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College of Commerce and Business Administration
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Summary

In this study, the value of non-market time is estimated for American families using the opportunity cost approach whereby the market wage is taken as a measure of the value of time and used to impute non-market income to each household. In cases where the market wage is not observed, a new estimation technique is used to obtain consistent estimates of the wage. It is shown that the non-market income of families increases with family money income and family size, but decreases with age and the number of job-holders in the family. The implications for taxation are discussed.

TAXATION AND THE VALUE OF NON-MARKET TIME

The evaluation of non-market time is a matter of concern for national income accounting. Failure to take into account the value of non-market productive activities of households undermines gross national product as a measure of social contributions. Without the value of non-market activities, the resulting GNP biases estimates of economic growth and makes comparisons between different countries unreliable.

Another reason for interest in the value of non-market time is that it comprises a major source of untaxed income. Morgan, Sirageldin, and Baerwaldt (1966) estimate that the inclusion of unpaid work in the national accounts in 1964 would have increased GNP by 38 percent, while Sirageldin (1969) places the average value of unpaid output for the American family in 1964 at approximately 50 percent of its disposable income.[1] As Musgrave (1959) points out, failure to tax the imputed value of non-market time leads to unequal treatment of people in essentially equal positions.[2] Two families with equal full incomes (money income plus imputed non-market income) do not pay equal taxes if imputed income is untaxed. Further, the distribution of taxes over income classes may be distorted by failure to tax imputed income.

The objective of this study is to estimate the value of non-market production of American families in 1975 using data from the Michigan Income Dynamics Survey for 1976. The study utilizes the opportunity cost approach whereby the market wage is taken as a measure of the value of time and used to impute non-market income to each household. For households where a market wage is not observed (i.e., where the wife does not work in the market), a technique developed by Heckman (1976, 1979) is used to

obtain consistent estimates of the wage rate.[3] Influences on the value of non-market production such as age, education, size of family, and race are studied, and the implications for tax policy are discussed.

I. Problems in Evaluating Non-market Time

Two major problems arise in evaluating non-market time. One is an absence of data on non-market activities, although recent improvements in data collection are solving this problem. A second is assigning a price to non-market activity.

Several approaches to the second problem are found in the literature. One is called the replacement cost approach, which uses the wage of a replacement service worker as a measure of non-market activity. This approach is explained and defended by Rosen (1974). One difficulty with the replacement cost approach is that it requires knowledge of time spent performing a wide variety of services, as well as the market price of these services. Also, in many cases, the household worker might value his or her own production differently from the market price for the same services; e.g., child care services.[4] In addition, the replacement cost approach may be downward biased because housekeepers rarely take over household tasks completely.[5]

A second approach to assigning a price to non-market time is called the opportunity cost approach. A price is assigned according to the price the family member would earn by selling his or her services in the market. A difficulty arises in applying this approach when the family does not sell any time in the market. It is hard to know what is the price the market would have offered this person for his or her time. But even if the wage of non-workers could be imputed accurately, its use

will understate the value of non-market activity for those who do not work outside the home. In addition, as Gronau (1977) points out, the wage provides a poor approximation to the value of time if the home production function displays non-constant returns.[6]

This last point can be seen by assuming that the value of home production depends on the input of non-market time, H, and is given by the function f(H), which is homogeneous of degree k. Then the function can be written as:

$$f(H) = H^k f(1).$$

Taking the derivative of f(H) and setting this equal to the wage gives:

$$W = f'(H) = kH^{k-1} f(1)$$

where W is the wage. Multiplying through by H and substituting for f(H) yields

$$WH = kf(H).$$

It follows that if k is less than one (decreasing returns), using the wage rate, W, to impute a value of non-market time, H, leads to an underestimate. Conversely, if k is greater than one, the market wage overestimates the value of non-market time. Only if home production displays constant returns will the market wage give an accurate estimate of the value of non-market time.

Whether or not the home production function displays non-constant returns is a matter for conjecture. It is difficult to make a general argument. Pollak and Wachter (1975) suggest that "many household production processes exhibit increasing or decreasing returns to scale in ways which are directly related to the use of time."[7] They go on to state

that "examples related to set-up time, time spent assembling materials, etc., are easy to find but depend on the particular commodity or production process being considered."[8] It will be assumed in the work that follows that the home production function displays constant returns and can be written as:

$$f(H) = \alpha H$$

where α is a constant. But even with this assumption, the problem that the imputed wage understates the value of non-market time for those who don't work outside the home remains.

This point is illustrated in the following model of home production behavior adapted from Gronau's (1977) model. This model disregards the input of other family members into market and home production, assumes zero costs related with work, and assumes constant returns to home production.

Utility, U, is determined by two factors: full income, Y, and hours of leisure, L.

$$U = U(Y,L)$$

It is assumed that the marginal utilities of income and leisure, U_Y and U_L, are both positive.

Utility is maximized subject to an income constraint:

$$Y = WN + \alpha H - T$$

where W is the market wage rate, N is hours worked in the market, α is the marginal productivity of home production, H is hours of home production, and T is the family's tax liability.

Utility is also maximized subject to a time constraint,

$$K = L + N + H$$

where K is total time available.

For simplification, it is assumed that the tax liability is a linear function of money income:

$$T = tWN.$$

Applying the Lagrangian multiplier technique yields the following first order conditions for utility maximization:

(1a) $W(1 - t)U_Y - U_L \leq 0$, and

(1b) $\alpha U_Y - U_L \leq 0$.

If H and N are greater than zero, $W(1 - t) = \alpha$ and full income, Y, is given by:

$$Y = W(1 - t)(N + H).$$

An unbiased estimate of full income can be obtained by multiplying the disposable (after tax) market wage by the number of hours of market and non-market work.

If H is greater than zero and N equal to zero, as would be the case for those who do not work outside the home, then:

$$W(1 - t)U_Y - U_L < 0 = \alpha U_Y - U_L.$$

And it follows that:

$$W(1 - t) < \alpha.$$

Hence:

$$Y = \alpha H < W(1 - t)H.$$

And even if $W(1 - t)$ could be imputed, its use would understate the value of non-market time for those who do not sell time in the market.

II. Method and Data

The approach of this study is the opportunity cost approach. Assuming constant returns for home production, the market disposable wage times the number of hours of home production provides an accurate estimate of the value of non-market time for those who work in the market. For those who do not work in the market, a disposable wage is imputed based on the characteristics of the person. The imputed wage is multiplied by the number of hours of non-market time to give an estimate of the value of non-market time. It should be noted in light of the theoretical discussion in Section I that this approach understates the value of non-market time for those who do not work in the market.

The problem of imputing a wage to those who do not work in the market is a source of difficutly. Since the wage for these persons is unobserved, a common approach is to estimate the wage rate over the employed persons in the sample and impute the wage according to the personal characteristics of the rest of the sample. Unfortunately, this approach leads to a censoring bias in the estimate of the wage coefficient.

Recent advances in econometric theory by Heckman (1976, 1979) suggest a solution to the problem of the unobserved wage. Heckman uses a two-stage procedure that corrects for the bias introduced by censoring the sample. This technique has been used successfully by Lee (1978), Fligstein and Wolf (1978), and others in different contexts.

Briefly, the Heckman technique adapted to our problem is as follows. As a first step, probit analysis is used to estimate the probability that an individual participates in the labor force:

$$p(LFP_i) = F(\gamma_1 X_1, \gamma_2 X_2)$$

where X_1 is a set of explanatory variables for labor force participation, X_2 is a set of explanatory variables for the expected wage, and the γ are parameters of the probit analysis.

The parameters of the probit estimation are then used to estimate λ, the inverse of the Mill's ratio, and the estimated value of λ is used as a regressor in the wage equation:

$$w = \beta_1 X_2 + \beta_2 \lambda + u$$

where u is a stochastic disturbance. The wage equation is then estimated using ordinary least squares on the labor force participants in the sample. Heckman has showed that the estimates of β_1 using this technique are consistent.

The study utilizes a valuable source of data for studying non-market behavior, the Michigan Income Dynamics data for 1976. These data are a cross-sectional sample of approximationly 5,000 households and contain information on hours of housework, child care, and market work, as well as more conventional data on income, education, age, etc. These data provide a crucial addition for the study of home production activity since wives as well as husbands were interviewed for the 1976 survey year.

A subsample of the data was chosen for the estimation. Only married households not on welfare and with non-negative non-work income were

included. The subsample also excluded certain observations where data were missing or where either spouse was less than 18 years of age. The subsample consisted of 1,574 families.

Various uses of family time were available in the data. From the husband's interview, data were available on his annual hours working for money in 1975, and on his average weekly hours spent on housework—such as time spent cooking, cleaning, and other work around the house. The husband's average weekly hours of housework were multiplied by 52 to put them on an annual basis. From the wife's interview, data were available on her annual hours working for money in 1975, her annual hours of housework, and her and her husband's annual hours of child care.

Table 1 shows the means and variances of some of the important variables in the data. It can be seen from the table that, on the average, wives work more hours at home than in the market, while the opposite is true for husbands. However, the total productive hours of wives exceed that of husbands by 10 percent.

III. Results

The first step in the estimation was to estimate the probability of the wife's labor force participation as a function of two sets of explanatory variables: one for labor force participation and the other for the expected wage. The results of the probit estimation appear in Table 2. The two variables explaining labor force participation were non-work income and the number of children in the family. Both have a negative influence on the probability of working outside the home. The other variables explain the expected wage.

TABLE 1

Mean and Variances for Married Households

	Mean	Variance
Family Money Income	$18,325	.1158 E+09
Annual Hours of Market Work		
Wives	1,264	.6325 E+06
Husbands	2,274	.4054 E+06
Annual Hours of Housework		
Wives	1,360	.5952 E+06
Husbands	362	.4424 E+06
Annual Hours of Child Care		
Wives	566	.2373 E+07
Husbands	277	.1051 E+07
Age		
Wives	35.8	.1328 E+03
Husbands	38.5	.1433 E+03
Education		
Wives	12.4	.5558 E+01
Husbands	12.3	.2553 E+02
Size of Family	3.47	.2006 E+01

TABLE 2

Probit Estimation of the Probability of Labor Force Participation of Married Women

Characteristic	Coefficient	t-Ratio
Constant	.111	.462
Disposable Wage of Husband	-.123	-6.66
Education	.081	4.58
Number of Children	-.158	-5.35
Experience	.039	3.08
Experience Squared	-.001	-3.70
Non-work Income	-.00004	-3.43

Number of Observations	1485
-2 x Log Likelihood Ratio	.135 E+03
Number of Iterations	4

The purpose of the probit estimation was to calculate λ which is used to adjust for bias in the wage equation. Together with λ, the explanatory variables in the wage equation are education, experience, experience squared, and the disposable wage rate of the husband. The results of the ordinary least squares estimation appear in Table 3. Since the survey did not include direct information about the hourly wage rates, total earnings were divided by the number of hours of market work, and this was multiplied by one minus the marginal tax rate to give an estimate of the disposable wage. Education was measured as the total number of years of school completed by the wife and experience was computed by subtracting years of education plus five from the age of the wife.

As the results show, education and experience both have a positive influence on the wife's disposable wage rate. The disposable wage rate of the husband also positively influences the wife's wage.

The expected disposable wage of those who do not work outside the home was then imputed on the basis of the estimated wage equation. Multiplying the imputed wage by hours spent in each non-market activity gives a lower-bound estimate of the home production income of those who do not work in the market. For husbands and for wives who worked outside the home, home production income was estimated by multiplying the market disposable wage by time spent in non-market activities. Average home production income for wives and husbands by money income class is shown in Table 4.

Table 4 shows the relation of home production income to family money income. While home production income increases as money income increases for both husbands and wives, the increase is more dramatic for husbands.

TABLE 3

Ordinary Least Squares Estimation of the Disposable Wage Rate of Employed Married Women

Characteristic	Coefficient	t-Ratio
Constant	-1.12*	-2.57
Education	.256*	8.12
Experience	.011	0.58
Experience Squared	-.00006	-0.13
Disposable Wage of Husband	.068*	1.72
Probit λ	.288*	1.39

Number of Observations	966
Adjusted R^2	.105
F(5,960)	23.62

*Significant at the .10 level.

TABLE 4

Family Home Production Income of Husbands and Wives
by Family Money Income Class

Family Money Income Class	Mean Home Production Income of: Husbands	Wives	Total
$5,000 or less	$1,752	$4,172	$5,925
$5,0001 through $10,000	2,289	4,852	7,141
$10,001 through $15,000	3,040	5,542	8,582
$15,001 through $20,000	2,545	5,903	8,449
$20,001 through $30,000	3,340	5,672	9,011
Above $30,000	3,389	5,426	8,815
Entire Population	$2,874	$5,483	$8,357

Families in the upper income bracket (over $30,000) show a slight decrease in home production income. On the average, home production activity adds $8,357 to family income, which was about 52 percent of family disposable income in 1975. This estimate is very close to Sirageldin's (1969) estimate of 50 percent for 1964.

Table 4 shows that over 65 percent of family home production income is due to the wives' activities. Table 5 shows a breakdown of home production income of wives by type of activity: child care and housework. On the average, income from housework exceeds income from child care. Income from child care remains fairly constant over the middle income ranges, being somewhat less for those with less than $5,000 income and less for those with over $20,000 income. Income from housework declines with family money income throughout the income classes.

Table 6 through 9 show the effect of various factors on the home production income of families, namely, family size, age, education, and race. Table 6 shows that families with only two persons have substantially less home production income than families with more than two persons. Since children account for families of size three or more, the increase in home production income for larger family size is due to the presence of children. Home production income increases for families up through size four and then decreases slightly. This may be because in larger families older children assist with the home production activities but their contribution to family home production income is not reflected in our estimate of home production income.

Tables 7 and 8 show the effect of age and education on family home production income. The age and education of the husband were taken as

TABLE 5

Wives' Home Production Income by Activity and by Family Money Income

Family Money Income Class	Child Care	Housework	Total
$5,000 or less	$1,752	$2,420	$4,172
$5,001 through $10,000	1,953	2,900	4,852
$10,001 through $15,000	1,999	3,543	5,542
$15,001 through $20,000	1,987	3,916	5,903
$20,001 through $30,000	1,649	4,022	5,672
Above $30,000	948	4,477	5,426
Entire Population	$1,787	$3,695	$5,483

TABLE 6

Family Home Production Income by Size of Family

Family Size	Mean Home Production Income
2 persons	$4,543
3 persons	9,424
4 persons	10,840
5 persons	10,119
6 persons	10,020
7 or more persons	9,567
Entire Population	$8,357

TABLE 7

Family Home Production Income by Age of Husband

Age of Husband	Mean Home Production Income
Younger than 30	$8,877
30 through 50	8,982
51 through 65	5,932
Older than 65	4,011
Entire Population	$8,357

TABLE 8

Family Home Production Income by Education of Husband

Years of School	Mean Home Production Income
8 years or less	$5,931
9 through 12 years	8,209
More than 12 years	9,574
Entire Population	$8,357

TABLE 9

Family Home Production Income by Race

Race	Mean Home Production Income
White	$8,459
Black	8,051
Entire Population	$8,357

proxies for family age and education. Home production income declines in households where the husband is over age 50. The home production income of households where the husband is over 65 is less than half that of households where the husband is under 50. Table 8 shows that home production income increases with education. Those with more than 12 years of education have home production income over one and one-half times the home production income of those with a grade school education or less.

Racial differences in family home production income are shown in Table 9. The home production incomes of white families are slightly higher than those of black families. This differential in home production income between races further contributes to the differential in family money income between races, which has been well documented elsewhere.

IV. Implications for Taxation

Our estimates have shown that through home production, the average American family increased its income by approximately $8,400 in 1975, or roughly 52 percent of family disposable income. By these estimates, home production income constitutes an important source of untaxed income.

Several arguments against the taxation of home production income are found in the tax literature. Some do not view home production income as a form of income. For example, McIntyre and Oldman (1977) find the argument that self-performed services constitute income unpersuasive. They argue that self-performed services are difficult to define and are related to life style, aptitude, and inclination. McIntyre and Oldman point out that persons without children have little or no child care

services, while small children and retired persons have insignificant amounts of handy person or household services.[9] While this observation is no doubt correct, this study did show that families without children and older families do have significant amounts of home production income, though their home production incomes are less than other families.

A second reason for excluding home production income from taxable income is administrative. Due and Friedlaender (1977) point out that it would be difficult to tax home production activities if persons do not report them, and it is also difficult to delimit home production activities from leisure activities (raising a flower garden vs. raising a vegetable garden, for example). However, Due argues that the practice of not taxing self-produced goods goes too far in the opposite direction; it encourages persons to produce their own goods and services rather than buying them.[10]

A final problem in taxing home production income, brought out by Due and Friedlaender, is that housework and child care do not generate money income with which taxes could be paid. To tax home production income would cause inequity for families with low money incomes. Due argues that any adjustment must be along the lines of allowing tax deductions or credits for the expenses of hiring housework by those who work outside the home.[11]

Prior to 1977, all married couples with both the husband and wife employed and having incomes less than $6,000 were able to deduct up to $600 for the cost of the care of one child while they were at work and up to $900 for two or more children. Tax legislation in 1976, effective 1977, allowed two-earner families a 20 percent nonrefundable tax credit

on expenditures up to $2,000 for the care of a dependent while at work and up to $4,000 for two or more dependents.

McIntyre and Oldman (1977) raise an interesting argument in opposition to the child care tax deduction. The argument would also apply to the child care credit. They argue that the child care credit tends to equalize the treatment of purchased child care services and self-performed child care services, but discriminates against those who neither purchase nor perform the service themselves.[12] Consider, for example, three families with equal money incomes. The first family works in the market and purchases child care services, the second family performs child care services at home, and the third family has no children. A deduction for child care services purchased equalizes treatment between families one and two since neither pays taxes on child care services. But family three now pays higher taxes than family one even though both families have equal home production incomes (zero). If home production income could be assigned, family two should pay higher taxes, and families one and three should pay equal taxes. The child care deduction does not achieve this result.

An alternative to the child care deduction for working families is an earned income allowance for two-job couples. Break and Pechman (1975) suggest that working couples might be given a special deduction of 25 percent of the earnings of the spouse with the lower earnings, up to a maximum of $2,500; or they might be given a tax credit of 10 percent of the earnings of the spouse with the lower earnings, up to a maximum of $1,000.[13] The U.S. Treasury in its recent study of U.S. tax reform suggests that only 75 percent of the wage income of secondary earners

should be included in family income, this exclusion limited to the first $10,000 of earnings.[14]

In order to determine the importance of home production income for two-earner families, home production income was regressed on a dummy variable equal to one if the family has two earners and zero otherwise and on some control variables. The results appear in Table 10. The results tell us that after controlling for other factors, such as size of the family and family income, two-earner families have home production incomes approximately $1,700 less than comparable one-earner families. It should be noted that this estimate is probably downward biased because the home production income of one-earner families is understated by our approach.

Table 10 also tells us something about who is benefited and who is hurt because home production income is currently untaxed. Two-earner families and older families are hurt because they have less home production income than other groups, and hence, have to pay higher taxes. Large families and families with high money income are benefited because they have larger amounts of untaxed home production income.

IV. Summary

Home production income constitutes a major source of untaxed income in the United States. This study estimates that for the American family in 1975 home production income was approximately $8,400, or roughly 52 percent of family disposable income. A major finding of this study is that the failure to tax home production income distorts the horizontal equity of the tax system, giving an advantage to large families and

TABLE 10

Influences on Home Production Income of Married Families

Characteristic	Coefficient	t-Ratio
Constant	6,521*	4.68
Family Income	.074*	3.08
Size of Family	1,326*	7.76
Two-Earner Family? (yes=1, no=0)	-1,692*	-3.34
Education of Husband	58	1.26
Race (White=1, Black=0)	887	1.54
Age of Husband	-116*	-5.43
Adjusted R^2	.066	

*Significant at .10 level.

families with high incomes, and putting two-earner families and older families at a disadvantage.

Like home production, leisure can also be considered a consumer good and part of income. A truly comprehensive tax would include the value of leisure as well as the value of home production activity in its base. It would be interesting to use the techniques developed in this paper to analyze a tax on leisure. However, this is beyond the scope of the present paper.

The estimates of this study can be criticized for understating the home production income of one-earner families. An important extension of this work would be to relax the assumption of constant returns to home production and attempt to estimate the parameters of a home production function. The input of other family members, the cost of work, and non-linearities in the tax function are among the complications the researcher would want to consider. The parameters of the home production function could then be used to estimate the marginal productivity of home production, which, in turn, would give an estimate of the value of time for those with zero hours of market activity. It is hoped that future research will continue in this direction.

FOOTNOTES

[1]See Morgan, Sirageldin, and Baerwaldt (1966), p. 5 and Sirageldin (1969), p. 53.

[2]See Musgrave (1959), p. 170.

[3]The study did not include any data from the case in which the wife works in the market and the husband does not.

[4]See Weinrobe (1974), p. 91, for a discussion of this point.

[5]See Hawrylyshyn (1976).

[6]See Gronau (1977), pp. 1121-1122.

[7]Pollack and Wachter (1975), p. 270.

[8]Ibid., p. 270.

[9]See McIntyre and Oldman (1977), p. 224.

[10]Due (1977), p. 225.

[11]Ibid., p. 226.

[12]McIntyre and Oldman (1977), p. 225.

[13]Break and Pechman (1975), p. 26.

[14]U.S. Treasury, Blueprints for Basic Tax Reform (1977), p. 105.

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