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THE FAMILY LABOR SUPPLY RESPONSE TO DISABLING CONDITIONS

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ABSTRACT

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The role of time as an input into the utility maximization process has long been recognized in the labor-leisure decision. Expanded research has dealt with this input in a family context. Assuming a joint utility maximization model, the resulting labor supply functions can be determined for both spouses.

The model presented here is an extension of previous models by its incorporation of the effects of disabling conditions of the husband on the labor supply decisions of both spouses.

Because hours worked takes on a lower limit of zero, the standard simultaneous equation techniques would yield estimates lacking the ideal properties. Instead, the model is estimated using a simplification of a simultaneous TOBIT technique which yields consistent estimates.

THE FAMILY LABOR SUPPLY RESPONSE TO DISABLING CONDITIONS

by

L. Scott Muller, Jesse M. Levy, and Malcolm B. Coate *

The role of time as an input into the utility maximization process has long been recognized for its role in the labor-leisure decision. At first, this labor supply decision was considered in the context of the individual. 1/ More recently, the methodology has been expanded to deal with family labor supply. 2/ In this form, the model assumes a joint utility maximization process where the labor-leisure decisions of both spouses are simultaneously determined conditional on wages and prices. The consequence of this process is a pair of labor supply and leisure demand functions based on first and second order conditions sufficient to insure the maximization of utility.

Most recently the labor supply model has been expanded to examine the labor supply of disabled workers. Unfortunately, these models have often

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1/ See, for example:
Becker, Gary, "A Theory of the Allocation of Time," Economic Journal, September 1965, Vol. 75, pp 493-517.
Gronau, Reuben, "Leisure, Home Production, and Work - The Theory of the Allocation of Time Revisited," Journal of Political Economy, December 1977, pp 1,099-1,124.

2/ See for example:
Grahm, Wendy Lee, "Household Utility Maximization and the Working Wife," American Economic Review, March 1975, pp 90-100.
Ashenfelter, Orley and Heckman, James, "The Estimation of Income and Substitution Effects in a Model of Family Labor Supply," Econometrica 42 (1974), pp 73-85.
Kniesner, Thomas, "An Indirect Test of Complementarity in a Family Labor Supply Model," Econometrica, July 1976, 44(4), pp. 651-69.

been specified in the primary earner context by denoting the wife's earnings as an independent variable, thus considering her labor supply as parametric to the model. 3/ By not treating the wife's labor force behavior as endogenous, serious misspecification of the model results which causes biased, inconsistent estimates of the coefficients of the remaining variables. The model presented here will be concerned with the simultaneous labor supply decision while incorporating the effects of disability of one spouse. The first section will present the theoretical model. The second part will provide empirical results.

The Theoretic Model

The model presented here is a variation of the classic utility maximization model, with the maximization subject to a full income constraint. The arguments of the joint utility function are leisure of individual 1, leisure of individual 2 and goods. In the specification of the model we will allow for the disability of individual 1 and not of individual 2. While this constraint is not necessary theoretically, it does make for ease of exposition, both theoretically and empirically. The wage rate for individual 1 will be a function of disability, as will potential labor market time for that individual. For the disabled worker, potential

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3/ See, for example:
Berkowitz, M. and Johnson, W. G., "Health and Labor Force Participation," Journal of Human Resources, Winter 1974, pp 117-128.
Scheffler, R. and Iden, G., "The Effect of Disability on Labor Supply," Industrial and Labor Relations Review, October 1974, pp 122-132.
Luft, Harold, "The Impact of Poor Health on Earnings," Review of Economics and Statistics, February 1975, pp 43-57.
Parsons, Donald, "Health, Family Structure and Labor Supply," American Economic Review, September 1977, pp 703-712.

time may be lost due to increased time required for self-care and health maintenance. 4/ For the healthy member, there may be a decrease in market time because the value of the marginal product in maintenance of the spouse's health may be greater than it is in the market place. This is somewhat analogous to the wife facing a labor market-home production-leisure decision. In any event, the time available to the healthy member does not change due to the mate's disability, but the allocation may be altered.

Consequently, the goal is to maximize

(1) $U = U(L_1, L_2, X)$

Subject to the full income constraint

(2) $F = Y + W_1T_1 + W_2T_2 = P_xX + W_1L_1 + W_2L_2$

where:

L_1 =Leisure of first (possibly disabled) family member
L_2 =Leisure of second family member (non-disabled)
X =Goods
Y =Non-wage family income
W_1 $=W_1(\delta)=$ wage of first (possibly disabled) family member
W_2 =Wage of 2nd family member
T_1 $=T_1(\delta)=$available time of first family member
T_2 =available time of second family member
P_x =Price of goods
δ =disability parameter

4/ This approach has been taken by others, for example: Grossman, Michael, "The Demand for Health: A Theoretical and Empirical Investigation," NBER Occasional Paper #19, Columbia University Press N. Y. 1972.

This will yield the following Lagrangian equation:

(3) $\mathcal{L} = U(L_1, L_2, X) + \lambda((T_1 - L_1)W_1 + (T_2 - L_2)W_2 + Y - P_X X)$

The first order conditions are:

(4a) $\frac{\partial \mathcal{L}}{\partial L_1} = U'L_1 - \lambda W_1 = 0$

(4b) $\frac{\partial \mathcal{L}}{\partial L_2} = U'L_2 - \lambda W_2 = 0$

(4c) $\frac{\partial \mathcal{L}}{\partial X} = U'X - \lambda P_X = 0$

(4d) $\frac{\partial \mathcal{L}}{\partial \lambda} = (T_1 - L_1) W_1 + (T_2 - L_2)W_2 + Y - P_X X = 0$

$= F - L_1W_1 - L_2W_2 - P_X X = 0$

Conditions 4a - 4c can be rewritten to state the standard economic result that the ratios of marginal utility to price equate for all arguments in the utility function.

The solution of the first order conditions yields the following demand equations for leisure:

(5a) $L_1 = L_1(W_1, W_2, P_X, F)$

(5b) $L_2 = L_2(W_1, W_2, P_X, F)$

and since leisure is equal to the difference between total time (T_i) and hours of work (H_i) we have:

(6a) $L_1 = T_1 - H_1$

(6b) $L_2 = T_2 - H_2$

then by definition

(7a) $H_1 = H_1(W_1(\delta), W_2, P_X, F(\delta)) = H_1(W_1, W_2, P_X, T_1, T_2, Y)$

(7b) $H_2 = H_2(W_1(\delta), W_2, P_X, F(\delta)) = H_2(W_1, W_2, P_X, T_1, T_2, Y)$

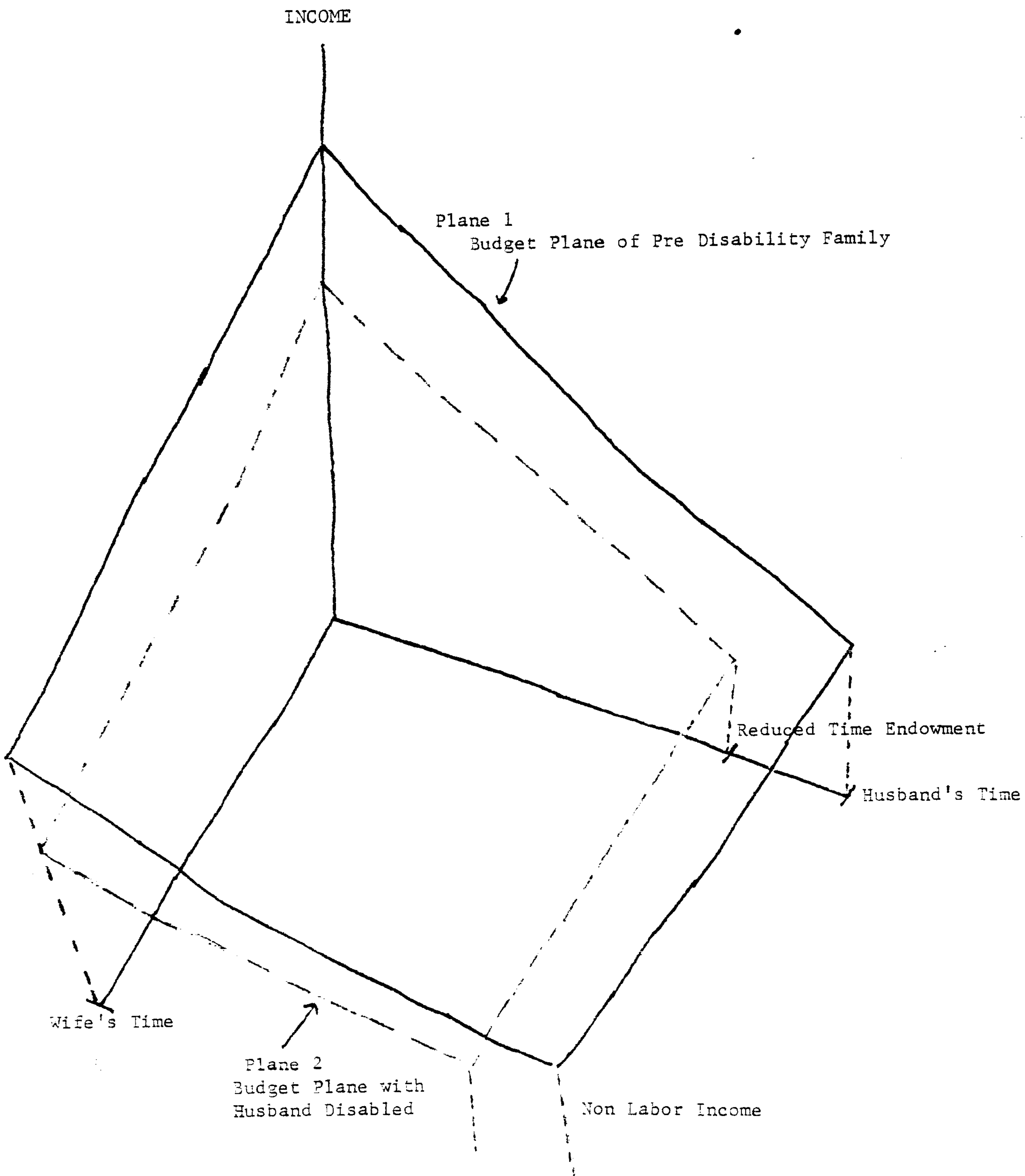
The second part of equation 7 is derived by implicity substituting $W_1 T_1 + W_2 T_2 + Y$ for full income F.

We hope to be able to deduce the effect of disability on labor supply of the two family members through the direct effect of W_1 and the indirect effect on F through W_1, T_1 and Y.

Insight into this problem can be gained by considering the choice set (options) facing the disabled worker illustrated in Figure 1. The initial choice set (plane 1) represents the full income constraint mapped on the space of husband's time, wife's time and market goods. Imposition of a utility map will yield a point revealing the optimal choice of leisure (and thus labor and labor income) in the predisability state. With the onset of disability the full income constraint is shifted downward to plane 2 due to the decrease in both wages and potential market time of the disabled worker. While this will necessarily imply a low equilibrium point on the utility hyperplane the directions and magnitudes of changes in leisure and market goods cannot be determined without a priori restrictions on the utility function. Only through placement of an arbitrary utility map will be equilibrium values be unambiguously defined. In general, there is no reason to constrain oneself to a solution by the imposition of a specific utility function.

Our goal being to investigate the effect of a change in disability on hours of the first and second members (i.e. $\frac{\partial H1}{\partial \delta}$ and $\frac{\partial H2}{\partial \delta}$), we employ a comparative statics methodology. Substituting the appropriate functional relationships (equations 5a, b and 6a, b) and differentiating with respect to δ yield the following partial derivatives.

FIGURE I - Budget Constraint Facing Family



$$8)\quad \frac{\partial H_1}{\partial \delta} = \frac{\partial (T_1 - L_1)}{\partial \delta} = \frac{\partial T_1}{\partial \delta} - \left(\frac{\partial L_1}{\partial W_1} \frac{\partial W_1}{\partial \delta} + \frac{\partial L_1}{\partial F} \frac{\partial F}{\partial \delta} \right)$$

$$9)\quad \frac{\partial H_2}{\partial \delta} = \frac{\partial (T_2 - L_2)}{\partial \delta} = - \left(\frac{\partial L_2}{\partial W} \frac{\partial W_1}{\partial \delta} + \frac{\partial L_2}{\partial F} \frac{\partial F}{\partial \delta} \right)$$

Where $\frac{\partial F}{\partial \delta}$ can be broken into its component parts consisting of a wage effect, a time effect and an unearned (asset and transfer) income effect. Thus:

$$10)\quad \frac{\partial F}{\partial \delta} = \frac{\partial F}{\partial W_1} \frac{\partial W_1}{\partial \delta} + \frac{\partial F}{\partial T_1} \frac{\partial T_1}{\partial \delta} + \frac{\partial F}{\partial Y} \frac{\partial Y}{\partial \delta} = T_1 \frac{\partial W_1}{\partial \delta} + W_1 \frac{\partial T_1}{\partial \delta} + \partial Y / \partial \delta$$

Of the three terms in equation (10), only $\partial Y/\partial \delta$ is indeterminate. Whereas the first two terms are unequivocally negative (both wages and time are reduced by disability), it is impossible to sign, a priori, the effect of disability on unearned income. We believe two factors may be exhibited in this term.

First the initial onset of disability may require complete, but perhaps temporary, withdrawl from the labor force or large expenditures on health care which will erode accummulated wealth and reduce unearned income. However, there is another factor which will tend to offset the effect. The onset of disability may make the person eligible for public transfers which would increase non-wage earnings.

Expressions (8) and (9) are similarly of ambiguous signs, and not solely due to the ambiquity inherent in the term $\partial F/\partial \delta$. In (8) the term $\partial L_1/\partial W_1$

depends on the relative importance of income and substitution effects. This can be seen from the familiar Slutsky decomposition (derived in Appendix A):

$$(11)\quad \frac{\partial L_1}{\partial W_1} = \left(\frac{\partial L_1}{\partial W_1}\right)_{u=\bar{u}} + H_1 \frac{\partial L_1}{\partial Y}$$

While the income compensated (substitution) effect is always negative, the income effect may be either positive or negative. Under the usual assumption of normality of leisure as a good, the gross effect of wages on leisure is indeterminate, depending on relative magnitude of the income and substitution effects. In (9) the term depends on the cross effects of the spouse's wage on leisure. From the Slutsky decomposition we obtain

$$(12)\quad \frac{\partial L_2}{\partial W_1} = \left(\frac{\partial L_2}{\partial W_1}\right)_{u=\bar{u}} + H_1 \frac{\partial L_2}{\partial Y}$$

The sign of this term is dependent on the complimentarity of leisure of the two individuals.

It becomes clear that the effect of disability on H_1 and H_2 can not be determined a priori. Given the indeterminate state of the theoretical solution, we must attempt to answer this question empirically. The empirical specification and estimation techniques are presented in the section which follows.

The Data

The data employed in this paper come from the 1976 Survey of Income and Education. That survey contains 151,170 respondent households representing the population of the United States. In generating our data sample we selected only single family households where the respondent was married with spouse present, the wife was nondisabled, and neither husband nor wife were self-employed or farm workers. This generated a sample of 54,594 families from which the 1,338 households whose head listed racial background other than black or white were eliminated. The resulting sample included 50,235 white households (94.3%) and 3,021 black households.

Unfortunately, where data were missing values were allocated. Since allocated values of our dependent variables were not flagged, we were not able to delete cases where missing values had been allocated. The allocation procedure, which is not random, may induce a bias problem in the estimating procedure. In addition we have uncovered several inconsistencies in the data documentation and in the allocation techniques. We have attempted to resolve these problems, although some inconsistencies may remain. 5/

The Empirical Model

The theoretic model yielded the following two hours of work equations:

(7a) $H_1 = H_1(W_1, W_2, F, P_x)$

(7b) $H_2 = H_2(W_1, W_2, F, P_x)$

Since the data is of a cross-sectional nature the prices of goods are fixed and can be eliminated. Full income is a function of wages, (of both workers) time available for work, and other unearned income. 6/ Since time available

5/ The Bureau of the Census has been made aware of these problems and is, hopefully, attempting to work them out.

6/ The use of unearned income as an exogeneous variable or parameter to this model may present theoretical problems. One source of unearned income is disability transfer programs where the amount of the benefit is determined by the loss of income (through reduction in wages and/or hours) or the severity of the disabling condition. For the purpose of this paper disability benefits will be taken as an exogeneous variable. The treatment of this variable as endogenous to the system will be left to future research.

is a function of disability we can establish the equivalence of (7a,b) to (13a,b);

(13a) $H_1 = H_1(W_1, W_2, \delta, Y)$

(13b) $H_2 = H_2(W_1, W_2, \delta, Y)$

In addition to these theoretically generated parameters we have chosen to include additional variables which measure either tastes or constraints to the decision making process. Among these variables are education and labor force experience of each individual, number of children, and the receipt of social security disability insurance.

Education and potential labor force experience are included as determinants of labor force participation rates and to control for tastes. Labor force experience will also control for the life cycle effects of aging on participation.

The number of children and the presence of children under 6 are included in the wife's equation to measure the wife's home productivity. A child under 6 years of age represents a strong time constraint for women, tending to limit the hours of work. (The number of children is included in the wife's equation to measure the amount of home production which is necessary. Four children, for instance, will require considerably more meal preparation, cleaning, laundering, etc. than a single child). The number of children is also entered in the husband's labor supply equation in order to assess the relative home productivity vs. the increased costs to the household of children.

The receipt of social security is entered in the husband's labor supply equation to account for the substantial gainful activity constraint imposed by the social security legislation. The program limits the earnings of persons who receive disability benefits to $280 per month. The social security legislation provides dependents benefits for wives who are aged or have dependent children and do not work. In order to assess her incentives to withdraw from the labor force the social security variable was entered in her equation. The social security legislation also provides benefits for dependent children, although the family maximum is reached with two dependents whether it be a wife and child or two children. Thus the wife can work and not reduce the social security benefits as long as there are two or more children. We have included an interaction term for families with two or more children who receive social security payments. This variable will pick up any change in the wife's labor force behavior due to this kink in her budget constraint.

Thus our estimated model is defined as:

(14a) $H_1 = \alpha_0 + \alpha_1 H_2 + \alpha_2 W_1 + \alpha_3 W_2 + \alpha_4 \delta + \alpha_5 Y + \alpha_6 KIDS + \alpha_7 exp_1 + \alpha_8 S_1 + \alpha_9 SS$

(14b) $H_2 = \beta_0 + \beta_1 H_1 + \beta_2 W_1 + \beta_3 W_2 + \beta_4 \delta + \beta_5 Y + \beta_6 KIDLT6 + \beta_7 KIDS + \beta_8 exp_2 + \beta_9 S_2 + \beta_{10} SS + \beta_{11} SSxKID$

where W_1 = wage of first individual

W_2 = wage of second individual

H_1 = hours of first individual

H_2 = hours of second individual

δ = measure of disability of the first individual

KIDLT6 = presence of child less than 6

KIDS = number of children under 18

Y = amount of unearned income (total amount)

exp_1 = experience of 1st indiv. computed as (age_1 - S_1 - 6)

exp_2 = experience of second individual (age_2 - S_2 - 6

S_1 = schooling of first individual

S_2 = schooling of second individual

SS = receipt of social security disability insurance

SSxKID = interaction of SS and the presence of more than 1 child

Estimation

The hours of work equations are simultaneously determined and therefore must be estimated as a system of two equations. However due to the relatively large proportion of disabled individuals and married women who work zero hours, the dependent variable will have a distribution truncated at zero hours. The table below presents the number of persons in the sample by the decision to work or not work.

Race	Sex	0 hours	>0 hours	Total
White	Male	3,508	46,727	50,235
	Female	20,196	30,039	50,235
Black	Male	381	2,640	3,021
	Female	887	2,134	3,021
TOTAL		24,972	81,540	106,512

Because of the bunching of hours worked at zero for husbands and wives, and consequently the non-ideal conditions of the random disturbances standard simultaneous equation techniques would not be appropriate. In a paper which dealt with a simultaneous equation analog to the single equation TOBIT model, Amemiya 7/ proposed three estimation techniques to be employed in such a situation. The simplest procedure computationally, using only observations where both dependent variables were positive, was designed to yield consistent but non-efficient results. Unfortunately, this multi-stage least squares procedure yielded negative variance estimates and was not deemed operational with our data. The other two procedures were maximum likelihood estimators applied to the reduced form and structural systems respectively. While both procedures yield consistent estimates, estimation of the structure is preferable because of the gain in efficiency. Its drawback is a more complicated likelihood function.

The model was estimated by the simultaneous maximum likelihood procedure for the structural equations. The model is:

$$
\begin{aligned}
Y_{Ht} &= \gamma_H Y_{Wt} + \beta_H X_{Ht} + U_{Ht} && \text{if RHS} > 0, \\
&= 0 && \text{else;} \\
Y_{Wt} &= \gamma_W Y_{Ht} + \beta_W X_{Wt} + U_{Wt} && \text{if RHS} > 0 \\
&= 0 && \text{else}
\end{aligned}
$$

7/ Amemiya, Takeshi, "Multivariate Regression and Simultaneous Equation Models When the Dependent Variables are Truncated Normal," Econometrica, Vol. 42, No. 6, November 1974, pp 999-1012.

where H and W denote the husband's and wife's equations respectively; γ_H and γ_W are scalers, β_H and β_W are K_H and K_W dimensional parameters and X_H and X_W are TxK_H and TxK_W vectors subscripted for each couple $t = 1,\ldots,T$. Here, Y_{Ht} and Y_{Wt} denote hours worked of the husband and wife.

Dividing the data into four groups:

$$S_1 \equiv \{t/\ Y_{Ht} > 0,\ Y_{Wt} > 0\}$$

$$S_2 \equiv \{t/\ Y_{Ht} > 0,\ Y_{Wt} = 0\}$$

$$S_3 \equiv \{t/\ Y_{Ht} = 0,\ Y_{Wt} > 0\}$$

$$S_4 \equiv \{t/\ Y_{Ht} = 0,\ Y_{Wt} = 0\}$$

Then the resulting likelihood function can be written as the product of the likelihood functions for each group.

$$L = \prod_1 (1-\gamma_H\gamma_W) f(Y_{Ht} - \gamma_H Y_{2t} - \beta_H X_{Ht} Y_{Wt} - \gamma_W Y_{Ht} - \beta_W X_t)$$

$$\cdot \prod_2 \int_{-\infty}^{-\gamma_W Y_{Ht} - \beta_W X_{Wt}} f(Y_{Ht} - \beta_H X_{Ht}, U_W)\, dU_W$$

$$\cdot \prod_3 \int_{-\infty}^{-\gamma_H Y_{Wt} - \beta_H X_{Ht}} f(U_H, Y_{Wt} - \beta_W X_{Wt})\, dU_H$$

$$\cdot \prod_4 \int_{-\infty}^{-\beta_H X_{Ht}} \int_{-\infty}^{-\beta_W X_{Wt}} f(U_H, U_W)\, dU_H dU_W$$

where f is the bivariate $N(0, W_1^2, W_2^2, W_{12})$ density. Maximization of this function will yield well behaved parameter estimates. Because of the clumping of hours worked at zero, and because of the inherent simulteneity of the model the coefficients cannot be interpreted as linear effects on hours $(\partial H/\partial X)$. Instead, suffice it to say that a positive coefficient on a regressor implies that hours is a positive monotonic, although not linear, function of that variable.

The Sample

The model was estimated on a subsample of 2,835 white families due to the computational difficulties associated with the simultaneous Tobit program. Social security disability recipients were excluded from this sample because of the apparent coding error that many of them worked full-time. Thus the social security variables were deleted from equation 14a and b. This exclusion could bias the results since many seriously disabled workers are on disability. 8/

The Survey of Income and Education contained 10 health conditions which were aggregated into one dummy variable representing the presence of a disabling condition. It is important to note that this measure really represents the presence of a health impairment which we have assumed to be a disabling condition. The aggregation was necessary because the Tobit procedure was limited in the number of independent variables which could be employed.

It should be noted that since wage rates are not observed for nonworkers it was necessary to impute values for the wage rate of these individuals. For this purpose we constructed a wage instrument based on the human capital model with health impairments added. We estimated the relationship in natural log form using data for the entire sample under the assumption that the offered wage does not vary among individuals with like human capital characteristics. The results for the wage instruments are presented in

8/ We were able to estimate the complete model (equations 14a and 14b) with all 54,594 observations using a two stage least squares procedure. Although the estimating procedure yields biased, inconsistent, and inefficient parameter estimates, we gain from a correctly specified model (in terms of the variables included) and a larger sample size. These results are presented in Appendix C. We note that the proportion of SSDI recipients who worked full time was much smaller in the 54,594 observation sample than in our 2,835 subsample and thus creates less of a problem in estimating the entire model.

Appendix B and are used to predict values of the wage in the sample. Theoretically, this could lead to sample selectivity bias and consequently biased and inconsistent instruments. 9/

It is possible to include a "bias correction factor" in the estimation of the wage offer equation, in which case the resulting estimates of this equation (and consequently our instruments) are well behaved. In the paper cited earlier, Heckman shows that heteroskedasticity in the censored model is symptomatic of the need for the correction factor. Thus rejection of the null hypothesis of heteroskedasticity of the disturbances in the wage offer equation without the bias correction factor implies that these results are consistent for both workers and nonworkers. A plot of residuals showed this to be the case and, consequently, our instruments are consistent.

The means and standard deviations of the variables entered into the Tobit estimation procedure are given in Table 1. The characteristics of an average sample family seem to approximate the overall population.

9/ Heckman, James, "Sample Selection Bias as a Specification Error" National Bureau of Economic Research (NBER) Working Paper No. 172, Stanford, California, March 1977.

TABLE 1.--Means and Standard Deviations of Data

	Mean	Standard Deviation
Hours Husband	42.4	13.1
Hours Wife	19.3	18.7
Education Husband	12.6	2.99
Education Wife	12.3	2.39
Experience Husband	23.4	11.0
Experience Wife	21.0	10.8
(ln) Wage Husband	6.40	.193
(ln) Wage Wife	5.75	.196
#KIDS < 18	1.55	1.43
KIDS < 6	.295	.456
Health	.081	.273
Other Income	2,088	3.805

Results of Maximum Likelihood with Usual Weekly Hours

The results of the nonlinear Tobit procedure are presented in Table 2. The estimation yielded some parameters that were logical consequences of the model and a few that were counter intuitive.

The health variable reduced the disabled husband's work by a significant number of hours. The reduction in the hours of work can be attributed to a change in the relative productivity of home vs. market time and/or a reduction in the overall time endowment (i.e., an increased health maintenance time).

Presence of a health impairment in the husband did not significantly increase hours of work of the wife. This result could be caused by different health conditions requiring different combinations of hospital and home nursing care. Thus some women would reduce hours of work to offer home care and others increase it to make up lost earnings or perhaps to assist in the payment of medical expenses.

Spouse's hours had a significant positive effect on the hours of the mate, regardless of sex. This may imply that spouses like to consume their leisure jointly or that both family members tend to work more when the family prefers market goods.

Both spouses exhibited strong and significant negative responses to change in their own wages and the husband's response seemed to be the larger of the two. Holding other variables constant, this can be interpreted as a

TABLE 2.--Maximum Likelihood Results for Labor Supply of White Families

	Husband	Wife
Health	-7.4035	.46331
	(5.82)	(.23)
Hours Husband	--	.13305
		(3.83)
Hours Wife	.63345	--
	(3.36)	
Wage Husband	-.42884	-.04832
	(35.45)	(4.09)
Wage Wife	.23201	-.28859
	(19.65)	(25.12)
#KIDS < 18	-1.5534	-4.0700
	(6.24)	(10.16)
KIDS < 6	--	-9.983
		(8.83)
Other Income	-.00006	-.00004
	(1.59)	(.53)
Education Husband	.22317	--
	(2.40)	
Education Wife	--	.20311
		(1.33)
Experience Husband	-.03617	--
	(1.13)	
Experience Wife	--	-.40827
		(8.08)
Constant	56.971	22.954
	(30.45)	(7.43)

Note: t ratios are presented in parenthesis combination of income and substitution effects on hours worked. In this case the income effect outweighs the substitution effect producing a backward bending supply curve of labor for each spouse. Past research has produced additional empirical evidence that it is the income effect which predominates. 10/ We note, however, that this result is in contrast with our initial research employing Two Stage Least Squares on the entire sample. 11/

Looking at the effects of a change in the natural logarithm of the wage on the hours of the spouse, it was found that the wife responds negatively to an increased spouse wage while the husband offers more hours when the wife's wage increases. These coefficients cannot be interpreted as cross-substitution effects, but instead as a combination of income and cross-substitution effects. It is not obvious that this lack of symmetry is contrary to the implications of the model. However, this lack of symmetry does seem unusual. This result may have been caused by the construction of the natural logarithm of the wage instrument. The instrument was created using variables required by the human capital model, and as a result, included many of the same regressors used in the estimated structural equations. Furthermore, there was relatively little variance in the instrument, leading to possible collinearity problems. These problems may have been caused by

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10/ See, for example:
Finegan, T. Aldrich, "Hours of Work in the United States: A Cross-Sectional Analysis," Journal of Political Economy, October 1962, pp 452-470.

11/ The Two Stage Least Squares results are presented in Appendix C.

an instability of the coefficients on the natural logarithm of the wage instruments given slight variations in the model. For these reasons one might be skeptical about these estimates.

The presence of children under 6 and the total number of children exert the traditional downward pull on the wife's hours of work. This implies the presence of children increases the home productivity of the wife and causes a switch from market to home production to restore the equilibrium. Although the magnitude is smaller for the husband than for the wife there is a significantly negative coefficient on the number of children which implies the father's home productivity increases also. It could represent the husband declining extra overtime or moonlighting so he can spend time with the family. Because this result is inconsistent with the increased costs associated with children we question the true underlying cause of this relationship.

Holding other variables constant, the other income variable may be interpreted as a pure income effect. For both spouses this variable had a small negative magnitude but was insignificant. Thus small increases in nonlabor income would probably not affect the hours of work decision of either person.

Husband's education had a significant positive effect on his hours worked. While the economic model does not specify a sign, this is the result found in past research on hours of work. Finegan 12/ notes that holding gross earnings and other factors constant, those with higher educational attainments have lower net hourly wages and hence choose longer work weeks. In addition we believe those with greater years of schooling will have jobs with more desirable working conditions and will thus be less resistant to working longer hours. The effect of education on the hours worked of the wife were also positive but insignificantly different from zero.

Experience is a proxy for both aging and potential labor market attachment. The insignificant male experience variable indicates much of the reduction in hours associated with aging can be explained by the other variables such as disability and wage level.

The strong negative effect of experience on the wife implies the aging effect is not captured as much by other variables. The negative impact of aging may be caused by the wife's market productivity declining faster than her productivity in the home.

The Total Disability Effect

Our analysis has shown that the direct impact of health is significant in reducing the hours of work of the husband, but insignificant in increasing the hours of the wife. The true relationship, however, is more complex than that represented by the coefficient on our impairment variable. The

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12/ Finegan, T. Aldrich, "Hours of Work in the United States: A Cross-Sectional Analysis," Journal of Political Economy, October 1962, pp 452-470.

multiple effects of disability on the hours of work of the husband and wife are diagramed in Figure II. Of the seven effects we have shown only one to be insignificant while the others are significant.

Effects 1 and 2 in figure two cannot be separated in our analysis. The effect of the husband's health on his time endowment and the direct effect on his hours of work are represented by the coefficient on the impairment parameter in the husband's equation, and the net effect is a reduction of hours of work.

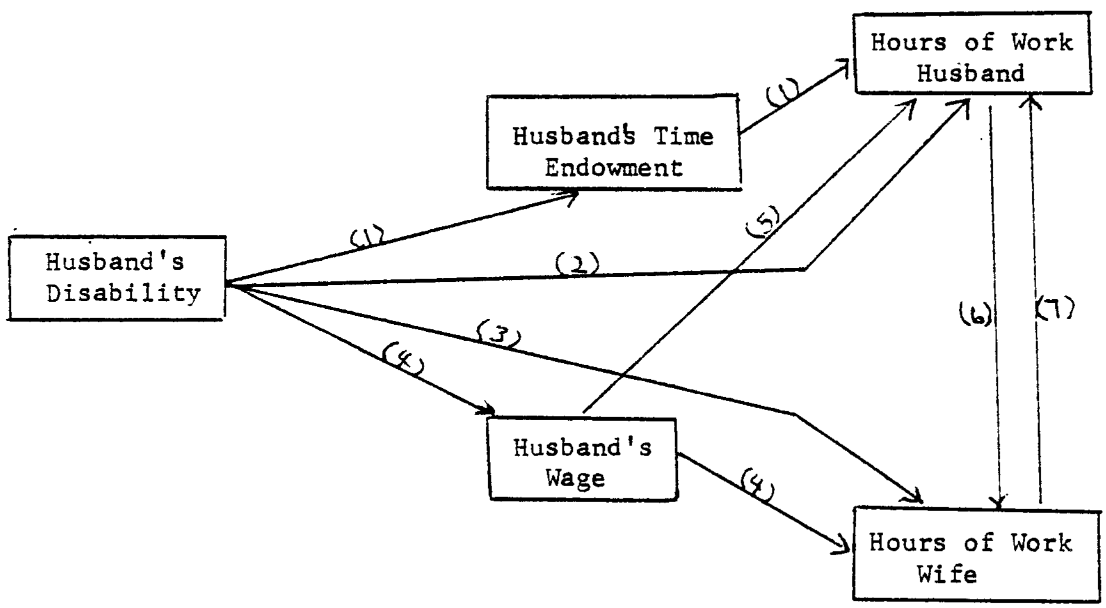
The third effect (#3) is represented by the coefficient on the health variable in the wife's equation. This is the only insignificant relationship. Effect #4 is composed of 2 changes. First the husband's health reduces his wage rate while the reduction in the wage rate increases the wife's hours. Effect #5 is the husband's own wage effect, which tends to increase his labor supply.

Finally there exist the simultaneous changes in hours of one family member produced by a change in hours of the other family member (represented by effects 6 and 7). In each case an increase in hours of work of one will increase the hours of work of the other, indicating the preference to consume leisure together.

The total effect is indeterminate by sign alone, and becomes a question of the relative magnitudes of the several effects. Unfortunately, due to the

FIGURE II

Effects of Disability on Hours of Work
in a Family Labor Supply Context



nonlinear Tobit parameter estimates, it is impossible to make point estimates of the total effect. (Estimates of the total disability effect are given in Appendix C for the two stage results).

Conclusion

The policy implications of the paper are limited at best. The problems associated with the sample required the deletion of all Disability Insurance beneficiaries and the combination of the health variables into one dummy variable. This drastically reduced the scope of the paper. Also, total disability effects cannot be calculated because the parameter estimates are not linear.

We are left with the conclusion that husbands with disabling conditions work less and their wives work about the same when the other variables in the model are held constant. Future research incorporating a sample of Disability Insurance beneficiaries would be useful to illustrate the direct effects of the program on the hours of work of each family member. Methodological research on the Tobit procedure is needed to make it possible to calculate the total disability effect and answer the questions posed in this paper.

APPENDIX A

The Slutsky equation can be derived from the total differential of the first order conditions.

The first order conditions (equation 4) are differentiated with respect to all the variables and the resulting equations are given below:

(1a) $U_{11}\ dL_1 + U_{12}\ dL_2 + U_{13}\ dX - W_1 d\lambda = \lambda dw_1$

(1b) $U_{21}\ dL_1 + U_{22}\ dL_2 + U_{23}\ dX - W_2 d\lambda = \lambda dw_2$

(1c) $U_{31}\ dL_1 + U_{32}\ dL_2 + U_{33}\ dX - p d\lambda = \lambda dp$

(1d) $-W_1 dL_1 - W_2 dL_2 - p\ dX + 0 = -dF + L_1 dW_1 + L_2 dW_2 + X\ dp$

or in matrix notation (the matrix of second derivatives is the Hessian matrix in the second order conditions)

$$\begin{bmatrix} U_{11} & U_{12} & U_{13} & -W_1 \\ U_{21} & U_{22} & U_{23} & -W_2 \\ U_{31} & U_{32} & U_{33} & -p \\ -W_1 & -W_2 & -p & 0 \end{bmatrix} \begin{pmatrix} dL_1 \\ dL_2 \\ dX \\ d\lambda \end{pmatrix} \begin{pmatrix} \lambda dW_1 \\ \lambda dW_2 \\ \lambda dp \\ -dF + L_1 dW_1 + L_2 dW_2 + Xdp \end{pmatrix}$$

Cramer's Rule is then used to solve for dL_1. The notation D is used for the determinant of the matrix and Dij is used for the determinant of the ij cofactor.

(2) $dL_1 = \lambda dW_1\ D_{11}/D + \lambda dW_2\ D_{21}/D + \lambda dp\ \ D_{31}/D$

$+ (-dF + L_1 dW_1 + L_2 dW_2 + Xdp)\ D_{41}/D$

This equation can be simplified by setting $dT_1 = dT_2 = dW_1 = dW_2 = dp = 0$ and observing $dF = dY$ so

(3) $dL = -dY \quad D_{41}/D$ so $dL_1/dY/ = -D_{41}/D$

which represents an income effect.

Next setting $dW_2 = dP = 0$ in equation 2 gives:

(4) $dL_1 = dW_1\lambda \quad D_{11}/D - dL_1/dY/ \; (-dF + L_1 dW_1)$

dividing thru by dW_1 and using partial derivatives

(5) $\partial L_1/\partial W_1 = \lambda D_{11}/D + (\partial F/\partial W_1 - L_1)\; \partial L_1/\partial \; Y$

Noting that $\lambda D_{11}/D = \partial \tilde{L}_1/\partial W_1$, the compensated derivative and $\partial F/\partial W_1 - L_1 = T_1 - L_1 = H_1$ gives the final form of the Slutsky equation.

(6) $\partial L_1/\partial W_1 = (\partial L_1/\partial W_1 \;{}_{u=\bar{u}} + H_1 \; (\partial L_1/\partial Y))$

APPENDIX B

Table 3

Wage Instrument Results

Variable	White Males	White Females	Black Males	Black Females
School	.06155	.08606	.06411	.10651
	(72.109)*	(56.442)*	(16.370)*	(20.234)*
Experience	.04436	.01887	.02592	.02899
	(59.263)*	(17.766)*	(7.832)*	(7.623)*
Experience^2	- .00072	- .00028	- .00035	- .00051
	(43.796)*	(10.743)*	(5.073)*	(5.660)*
D6 Sight	- .17751		- .04504	
	(3.716)*		(.192)	
D8 Crippled	- .10576		- .45565	
	(3.869)*		(3.483)*	
D9 Arthritis	- .05465		- .16122	
	(2.012)**		(1.341)	
D10 Spinal	- .06895		- .10897	
	(4.306)*		(1.517)	
D11 Heart	- .11985		- .06071	
	(6.388)*		(.676)	
D13 Respiratory	- .08663		- .24080	
	(3.194)*		(1.758)***	
D14 Digestive	- .16667		- .13070	
	(4.171)*		(.871)	
H1 Hearing	- .08707		.37089	
	(2.451)**		(1.384)	
H2 Nervous-emotional	- .13088		- .39915	
	(3.492)*		(2.477)**	
D1 Other	- .11180		- .11270	
	(7.080)*		(1.961)**	
Constant	5.07468	4.45379	5.09791	4.22001
Df	46707	29910	2626	2129
R^2 (adjusted)	.16872	.10292	.12724	.19198
F	730.419	1144.94077	30.59421	169.84985

*Significant to .01 level (2 tail test)
**Significant to .05 level (2 tail test)
***Significant to .10 level (2 tail test)

APPENDIX C

An alternate approach to the non-linear Tobit estimation is Two Stage Least Squares. The parameter estimates from our intital research using this technique are presented in Table 4. Although the results are biased, inconsistent and inefficient (the disturbance term does not have a zero mean), the two stage procedure can estimate a more detailed model and use the entire sample. Thus we have a trade-off between estimation bias in the two stage results and possible omitted variable bias in the maximum likelihood results. Unfortunately, it is impossible to quantify the bias so any results must be interpreted with caution. Since the maximum likelihood results are not necessarily biased, we choose to present them in the paper.

The two stage estimates also yield comparative static results for the reaction of a worker who becomes disabled. The following system of equations derived from 14(a,b) define the total change in hours caused by disability.

1) $\Delta H_1 - \alpha_1 \Delta H_2 = \alpha_2 \Delta W_1 + \alpha_4 + \alpha_9 SS$

2) $-\beta_1 \Delta H_1 + \Delta H_2 = \beta_2 \Delta W_1 + \beta_4 + \beta_{10} SS$

Where the α_i's and β_j's are the estimated coefficients given in Table 4. The change in the husbands wage from disability was defined as the coefficient value from the instrumental regression in appendix B and the SS variable was set to 1 when the change in hours was calculated for a Disability Insurance beneficiary. One can solve these equations to yield the estimates for the total disability effect of a single impairment.

It is extremely difficult to calculate a variance for the estimates and thus hypothesis testing is impossible, but the point estimates do give interesting results. Table 5 presents the change in usual weekly hours worked after onset of disability for white families. The effects for both families on disability insurance and those not receiving payments are given.

The disabled men reduce their hours of work between 2-6 hours if they are not participating in the disability program and about 30 hours if they are disability recipients. Unfortunately we cannot tell if the DI effect is due to the substantial gainful activity (SGA) limitation or the more severe disability of the DI beneficiary. The wife's hours are increased minimally for most disability types. For husbands on DI we find the wife's hours are reduced relative to wives whose husbands are not on DI. The nervous-emotional disability causes the largest reduction in work effort for both the husband and wife. On the other hand, the wife increases her hours of work to partially make up for the drop in the husbands hours for the respiratory, spinal, heart and crippled type of disability. Finally, in all the other disabilities the wife's hours change slightly as the husband reduces his hours.

It is difficult to tell if the DI husband's drop in hours is caused by the SGA limitation or if DI beneficiaries are too disabled to work.

But we can observe a noticeable drop in the total disability effect on the wife's hours as the husband moves from disabled to DI beneficiary. A further reduction in hours takes place if the wife has children so the family is eligible for additional benefits. Thus the DI program seems to discourage the wife from working.

The lack of variances on the point estimates in table 5 make it impossible to test the hypothesis that the DI program discourages the wife from working. A cross-tabulation procedure allowed us to test the hypothesis, but we were unable to control for as many variables as with the Two Stage regression procedure. Table 6 shows the cross tabulation on the entire sample for hours of work of the wife. The significance of the differences in hours worked can be tested by a weighted least squares dummy variable regression. The data is initially broken down into cells for all possible combinations of variables. Then the mean hours of each cell is calculated, weighted by the variance of the cell and used as the dependent variable. Dummy variables are used as the independent variables. The parameter estimates are presented in Table 7 and all the variables are significant. Thus we have statistical support for the findings of Table 5 in which wives of disabled social security recipients work significantly less than wives of disabled non-recipient men. The magnitude of +1.9 hours is in the range of point estimates for the wives of disabled workers and the estimate of -2.7 is in the range of the change in wife's hours when children are present in DI beneficiary families.

TABLE 4 .--Two Stage Least Squares Results for the Labor's Supply of Husband and Wife

	Usual hours of work per week				*Hours worked in 1975*			
	White		*Black*		*White*		*Black*	
Variable	Male	Female	Male	Female	Male	Female	Male	Female
Hours Husband	--	.57666	--	- .21975	--	20.37807	--	- 4.67493
		(5.569)*		(.803)		(4.179)*		(.349)
Hours Wife	- .00751	--	.09705	--	- 3.29050	--	3.94762	--
	(.488)		(.568)		(3.864)*		(.423)	
Wage Husband	13.47636	- 14.30827	28.82573	- 1.43854	910.8067	- 627.63272	1603.07617	58.74576
	(19.821)*	(19.350)*	(4.959)*	(.636)	(24.216)*	(18.021)*	(5.054)*	(.532)
Wage Wife	2.78638	25.14786	- 1.64554	22.11681	279.26728	2136.87845	1.24282	1374.86712
	(6.202)*	(7.314)*	(.651)	(3.221)*	(11.238)*	(13.195)*	(.000)	(4.097)*
Other Income	- .00013	.00001	- .00026	- .00023	- .01592	- .00292	- .03090	- .01260
	(7.703)	(.448)	(2.820)*	(1.784)***	(17.570)*	(2.504)**	(6.033)*	(1.964)**
S.S.	- 26.21306	14.23027	- 18.32659	- 3.16175	- 1254.41694	507.89696	- 839.02313	- 63.11641
	(52.259)*	(4.895)*	(9.251)*	(.502)	(45.209)*	(3.709)*	(7.761)*	(.205)
S.S. x KID	--	- 2.17213	--	- 1.05292	--	- 31.73911	--	- 25.68737
		(1.621)		(.245)		(.503)		(.122)
KIDLT6	--	- 9.92297	--	- 3.93858	--	- 479.81906	--	- 241.75800
		(46.679)*		(4.592)*		(47.923)*		(5.766)*
KIDS > 18	.23663	- 2.53904	.10657	- 1.58463	9.87622	- 134.93459	6.58271	- 79.67750
	(3.236)*	(31.181)*	(.285)	(6.607)*	(2.442)**	(35.183)*	(.322)	(6.796)*
Labor Market Exp.-*Male*	- .09469	--	- .10448	--	- 3.81084	--	- 1.05215	--
	(8.055)*		(1.476)		(5.860)*		(.272)	
Labor Market Exp.-*Female*	--	- .45168	--	- .20975	--	- 21.92468	--	- 8.16964
		(19.080)*		(3.618)*		(19.663)*		(2.883)*
D6 Sight	- 2.30769	1.15525	- .08392	3.10616	- 129.16208	35.99272	- 98.10601	24.47980
	(2.238)**	(.824)	(.000)	(.696)	(2.265)**	(.545)	(.435)	(.100)
D8 Crippled	- 3.05768	3.79846	7.35998	- 8.98383	- 179.10701	140.52016	373.67903	- 247.05841
	(4.927)*	(4.182)*	(1.980)**	(2.380)**	(5.217)*	(3.285)*	(1.847)***	(1.339)
D9 Arthritis	- 4.71156	2.78021	- .47286	1.93141	- 278.99987	105.48240	4.31378	226.54422
	(8.001)*	(2.956)*	(.161)	(.576)	(8.565)*	(2.381)**	(.032)	(1.383)
D10 Spinal	- 2.17316	2.51341	- 3.87386	- 2.20748	- 196.12721	74.89414	- 277.57738	- 76.47564
	(5.575)*	(4.320)*	(2.256)**	(.814)	(9.096)*	(2.733)*	(2.962)*	(.577)
D11 Heart	- 2.46766	2.42253	- 7.17471	- 3.39012	- 146.97782	84.14860	- 389.65375	- 119.08583
	(5.491)*	(3.540)*	(3.713)	(1.020)	(5.913)*	(2.611)*	(3.696)*	(.733)
D13 Respiratory	- 1.37374	2.27781	.53267	- 2.40527	- 111.40215	81.81137	71.49542	- 91.30981
	(2.191)**	(2.686)*	(.158)	(.596)	(3.212)*	(2.048)**	(.391)	(.463)
D14 Digestive	- 1.12931	.18141	- 3.16272	- .42784	- 59.86962	- 6.94645	- 70.20375	9.25938
	(1.258)	(.152)	(.937)	(.100)	(1.205)	(.122)	(.381)	(.045)
H1 Hearing	- 1.88518	1.75717	- 16.80101	.56638	- 38.84487	41.00508	- 837.23541	- 78.77306
	(2.411)**	(1.660)***	(3.286)*	(.095)	(.898)	(.823)	(3.001)*	(.268)
H2 Nervous-emotional	- 4.53145	.92337	7.19138	- .70081	- 253.99320	33.60779	263.59246	- 40.03179
	(6.074)*	(.815)	(2.032)**	(.200)	(6.155)*	(.630)	(1.365)	(.232)
D1 Other	- 2.67875	1.94219	- 5.74857	- 2.72358	- 219.11059	55.63427	- 410.07765	- 49.64668
	(6.644)*	(3.017)*	(3.780)*	(.930)	(9.824)*	(1.835)***	(4.941)*	(.346)
School husband	- .72328	--	- 1.78841	--	- 39.76957	--	- 88.67307	--
	(13.324)*		(4.289)*		(13.244)*		(3.897)*	
School wife	--	- 1.43667	--	- 1.17439	--	- 139.25249	--	- 86.36989
		(5.027)*		(1.522)		(10.345)*		(2.291)**
Constant	- 48.16267	- 24.46608	- 109.94096	- 61.73729	- 4662.22713	- 5821.20195	- 7116.68729	- 5579.57122
DF	50216	50214	3002	3000	50216	50214	3002	3000
R^2 (adjusted)	.12611	.12217	.12669	.06970	.14623	.12903	.14926	.08837
F	403.716	350.546	25.339	12.312	478.980	373.109	30.436	15.638

*Significant to .01 level (2 tail test)
**Significant to .05 level (2 tail test)
***Significant to .10 level (2 tail test)

TABLE 5.--Change in Hours Worked for Newly Disabled

		Not on DI	DI *
Sight	Husband	-4.75	-31.1
	Wife	.99	.082
Crippled	Husband	-4.54	-31.0
	Wife	2.75	1.85
Arthritis	Husband	-5.5	-32.0
	Wife	.42	-.48
Spinal	Husband	-3.14	-29.6
	Wife	1.72	.81
Heart	Husband	-4.14	-30.6
	Wife	1.79	.93
Respiratory	Husband	-2.58	-29.0
	Wife	1.96	1.15
Digestive	Husband	-3.41	-29.8
	Wife	.62	-.27
Hearing	Husband	-3.09	-29.5
	Wife	.246	-.642
Nervous-Emotional	Husband	-6.35	-32.8
	Wife	-.847	-1.73
Other	Husband	-4.23	-30.7
	Wife	1.13	.241

*Wife assumed not to have children; if wife has children and thus eligible for additional benefits, we find her hours of work decline by an additional 2.2 in each case.

TABLE 6.--Mean hours of married women by race and husband's health status

	Not disabled	Disabled (does not receive SSDI)	Disabled (receives SSDI)
Total..............	20.7 (60,225)	22.6 (5,832)	19.4 (942)
Race			
White....................	20.3 (57,368)	22.4 (5,508)	19.2 (869)
Black....................	26.4 (2,857)	24.5 (324)	21.8 (73)

NOTE: This table presents the weighted means. The number of actual unweighted observations is presented in parenthesis.

TABLE 7.--Coefficients of weighted least squares estimation for spouse's hours of work

Variable	Coefficient	t-statistic
Constant.................	18.185	18.62***
Disabled Husband.........	1.938	2.14*
Social security recipient	-4.650	-2.18*
Race (1 if black)........	7.021	7.63***
Child under 6 years......	-8.458	-19.11***
High school education....	3.986	3.99***
College education........	6.305	6.23***

*Significant beyond .05 level for two-tail test with 26 degrees of freedom.

**Significant beyond .01 level for two-tail test with 26 degrees of freedom.

***Significant beyond .001 level for two-tail test with 26 degrees of freedom.

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