocation of time. Three different time activities are considered: work in market, work at home, and leisure. A husband and wife home labor supply functions have been estimated using data for 1499 different families in the U.S. and the asymptotically efficient Nelson-Olson two-step estimation method.

The empirical results strongly support the theory of family allocation of time and home production and are consistent with prior expectations. Also, the results support the above mutual causation hypothesis.

Introduction

During the last three decades there were noticeable changes in the American family's use of time. Juster and Stafford [1] show that during the period of 1965 to 1980 husbands' weekly market hours have decreased and weekly housework hours have increased. And for the same period wives have increased weekly market hours and decreased weekly housework hours. Husbands have increased their home labor supply while wives have decreased it. This shift in husbands' and wives' home and market labor supply have occurred because of different economic and social reasons such as the increase in women's relative wages and the improvements in home technology.

This paper uses the household production model and the family utility-family budget constraint model to estimate a system of simultaneous equations of time spent working at home for both husband and wife using the asymptotically efficient Nelson-Olson two-step estimation method. In the first section of the paper, a home labor supply

model is developed in which a total family utility function is maximized subject to family budget and time constraints. A home production function is also specified and the marginal productivity of working at home is derived. The second part discusses and analyzes the data that will be used to estimate the model. In the third part estimation techniques are discussed. And the fourth part reports the estimation results. The final section provides a summary and conclusions.

I. The Home Labor Supply Model

The original allocation of time model, which is called the traditional or the simple labor supply model (LSM), has two main components: the wage rate and the value of non-market time or leisure. This model was constructed by setting up a standard utility maximization problem and solving for optimal labor supply. The main decision variables of the model are the time an individual allocates to work and then, conditional on this decision, the value of this time. Among the conclusions of the LSM are the following: first, an individual participates in the labor market if the wage rate is greater than the value of non-market time. Second, if an individual works, which means there is an interior solution, then the value of time is equal to the wage rate. Third, if an individual is not working, which means there is a corner solution, then the value of time is equal to the value of leisure time.

G.S. becker [2, p. 142; 3, p. 493] stresses two main problems with the traditional LSM. First, it treats all time not devoted to market work as leisure, therefore, it does not capture choices that are made by the individual engaged in non-market work because of the implicit assumption that all non-market time is leisure. And that ignores the time allocation and home production of the household (e.g., raising children, sewing, cooking, cleaning, etc.). Second, it gives a major role to tastes and preferences because income and prices explain only the observed behavior of the household, but the residual is attributed to taste and preferences.

M. Killingsworth [4, p. 34] mentioned two other criticisms. First, the LSM focuses labor supply as an aspect of individual choice and this has no ideological implication because individuals' income is not their choice. Second, it treats individuals as persons who make decisions about labor supply solely on the basis of pecuniary factors such as wage and property income.

From the above basic criticisms come the following three models: the male chauvinist model, the individual utility-family budget constraint model, and finally the family utility-family budget constraint model. The last model is not considered only to be the most popular extension of the traditional labor supply model, but also the most popular treatment of family labor supply behavior. In this model the utility that is maximized is total family utility which is assumed to depend on total family consumption and on the leisure times of each of the family's members subject to a family budget constraint. The problem with this family utility-family budget constraint model is that it still treat, as in the traditional model, all non-market time as leisure and it

does not show the amount of leisure time required to consume different amounts of different consumer goods. As an extension of this model comes the household production function model (HPM) of the Chicago School.[1] This model introduces the production concept within households. It shows how both consumption and production jointly take place at home. The essence of the HPM model is that all consumption goods are produced by combining market goods and time.[2] In this model each household must make decision about two things. First, what market and bome goods to be consumed and how much of each? Second, what combination of inputs or technology to be used to produce each of the home goods? The HPM asserts that production functions can be observed and quantified, but tastes are difficult to observe and quantify. The main two advantages of the HPM approach over the traditional LSM is that it separates tastes from technology and provides a flexible framework for analyzing different uses of total leisure.

The aim of this paper is to use the above HPM approach in the context of the family utility-family budget constraint model. Therefore, we assume the following total family utility function:

$$U(C, L_1, L_2) \tag{1}$$

where U is a well-behaved utility function that is strictly increasing, differentiable, and quasi-concave. L_1, L_2 are the leisure time of husband and wife respectively, and C is a composite good for family consumption of market and home goods.

The family can either purchase goods in the market (X) or produce them at home (Z). Moreover, the goods purchased in the market could be used as final goods for consumption (X_m) and as intermediate goods for the production of home goods (X_z)

This means: $$X = X_m + X_z \tag{2}$$

Therefore, the above composite good of market and home goods (C) could be expressed as:

$$C = X_m + Z \tag{3}$$

where Z is the total goods that are produced at home.

The Z goods are produced according to the following production function:

$$Z = f(H_1, H_2, X_z) \tag{4}$$

where the inputs are the part of market goods that are used as intermediate goods (X_z), and time inputs that are the amount of non-market time devoted by husband and wife to

[1] Graphical illustration of the household production function model can be found in Gronau [16, p. 1107].

[2] Consumption goods mean all goods that can be valued and produced such as meals, education, altruism, health and children [5, 7-8].

the production of Z goods, or, in other words, the time spent working at home by the husband and wife $H_1$and H_2 respectively). The above home production function is assumed to be monotonically increasing, twice differentiable and subject to decreasing marginal productivity.[3] Also we assume that the time inputs (H_1, H_2), as well as the intermediate goods (X_z), have no direct effect on the utility function.

This family utility-family budget constraint model assumes the following: One period of time; two-partner household husband and wife where both work in the market; and finally, the home produced goods and the market purchased goods are perfect substitutes for each other, therefore, both generate the same marginal utility.[4]

The family faces both budget and time constraints. For the full budget constraint, we have:

$$X_m + X_z = V + W_1M_1 + W_2M_2 \qquad (5)$$

where V is the non-wage or property income M_1 and M_2 are hours spent working at the market by husband and wife respectively. W_1 and W_2 are real wages received by the husband and wife respectively. The prices of goods X_z and X_m are normalized to one. This constraint states that total family expenditures per period must equal total family income per period which consists of the non-wage income and the sum of the earnings of the husband and the wife.

In addition, the family faces a constraint in its time allocation:

$$T_i=H_i+M_i+L_i \quad , i=1,2 \qquad (6)$$

This constraint states that total time of each spouse is divided among three activities: working in the market (M_i), working at home (H_i), and leisure (L_i).

By substituting Equations (3) and (4) into (1), we could rewrite the family utility function as follows:

$$U[X_M+Z(H_1,H_2,X_Z), L_1, L_2] \qquad (7)$$

The household maximizes Equation (7) subject to constraints (5) and (6). The optimal conditions are obtained by maximizing the Lagrangian function G,

$$G = U[(X_M+Z(H_1, H_2,X_Z), L_1,L_2]$$

$$+ \lambda (V+W_1M_1+W_2 M_2 - X_M - X_Z)$$

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[3] This is a standard assumption for most production functions [6, p. 245] and it means that as more and more of one variable input is used the marginal product of that variable eventually declines, given that other variable inputs are fixed.

[4] For more details about the nature of these assumptions see Becker [2] and Gronau [17].

$$+ \Sigma \mu_I(T_i - H_i - M_i - L_i) \tag{8}$$

The following first-order conditions are derived:

$$\frac{\partial G}{\partial X_M} = \frac{\partial u}{\partial X_M} - \lambda = 0 \tag{8a}$$

$$\frac{\partial G}{\partial X_Z} = \frac{\partial u}{\partial Z} \frac{\partial Z}{\partial X_Z} - \lambda = 0 \tag{8b}$$

$$\frac{\partial G}{\partial H_i} = \frac{\partial u}{\partial Z} \cdot \frac{\partial Z}{\partial H_i} - \mu_i = 0 \qquad i = 1,2 \tag{8c}$$

$$\frac{\partial G}{\partial L_i} = \frac{\partial u}{\partial L_i} - \mu_i = 0 \qquad i = 1,2 \tag{8d}$$

$$\frac{\partial G}{\partial M_i} = \lambda W_i - \mu_i = 0 \qquad i = 1,2 \tag{8e}$$

$$\frac{\partial G}{\partial \lambda} = V + W_1 M_1 + W_2 M_2 - X_m - X_z = 0 \tag{8f}$$

$$\frac{\partial G}{\partial \mu_i} = T_i - H_i - M_i - L_i = 0 \qquad i = 1,2 \tag{8g}$$

where,

λ = marginal utility of income.

μ_i = marginal utility of time for husband and wife. i=1,2.

Since, by assumption, Z and X_M are perfect substitute for each other, this means,

$$(dU/dZ) = (dU/dX_M)$$

Equation (8f) measures the sensitivity of the optimal utility to changes in the initial income, whereas Equation (8g) measures this sensitivity to changes in the initial time.

Therefore, it follows from Equations (8a) and (8b) that

$$(dZ/dX_z) = 1 \tag{9}$$

This equation indicates that the marginal product of market goods used in home production is equal to one, which is the cost of purchasing the goods. This means that at the margin, market inputs in home production (X_Z) should contribute to total consumption by as much as they cost. Also from Equation (8e), $W_i = \mu_i/\lambda$ which indicates that the market wage is equal to the marginal rate of substitution between goods and time consumption (MRS_{XzHi}). Equation (8a) shows that the marginal utility of consuming market goods (X_m) is equal, at the optimum, to the marginal utility of income (λ).

From these justifications, Equation (8c) could be written as,

$$\lambda = \frac{\partial Z}{\partial H_i} = \mu_i$$

and this gives,

$$\frac{\delta Z}{\partial H_i} = \frac{\mu_i}{\lambda} = W_i = f_i \tag{10}$$

where $f_i = g(H_1, H_2, W_1, W_2, X)$

Equation (10) indicates that the marginal productivity of spending time working at home is equal to the market wage rate. Solving for H_i and linearizing it from Equation (10), we get the following simultaneous equations model:

$$H_1 = \gamma_1 H_2 + \beta_1 X_1 + \varepsilon_1 \tag{11}$$

$$H_2 = \gamma_2 H_1 + \beta_2 X_2 + \varepsilon_2 \tag{12}$$

where β_1, β_2, γ_1 and γ_2 are unknown parameters and X_k is a set of exogenous variables, one specific to each equation. In this model the two dependent variables are the average hours spent annually working at home by the husband (H_1) and wife (H_2).

Specifically, the above simultaneous-equations model of husband and wife home labor supply could be written in the following form:

$$H_1 = f[\hat{H}_2, K, KK, W_1, A_1, E_1, NW, e_1] \tag{13}$$

$$H_2 = f[\hat{H}_1, K, KK, W_1, W_2, A_2, E_2, NW, e_2] \tag{14}$$

where the endogenous (indicated by a hat over the variable) and the exogenous variables are defined in the following way:[5]

H_1 = The average annual hours spent working at home by husband.

H_2 = The average annual hours spent working at home by wife.

K = Number of children in the family aged 0-5 years old.

KK = Number of children in the family aged 6-13 years old.

W_1, W_2 = Net average hourly earnings of husband and wife respectively, and it is obtained by dividing the total annual labor income of the spouse by the number of annual hours worked in the year by the same spouse.

A_1, A_2 = Age of husband and wife respectively.

E_1, E_2 = Average years of education for husband and wife respectively.

NW = Total annual non-wage income earnings of the family.

e_1, e_2 = Random errors.

II- Estimation Method

In the model that follows, two simultaneous equations are estimated, one for the time spent working at home by the husband (H_1) and the other for the wife (H_2). For the three different time activities: working in the market, working at home and leisure, we assume that

$$L_i \geq 0, H_i \geq 0, M_i > 0.$$

Since the husband is assumed to be the only person who has some corner solution with respect to working at home, then $H_1 \geq 0$, $H_2 > 0$. And that is because some values of $H_1 = 0$. Therefore, the model falls into the limited dependent variable category, which is the Tobit case (7, p. 170].

Next we need another variable, H_1^*, to be the unobserved latent variable, and H_2 will be just the observed counterpart of H_1^*. Therefore we can rewrite Equations (11) and (12) in the following way:

$$H_2 = \gamma_1 H_1^* + \beta_1 X_1 + \varepsilon_1 \quad (15)$$

and

$$H_1^* = \gamma_2 H_2 + \beta_2 X_2 + \varepsilon_2 \quad (16)$$

[5] Data sources are indicated in the next section.

where

$$H_1^* = \begin{cases} H_1^* \text{ if } H_1^* > 0 \\ 0 \text{ otherwise} \end{cases} \tag{17}$$

There is no need to impose any restrictions on the endogenous variable coefficients which are known as logically consistent conditions. This has been proved by Nelson and Olson [9, p. 697] and Peter Schmidt [9, p. 423]. The set of Equations (15), (16), and (17) is a model considered by Nelson and Olson [8] and Amemiya [10].

The reduced form of the structural equations in this model is

$$H_1^* = X\pi_1 + V_1 \tag{18}$$

$$H_2 = X\pi_2 + V_2 \tag{19}$$

where $\text{cov}(V_1, V_2) = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix}$

In order to estimate this kind of model, Nelson and Olson [8, p. 703] suggest the following two step in estimation method. The first step is to estimate the reduced form for H_2 by OLS. That is, estimate Equation (19) by OLS. After that, estimate the reduced form for H_1^* (Equation (18)) by Tobit, and finally, compute the predicted values from these two procedures. In the second step, use the predicted values of H_1^* to estimate the H_2 structural equation (Equation (15)) using OLS, and also use the predicted values of H_2 to estimate the H_1^* structural equation (Equation (16)) using Tobit method.

One of the main issues in simultaneous-equations models is the identification of the system for any estimation method. In order to be able to estimate the model, each equations has to be just or over identified. Generally, there are two conditions for identification. The first is necessary and is called the order condition, and the second is necessary and sufficient and is called the rank condition.[6] Greene [11, p. 594] argues that in models that have many predetermined variables, the two conditions are met trivially, and only the order condition should be verified. And by examining the H_1 and H_2 equations in section II, we find that each one has excluded exogenous variables greater than the included variables, which means each equation is over identified. Therefore, the system is over identified and consistent estimation of all parameters is possible.

III. Data

The data used in this study were obtained from the Panel Study of Income Dynamics (PSID) [12], 1987 wave, which is the most recent data set that has been

[6] A detailed discussion of both conditions can be found in Greene [8].

collected and designed by the Survey Research Center (SRC) at the University of Michigan. The PSID survey is considered to be one of the most widely used social science data sets in the world because it covers many different social and economic variables.

The survey original sample consists of 7,018 households, where each household has been interviewed by telephone or in person. This study by random sample has been restricted to households of married couples where both husband and wife live in the same unit. Moreover it is restricted to households where both husbands and wives work in the market. Therefore, spouses beyond working age, above 65 years old, have been eliminated. After imposing these restrictions, the sample consists of 1,499 households.

The descriptive statistics of all variables are displayed in Table 1; it shows that the minimum average weekly hours spent working at home by the husband (H_1) and wife (H_2) is zero and one hour respectively, whereas the maximum is 84 hours per week for the wife and 80 for the husband. The mean is about twenty hours for the wife and eight hours for the husband; this suggests that females spend more time working at home than men. On average, the number of children aged 6-13 years old in the families greater than those aged 0-5 years old. The maximum number of children aged 0-5 years old is 3, whereas the maximum number of children aged 6-13 years old is 5. The minimum number of children aged 0-5 and 6-13 years old is zero; this means some families in the sample have no children.

Table 1. Descriptive statistics

Variable	Mean	Minimum	Maximum
H_1	7.5	0.0	80.0
H_2	20.2	1.0	84.0
K	0.50	0.0	3.0
KK	0.63	0.0	5.0
W_1	12.1	0.27	85.0
W_2	7.9	0.10	43.0
A_1	36.6	19.0	65.0
A_2	34.2	16.0	65.0
E_1	13.5	3.0	24.0
E_2	12.8	3.0	24.0
NW	4421	0.0	87200

The sample tends to have older males than females, the average age of husbands is about 37 years while the average age of wife is about 34 years. The maximum age of the males is 65 years and the minimum is 19 years, and the maximum age of the females is 65 whereas the minimum is 16 years. The average years of education of both husbands

and wives is about 13.5 and 12.8 years respectively. The average hourly wage in the market of the husband is greater than that of the wife. The average hourly wage of the husband is about 12 dollars whereas the average hourly wage of the wife is about 8 dollars. The maximum hourly wage of the husband is 85 dollars, while it is 43 dollars for the wife. Finally, some families have no other sources of income which means their non-wage income is zero. The maximum annual non-wage income in the sample is $87,200. On average the annual non-wage income in the American family is about $4,421.

Table 2 represents the frequencies for both husband and wife hours. It shows the number of husbands and wives who work at home for different weekly hours starting from zero to over 30 hours. There are 176 men who spent zero hours working at home, consisting of 12% of the sample. Most men, 44% of the sample, spent between one to six hours a week working at home. This means that more than half of the men in the sample (56%) spent less than seven hours working at home. Moreover, only 1% of the husbands worked at home more than 30 hours per week and 2% of them spent 25-30 hours a week. The same table shows that every wife in the sample worked some time at home, and no women worked zero hours. About two-thirds of the wives worked at home between seven and 24 hours a week. Only 207 women (14% of the sample) worked at home more than 30 hours a week. In general the table shows that most husbands tend to work at home between 1-12 hours a week whereas most wives tend to work at home between 7-24 hours a week.

Table 2. Frequency for husband (H_1) and wife (H_2)

Lower-upper limits	Husband (H_1)		Wife (H_2)	
	Frequency/ percentage	Cumulative freq/percentage	Frequency/ percentage	Cumulative freq/percentage
zero	176 (12%)	176 (12%)	0 (0%)	0 (0%)
1-6	666 (44%)	842 (56%)	114 (8 %)	114 (8 %)
7-12	417 (28%)	1259 (84%)	316 (21%)	430 (29%)
13-18	105 (7%)	1364 (91%)	284 (19%)	714 (48%)
19-24	83 (6%)	1447 (97%)	328 (21%)	1038 (69%)
25-30	36 (2%)	1483 (99%)	254 (17%)	1292 (86%)
over 30	16 (1%)	1499 (100%)	207 (14%)	1499 (100%)

Finally, Table 3 displays the simple correlation matrix coefficients for all the dependent and independent variables in the model based on all of the 1499 households sample. The correlation between two variables ranges from 0.002 and 0.919. The highest of those correlation's is between the husband age A_1 and the wife age A_2 which is expected , because as the husband gets older the wife gets older too.

Table 3. Simple correlation coefficients matrix

	H_1	H_2	K	KK	W_1	W_2	A_1	A_2	E_1	E_2	NW
H_1	1.0										
H_2	.181	1.0									
K	.081	.177	1.0								
KK	.046	.192	-.093	1.0							
W_1	.002	-.008	-.071	-.004	1.0						
W_2	.018	-.229	-.078	-.752	.357	1.0					
A_1	-.029	.030	-.355	-.053	.228	.113	1.0				
A_2	-.037	.040	-.365	-.044	.216	.122	.919	1.0			
E_1	.044	-.022	.035	-.018	.379	.306	-.303	-.019	1.0		
E_2	.023	-.115	.069	-.063	.250	.372	-.034	-.024	.480	1.0	
NW	-.054	-.007	-.169	-.054	.174	.120	.369	.363	.092	.041	1.0

IV. Empirical Results

The simultaneous equations model employed in this study consists of two structural equations. There was 15 estimated coefficient (variables) in the two equations (7 belongs to the husband equation and 8 to the wife equation).[7] Of these 15, 14 variables have the anticipated sign and 12 of these 14 variables are significant.[8] The results of the wife structural equation are strong and consistent with prior expectations. All the estimated variables in that equation are significant and of the expected signs. Therefore, the signs of the estimated coefficients are consistent with the theory of household production especially for the wife. Table 4 shows the estimated coefficients and t-values of the structural equations for the husband and wife equations, (15) and (16) respectively. And Table 5 shows these estimates for the reduced from equations. The same tables show the

[7] Constant terms are not included.

[8] The t ratios, which are the ratio of each estimated coefficient to its own standard error, give a rough indication of the statistical significance. When a coefficient has an expected sign, a one-tail test at the 10% level of significance (t.>1.29) is employed, and when a sign is not specified or when an unexpected sign is obtained, a two-tail test at the 10% level of significance (t>1.69) is employed. Therefore, throughout this paper when a coefficient is described as being significant, that means it is significant at the 10% level of better.

R^2 values assocaited with the estimates of husband and wife equations. Clearly, these values are low and that is expected for this kind of qualitative and limited dependent variable models [13, p. 189] and [14, p. 472]. Therefore, these coefficients of determination should not be used in judging the goodness of fit.[9] The analysis of the empirical results will be based on Table 4 which shows the empirical results of the structural equations.

For each equation, children tend to have a positive effect on the number of hours spent working at home by both parents. This means that the more children in a family, the more time needs to be spent at home by the wife and husband. The estimated coefficient of the number of children aged 0-5 years old is positive and significant in both equations, and also the estimated coefficient for the children aged 6-13 years old is positive and significant in both the husband and wife equations. The magnitude of these estimated coefficients of children is different, and it is greater for kids aged 0-5 years than aged 6-13 years old for both wife and husband. This means that, as the children grow older, the parents need to spend less time at home. Moreover, these magnitudes show that the wife is more responsive to the changes in these two variables (k and kk). This result indicates that children reduce the American wife's supply of work to the market and increase her work at home. This means that children cause their parents to transfer time from the market to home activities.

The age of both the wife and husband have a positive effect, as expected, on the time spent working at home. Age is positive and significant in the wife equation, which suggests that as women grow older they spend more time working at home and less in the market. The effect of education is negative in the wife equation. The estimated coefficient of this variable in that equation was negative and significant, this means that more educated women have a tendency to spend less time working at home and more time working in the market. In the husband equation, education is positive and significant which means that educated men have a tendency to spend more time working at home and this could be attributed to the fact that educated people are more aware of the importance of family ties than uneducated people.

The own wage effect for the wife is negative and significant, as expected. This means that as the wife's wage increases, she decreases the number of hours spent working at home and increases the number of hours spent at work. This is known as the substitution effect. The own wage effect for the husband is also negative, as expected, but not significant and this means that the husband wage has no effect on work at home.

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[9] Aldrich and Nelson [15, p. 15] stress that the use of R^2 as a summary statistics should be avoided in models with qualitative dependent variables.

This result is consistent with the earlier findings of Gronau [16, p. 1114). The cross substitution effect, which shows the effect of the husband's wage in the wife's equation, is positive and significant. This indicates that the wife will probably decrease the number of hours spent at the market when her husband's market wage increases. In other words, she will probably increase her time working at home as a result of that increase of her husband's market wage. This result could be attributed to the income effect.

Table 4. Estimated coefficients of husband (H_1) and wife (H_2) structural equations

Variable	Husband equation (H_1)	Wife equation (H_2)
Constant	215.9[a]	403.8[b]
	(2.30)	(1.70
H_1		1.27[b]
		(1.91)
H_2	0.11[c]	
	(1.37)	
K	67.24[a]	150.6[a]
	(2.92)	(4.66)
KK	44.31[a]	111.8[a]
	(2.43)	(4.90)
W_1	-0.41	5.09[a]
	(-0.24)	(2.38)
W_2		-20.9[a]
		(-7.87)
A_1	1.64	
	(1.06)	
A_2		9.74[a]
		(5.28)
E_1	11.72[a]	
	(2.66)	
E_2		-14.62[a]
		(-.2.5)
NW	-0.003[a]	0.004[c]
	(-2.35)	(1.49)
R^2	0.17	0.41

* Numbers in parenthesis show the t-ratios.

** (a) indicates absolute $t \geq 1.96$; (b) indicates absolute $1.69 \leq t < 1.96$;
(c) indicates absolute $1.29 \leq t < 1.69$.

Table 5. Estimated coefficients of husband (H_1) and wife (H_2) reduced form equations

Variable	Husband equation (H_1)	Wife equation (H_2)
Constant	153.55[b]	722.54[a]
	(1.78)	(6.61)
H_1		
H_2		
K	45.58[a]	196.29[a]
	(2.73)	(9.23)
KK	28.72[a]	140.13[a]
	(2.15)	(8.25)
W_1	-0.87	4.21[b]
	(-0.49)	(1.90)
W_2	3.43[c]	-27.6[a]
	(1.29)	(-8.19)
A_1	2.65	-0.459
	(0.86)	(-0.12)
A_2	-2.29	10.44[a]
	(-0.71)	(2.57)
E_1	11.14[a]	12.58[a]
	(2.29)	(2.53)
E_2	-0.35	-15.71[a]
	(-0.07)	(-2.59)
NW	-0.034[a]	0.004[c]
	(-2.36)	(0.195)
R^2	0.21	0.45

* Numbers in parenthesis show the t- ratios.

** (a) indicates absolute $t \geq 1.96$; (b) indicates absolute $1.69 \leq t < 1.96$; (c) indicates absolute $1.29 \leq t < 1.69$.

The non-wage income variable has a positive effect in the number of hours spent working at home by the wife, and that is expected. This result means that as the family non-wage income increases, the wife will spend less time working in the market and more time working at home. That variable has a negative effect in the husband equation. This means the family non-wage income increases the number of hours spent working in the market. This result could be attributed to the fact that the more family non-wage income the more opportunities the husband has to start new businesses which lead him to spend less time at home.

One of the main objectives of this study is to test the hypothesis that husband and wife home labor supply are jointly dependent and each stimulates the other. The empirical results strongly support this mutual causation hypothesis. It shows that the time spent working at home by the husband (wife) tends to have a positive effect on the number of hours spent working at home by the wife (husband). This suggests that a complementary effect exists between the husband's time and his wife's time working at

home. That could be called the love effect or finite effect. This means if one of them increases his or her time working at home, the other will increase time working at home as well.

Table 6 shows some point elasticities with respect to own wage, children aged 0-5 years old, and the non-wage income for both husband and wife. Moreover, it shows cross wage elasticities for the wife equation. These elasticities are calculated using the following formula:

$$\frac{\delta H_i}{\delta W_i} \cdot \frac{W_i}{H_i} \qquad i = 1,2$$

where W_i and H_i are the mean values of wage and annual hours of the its person (husband and wife).

Table 6. Elasticities with respect to wage, children and non-wage income

Variable	Husband (H_1)	Wife (H_2)
Own wage	-0.013	-0.23
Cross wage		0.059
Children aged 0-5	0.086	0.072
Non-wage income	-0.038	0.015

These elasticities are relatively small and consistent with the earlier findings such as Gronau [16, p. 1117; 17, p. 299] and Killingworth [4, p. 124] as well as with the parameter estimates. If the wife's wage increases, she tends to increase labor supply and, consequently, her leisure time, or the number of hours spent in home production, decreases. The wife home labor supply is more elastic than that of the husband and that is expected because women are more sensitive than men of work at home to changes in the wage rate. Presumably, if the elasticity is small, then either the labor supply effect is small or time and money are not very good substitutes in the production of home goods.

V. Summary and Conclusion

This paper develops a simultaneous equations model and presents an application to the theory of the allocation of time between three different activities: work in the market, work at home, and leisure. There was noticeable change in the American family's use of time. Husbands have increased their home labor supply while wives have decreased it. In order to explain this phenomena, a husband and wife home labor supply functions have been estimated using the 1987 Panel Study of Income Dynamics data for 1,499 different families in the U.S.A. and also the asymptotically efficient Nelson-Olson two-step estimation method is used because some dependent variables fall into the limited dependent variable category (the Tobit Case). The paper considers the most important economic and socioeconomic factors affecting the time spent working at home by each

spouse. These factors are wage, income, education, age, number of children of different ages and the time spent working at home by the other spouse.

The empirical results strongly support the theory of family allocation of time and home production and are consistent with prior expectations. This study supports the mutual causation hypothesis, that is, the American husband's and wife's home labor supply are jointly dependent and each stimulates the other. Young and old children tend to have a positive effect on the number of hours spent working at home by husband and wife with a bigger magnitude for the young children, aged 0-5 years old, they increase the American wife's and husband's work at home. Wage and education tend to reduce the American wife's home labor supply. They have a negative and significant effect on the wife equation. As the American family non-wage income increases, the wife spends more time working at home while the husband spends less time. Finally, the results show that wife's home labor supply is more elastic than that of the husband.

This study is considered one of the few applications to the family allocation of time and household production theories at least in the aspect of distinguishing between work at home and other activities. This distinction is useful in the analysis of other studies such as marriage, fertility, and labor participation. The study is suggested to be explored and developed as follows: First, considering a more recent data set when it becomes available from the PSID; second, using different estimation techniques such as the Heckman two-stage method, Smith-Blundell Method and Amemiya method; third, relaxing some of the study assumptions such that each spouse does not have to be employed in the market or in the labor force age; fourth, expanding the sample to include all age groups in the family; and finally, using a specific characterization for the endogenous variables such as characterizing by age, education level, and income.

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تقدير دالة العمل المنزلي لكل من طرفي الأسرة: الزوج والزوجة

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ملخص البحث. لقد برزت خلال السنوات الأخيرة تغيرات جوهرية في عرض العمل في العديد من المجتمعات وخاصة فيما يتعلق بنواة المجتمع الرئيسية وهي العائلة. فنلاحظ أن هناك تغيرات في عرض العمل واستخدام الوقت داخل وخارج المنزل من قبل الزوج والزوجة.

يستهدف هذا البحث إلقاء الضوء على ظاهرة انخفاض عرض العمل في المنزل من قبل الزوجة وزيادته من قبل الزوج، كما يستهدف اختبار فرضية السببية المتبادلة في عرض العمل المنزلي. وعليه فقد تم تقدير دالة الوقت المستخدم في العمل المنزلي لطرفي الأسرة الزوج والزوجة. ولقد تم اختيار الولايات المتحدة الأمريكية كمجتمع للبحث وذلك لتوافر البيانات اللازمة لمثل هذه الدراسات.

ولتحقيق هذا الهدف فقد تم تقسيم البحث إلى خمسة أقسام، في الجزء الأول تم إلقاء الضوء على أوجه القصور في نماذج عرض العمل التقليدية ومن ثم تقديم نموذج مقترح لتعظيم دالة منفعة العائلة يأخذ في الاعتبار قيدي الدخل والوقت للأسرة، كما تم في الجزء الثاني توضيح الأسلوب القياسي المستخدم في التقدير. أما الجزء الثالث فقد تم فيه تحليل البيانات المستخدمة، وفي الجزء الرابع تم عرض ومناقشة نتائج البحث. وتضمن الجزء الأخير ملخص لفكرة ونتائج البحث، والتي كانت متفقة مع نظرية الإنتاج وعرض العمل المنزلي وتؤكد على فروض هذا البحث، وخاصة فيما يختص بفرضية السببية المتبادلة في عرض العمل المنزلي من قبل الزوج والزوجة.