

OXFORD BULLETIN of ECONOMICS *and* STATISTICS

Volume 52

May 1990

No. 2

OXFORD BULLETIN OF ECONOMICS AND STATISTICS, 52, 2 (1990)
0305-9049 \$3.00

ESTIMATION AND VALUATION OF NON- LEISURE TIME

B. F. Kiker and M. Mendes de Oliveira

I. INTRODUCTION

In this analysis, we extend the work of Gronau (1974) and Heckman (1974, 1976) on wage determination by recognizing that the allocation of time to market endeavors is but *one* choice variable within the more general problem of the allocation of time to *multiple* activities. Individuals participating in multiple activities will allocate their time in such a way that returns to the pursuit of each activity are equated at the margin. If observed allocations are optimal, two consequences follow. First, observed earnings and labor supply convey information about the value of time supplied to other activities. Secondly, allocation of time to other activities itself provides valuable insights into the value of time in the labor market. One such activity to which most individuals supply a large fraction of their non-leisure time is household production or housework. Given the abundance of studies of market wage functions, the focus here will be primarily on the estimation and valuation of non-market, or household, production.

The economic worth of services produced in the home is an important consideration in areas of public policy regarding alimony, taxation, compensation in case of wrongful injury or death litigation, the amount of life insurance that should be carried to restore these services if lost to the household, the extent (if any) of exploitation of women because they are not paid for their household services, and more accurate measures of economic wealth produced, economic welfare and economic growth. Yet the methodology for

determining this value is inexact, and there has been relatively little attention devoted to the measurement problem.¹ In essence, two methods have been employed to measure the value of non-market time. In the first method, known as the opportunity cost approach, non-market time is assigned the value that the individual could command in the labor market for the same amount of time. One who uses the second procedure evaluates non-market time at the prices that would have to be paid in the market to purchase the same services. A generic price, usually the market wage for domestic help, is used to value this time, or, in a more reasonable variant of the approach, several grades of non-market work are distinguished and time inputs of each category of services is evaluated at the price of the closest market substitute. Both methods lack a firm grounding in the theory of the allocation of time. Against the replacement cost approach, Gronau (1980, p. 44) convincingly points out that the method requires that values be assigned to non-market time which 'have been explicitly rejected by the household as a true measure of its productivity'. If market-provided home services were not found to be too high in price, or lacking in quality, economic agents would surely have purchased them in the market. A similar argument holds with regard to the opportunity cost approach: if the value of non-market time were the same as its market counterpart, the individual would have been indifferent between the allocation of time to either market or non-market work. This premise evidently fails to rationalize observed allocations, unless one is to invoke institutional or social constraints that limit the amount of time a person can work in the market. Furthermore, the method is plagued by severe difficulties in the measurement of the opportunity cost, especially for individuals who do not participate in the labor force.

The affinities of the present work run close to the papers by Gronau (1980, 1986) and Chiswick (1982). Specifically, valuation of time is tightly linked to the optimization of time allocation in a trichotomous setting of leisure, market work and household production, and the fundamental principle agreed upon is that interior allocations in the time-uses space are characterized by equality of the market and non-market marginal products and of the marginal rate of substitution between leisure and goods. Although the main focus of Chiswick differs somewhat from Gronau's and our analysis,² the conclusions reached in her paper are essentially the same. In this work an attempt is made to improve upon previous research by a more thorough analysis of corner allocations, by developing a more comprehensive approach to non-market activities and by widening the population coverage.

The plan of the study is as follows. In the next section we construct a generalization of the theory of work-leisure choice to incorporate household

¹ For a critique of the methodology, see Gronau (1986), Ferber and Greene (1983), Ferber and Bernbaum (1980) and Hawrylyshyn (1976).

² Chiswick views the allocation of time to non-market activities in light of the choice faced by a producer between production for own consumption or for market sale.

production, and then derive an econometric model that addresses simultaneously the issue of sample censoring and the joint determination of non-market returns and non-market time in a framework of optimal allocation of time. The sample and variables used in the analysis are presented in Section III. Section IV contains maximum likelihood estimates of the parameters of the model which are used to estimate time allocations and time values. Section V consists of concluding remarks.

II. THEORETICAL FRAMEWORK

The individual is assumed to possess a well-behaved utility function (U) defined over the goods-leisure space:

$$U = U(X, L), \quad (1)$$

where X denotes consumption of goods and services per period, and L is leisure, or consumption time (Becker, 1965). The individual is provided with initial endowments of goods and leisure. The former corresponds to consumption made available in a manner independent of the use of one's own time, and will be denoted by V . V sets a non-negative lower bound on X ; that is, $X \geq V \geq 0$. The symbol T will be used for the initial endowment of time. Assuming leisure cannot be enjoyed through surrogates, T is also the feasible upper bound on L , and $0 \leq L \leq T$.

Time is the basic resource available to the individual. He can use his time in a number of commodity-producing activities, in the process trading some of his initial endowment of leisure and goods for other commodities. Although the model can be generalized to a multiplicity of activities, we restrict our attention to only two activities (other than leisure) to which the agent may supply his time. The first activity is denoted by the subscript M and has the production function

$$X_M = m(T_M, Y), \quad (2)$$

where X_M is the output of activity M and T_M is the time input to activity M . The subscript H corresponds to the second activity and the production function is given by

$$X_H = H(T_H, Z), \quad (3)$$

where X_H denotes the output of activity H and T_H the time supplied to H . Y and Z are vectors of (possibly overlapping) determinants of productivity in each activity. Total goods consumption is given by

$$X = X_M + X_H + V. \quad (4)$$

Consumption time, or leisure, is

$$L = T - T_M - T_H. \quad (5)$$

The individual selects allocations of time to activities M and H and to leisure in such a way as to maximize the utility function in (1), subject to the production functions in (2) and (3), the budget constraint in (4) and the time constraint in (5). Let the utility-maximizing allocation of time be $t^* = (T_M^*, T_H^*, L^*)$. If t_1^* is an interior allocation in the time-uses space,³ it is easy to verify that

$$\frac{\partial X_M}{\partial T_M} = \frac{\partial X_H}{\partial T_H} = \frac{\partial U/\partial L}{\partial U/\partial X} \quad (6)$$

must hold at t_1^* . The condition in (6) simply states that, in equilibrium, each activity will be pursued up to the point at which marginal returns to time inputs are equal, and equal to the marginal rate of substitution of leisure for goods.

For the sake of concreteness, let M denote the activity 'work in the market' and the competing activity (H) be household, or non-market, production. Condition (6) characterizes then the allocation of time by individuals who supply positive amounts of time to both market and non-market work.

Two corner solutions of interest are $t_{II}^* = (T_M^*, 0, L^*)$, that is, the individual supplies all of his time in production to the market and $t_{III}^* = (0, T_H^*, L^*)$, when the individual chooses not to participate in the labor force and hence allocates all of his productive time to non-market work.⁴ Individuals who select an interior allocation will be called Group I individuals, whereas the choice of t_{II}^* or t_{III}^* identifies Group II and Group III individuals, respectively.

Under the assumption of wage rates independent of hours worked, we have

$$\frac{\partial X_M}{\partial T_M} = w, \quad (7)$$

where w is an hourly wage that does not depend on T_M but is allowed to depend on Y . Following Heckman and Polachek (1974) and Mincer (1974), the marginal product function of market work is specified as

$$\ln w_i = Y_i \alpha + \varepsilon_{1i}, \quad (8)$$

where i is an individual subscript, α is a vector of unknown parameters and ε_{1i} is a random error term with mean zero and uncorrelated with the variables in Y . Furthermore,

$$E(\varepsilon_{1i} \varepsilon_{1j}) = \begin{cases} \sigma_1^2 & \text{if } i = j, \\ 0 & \text{otherwise} \end{cases}$$

³ That is, if $0 < T_M^* < T$, $0 < T_H^* < T$, $0 < L^* < T$ and $T_H^* + T_M^* + L^* = T$.

⁴ Other corner solutions (e.g., when the individual allocates his time entirely to consumption or spends no time at leisure) are of no interest empirically and will be ignored in the following.

Similarly,⁵ let the marginal product function of non-market work be given by

$$\ln h_i = Z_i\beta + \gamma T_{Hi} + \varepsilon_{2i}, \quad (9)$$

where the unknown parameter γ allows for variable returns to scale of utilization of time inputs in non-market activities, β is a vector of parameters associated with the variables in Z , and ε_{2i} is a zero-mean random error with finite constant variance, σ_2^2 , and uncorrelated both across observations and with the variables on the right-hand side of (9). We allow for correlation of errors across equations for the same observation; let σ_{12} denote the covariance between the disturbances ε_1 and ε_2 .

Information on variables pertaining to non-participants in the labor market is customarily used only in a probit analysis of labor force participation or in a tobit regression in which hours of market work is the dependent variable (Schultz, 1980). If the time of non-participants is optimally allocated, however, valuable information can be extracted from the amount of time they are observed to supply to non-market work and to leisure. For this purpose consider the latent variable T_H^* , defined by

$$T_H^* = \frac{1}{\gamma} (Y_i \alpha - Z_i \beta) + \frac{1}{\gamma} (\varepsilon_{1i} - \varepsilon_{2i}). \quad (10)$$

That is, T_H^* is the amount of time the individual should allocate to non-market work to bring into equality marginal returns to market and non-market work. Three allocative possibilities are illustrated in Figure 1. T_H^* may be negative, signalling the fact that market wages are greater than non-market wages at all (positive) levels of time inputs. This case identifies Group II individuals, for whom observed T_H will be zero. T_H^* may exceed the desired amount of foregone leisure signalling that, if the agent were willing to consume less of the latter, time supplied to non-market work would be increased. Non-market wages exceed market wages at the margin, observed T_H is equal to non-leisure time and the individual belongs in Group III. Finally, if $0 < T_H^* < (T-L)$ we have a Group I individual; T_H^* units of time are supplied to non-market work and $T-L-T_H^*$ units to market work. Given non-leisure time, $T-L$, the individual represented in Figure 1 would belong in Group II, Group I or Group III according to whether non-market marginal productivity is described by the $\ln h$ - curves labeled A , B or C , respectively.

Consider now the joint density $g(\ln h, T_H^*)$. Because T_H^* coincides with T_H and market and non-market products are equated at the margin for Group I individuals (that is, $\ln h = \ln w$), both variables are observed for that group. Neither non-market productivity nor T_H^* are observed for Group II or Group III individuals. For the latter, we know, however, that $T_H^* > T-L$ and that $T_H^* < 0$ holds for the former. Thus, over these groups we have probability

⁵ See, e.g., Gronau (1980).

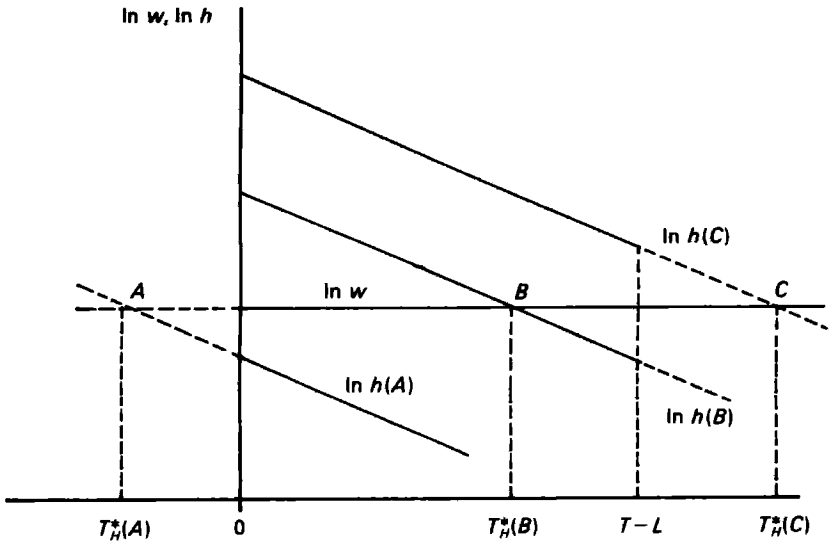


Fig. 1. Definition of the latent variable T_h^*

measures

$$Pr(T_h^* \geq 0) = 1 - F(Z_i\beta - Y_i\alpha), \tag{11}$$

for Group II individuals and

$$Pr(T_h^* \geq T - L_i) = F(Z_i\beta - Y_i\alpha + \gamma(T - L_i)) \tag{12}$$

for Group III individuals, where $F(\bullet)$ denotes the cumulative distribution function of $(\varepsilon_1 - \varepsilon_2)$ and use was made of the side condition $\gamma < 0$ (Gronau, 1977). Given a sample of observations on $Y_i, Z_i, \ln h_i$ and T_{Hi} , the likelihood function can be written

$$L(\alpha, \beta, \gamma, \sigma_1^2, \sigma_2^2, \sigma_{12} | Y_i, Z_i, \ln h_i, T_{Hi}) = \prod_I g(\ln h_i, T_{Hi}) \prod_{II} [1 - F(Z_i\beta - Y_i\alpha)] \prod_{III} F(Z_i\beta + \gamma T_{Hi} - Y_i\alpha). \tag{13}$$

Assuming ε_1 and ε_2 to be jointly normally distributed, maximization of (13) will yield full information maximum likelihood (ML) estimates of the parameters of the wage and household productivity functions that solve simultaneously the problem of sample censoring and the joint determination of non-market returns and non-market time in a framework of optimal allocation of time.

III. THE SAMPLE AND SELECTION OF VARIABLES

The data used in this study were drawn from the XVI wave (1983) of the Panel Study of Income Dynamics (PSID) conducted by the Survey Research Center of the University of Michigan. The sample consists of individuals who

were head of household or spouse of the head in both the interviewing years 1976 and 1977. A number of reasons dictated the choice of 1976 as the reference year. That was the only wave of the panel in which wives were separately interviewed and responses collected for questions that covered their personal background, personal characteristics, labor force history, family arrangements, time use, etc. In the remaining waves the coverage is much less extensive, and information regarding the wife's variables is collected, as a rule, from the husband. Especially unreliable are the latter's answers to their wives' use of time, a variable that plays a key role in this study.

After discarding observations with restricting health impairments and with missing values for the selected regressors and for which serious inconsistencies could not be resolved, the total working sample consists of 6,929 individuals. The variables used in the analysis as well as the descriptive statistics for the full sample are shown in Table 1. These individuals were split into three groups, according to the number of hours of market work and housework they reported. Group I contains 4,653 individuals who supplied a positive number of hours to both market and household production. The descriptive statistics for Group I individuals are reported in Table 2. Note that 72 percent of the males and 63 percent of the females in the full sample belong to this group. Group II individuals, who are predominantly married males, work solely in the market. The descriptive statistics for the 642 observations in this group are displayed in the middle columns of Table 2. The columns on the right side contain the statistics for the 1,634 Group III non-labor force participants who work exclusively in the home. The average age of this group is significantly higher than in the other groups, and of course most of them are women.

Selection of the right-hand side variables for the (market) wage equation follows the standard Mincer specification (Mincer, 1974, Heckman and Polachek, 1974, Mincer and Polachek, 1974). EDUC is the number of years of schooling. TEN and its square, TEN², and EXP and its square, EXP², purport to proxy the stock of human capital accumulated through post-school investments. TEN reflects years of tenure in the current (1976) job, and is expected to capture predominantly firm-specific human capital. EXP measures years of full-time labor-market experience (since 18 years of age) in other than the current job, and is a proxy for the stock of non-educational general human capital. The traditional measure of EXP, (in which the presumed age of completion of schooling is subtracted from current age) is improved upon in this analysis (1) by counting part- or full-year work since 18 for all individuals, even those who left school later, (2) by converting part-year work into a fraction of full-year participation, and (3) by disentangling current tenure from other labor market experience. Both TEN and EXP are entered in a quadratic formulation which approximates non-linearities in the rates of return. The earnings-tenure and earnings-experience profiles are thought to be concave, with positive coefficients for the linear terms and negative coefficients for the quadratic terms.

TABLE I
Definition of Variables and Descriptive Statistics, Full Sample

<i>Variable</i>	<i>Mean</i>	<i>Standard deviation</i>	
ln <i>w</i>	—	—	Natural logarithm of average hourly earnings in dollars
EDUC	11.55	1.13	Number of years of schooling
TEN	4.25	6.57	Number of years of tenure in the current job
TEN2	61.31	166.92	TEN squared
EXP	9.90	11.70	Number of full-time-equivalent years of market work prior to the current job
EXP2	234.96	485.61	EXP squared
AGE	39.75	15.17	Age, in years
MALE	0.45	—	Dummy variable, 1 if male, 0 otherwise
MARRIED	0.76	—	Dummy variable, 1 if married, 0 otherwise
WHITE	0.67	—	Dummy variable, 1 if white, 0 otherwise
SMSA	0.69	—	Dummy variable, 1 if resident in an SMSA, 0 otherwise
UNION	0.16	—	Dummy variable, 1 if current job covered by a union-negotiated contract, 0 otherwise
NCHILD	1.28	1.51	Number of children in the household
AGEYGST	3.78	4.96	Age, in years, of the youngest child in the household
T_H	861.35	801.27	Number of hours per year of unpaid work
T_M	1,451.99	1,082.29	Number of hours per year of paid work
Number of observations (<i>N</i>): 6,929			

To control for other personal traits and/or factors of discrimination in labor markets, binary variables were chosen for gender and race, the value 1 attributed to males (MALE) and whites (WHITE). Females and non-whites are the omitted categories. Similarly, the dummy variables SMSA and UNION purport to control for differences in place of residence (whether a Standard Metropolitan Statistical Area or not) and the effects of collective bargaining in job coverage.

Of course, individuals who tend to be more productive may tend also to acquire more tenure on the job. Hence, tenure may be endogenous. A similar argument may be made for experience and, particularly, union membership. Although these issues may turn out to be important in practice, we follow the usual formulation of wage equation and assume that TEN, EXP and UNION are exogenous.

In conformity with the assumptions underlying the model, the hourly wage rate was computed by dividing annual labor earnings by hours devoted to market production, i.e., average and marginal wage rates were assumed to

TABLE 2
Descriptive Statistics, Groups I, II, and III

Variable	Group I		Group II		Group III	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
$\ln w$	1.35	0.67	1.48	0.71	—	—
EDUC	12.16	2.86	10.36	3.63	10.25	3.13
TEN	5.27	6.81	7.71	8.07	0	—
TEN2	74.12	179.91	124.50	226.87	0	—
EXP	8.48	9.95	13.75	12.25	12.44	14.90
EXP2	170.87	375.47	338.93	492.12	376.66	683.91
AGE	36.64	13.25	41.48	13.22	47.93	17.68
MALE	0.49	—	0.97	—	0.15	—
MARRIED	0.76	—	0.91	—	0.69	—
WHITE	0.67	—	0.67	—	0.65	—
SMSA	0.71	—	0.55	—	0.69	—
UNION	0.20	—	0.27	—	0	—
NCHILD	1.24	1.43	1.55	1.57	1.31	1.68
AGEYGST	3.79	4.95	4.78	5.23	3.33	4.83
T_H	773.63	659.59	0	—	1,449.55	908.11
T_M	1,846.19	810.16	2,290.58	830.60	0	—
N	4,653		642		1,634	

coincide.⁶ Time spent commuting to work was added to the actual time of paid work. Because the wage rate is independent of hours worked, there is little room in the analysis for the variable T_M . As a matter of information, however, labor market participants in the sample were found to supply some 1,900 annual hours to the market (an average of 1,846 hours for Group I individuals and 2,291 for Group II).

The guidelines have been less well-established on what determines productivity in non-market work. Hence, the options below reflect an attempt to parallel somewhat the market work counterpart. Education has been found to affect household productivity (Michael, 1973, Gronau, 1973). In the absence of a better measurement for the amount of non-market related human capital, following Gronau (1980) it was decided to employ age (AGE) as a proxy. Household characteristics are represented by a marital status dummy (MARRIED, equal to 1 if the individual lives with a legal or

⁶ Like many of the larger national probability samples, the PSID does not contain an independent measure of the hourly wage rate. The fact that we had to use labor income divided by hours worked raises the issue of how to treat individuals who work overtime. Following others, we assume that all hours are straight-time. See Borjas (1980) for a discussion of the problem associated with our measure of hourly wage.

common-law spouse), by the number of children present in the household (NCHILD) and by the age of the youngest child (AGEYGT).⁷ It is expected that marriage and presence of children increase the scope for one's productive use of non-market time and, other things equal, the value attributed to it. Differences related to gender, race or residence in home production technology are proxied by the regressors MALE, WHITE and SMSA.

Finally, T_H denotes the annual number of hours supplied to non-market production. Respondents in the sample reported on average an annual supply of time to non-market production that varies from 0 hours (Group II) to 774 in Group I and 1,450 in Group III.⁸

IV. EMPIRICAL RESULTS

The first step in using the ML method of estimation is to choose the starting values for the iterative maximization process. The starting values for this application were generated from an estimation (unreported) of the market wage equation and the non-market productivity equation using Heckman's (1976) two-step method.⁹ The ML estimates, which adjust for both censoring and simultaneity, are displayed in Table 3.

It is customary to check the overall significance of maximum likelihood estimates by means of a test of the null hypothesis that all coefficients and parameters of the variance-covariance matrix are zero. In the case here, however, such an hypothesis would be meaningless. As discussed earlier, if the h -curve and w -curve were zero-slope lines, there would be no room for interior (in the time-user space) solutions — unless the curves should coincide. Instead, we check the overall significance of the ML estimates in Tables 3, 9 and 10 by means of a test of the null hypothesis that all slope coefficients, γ excepted, are zero. That is, if we let α_1 and β_1 be derived from the vector parameter α and β by suppression of the intercepts, the null hypothesis is $H_0: \alpha_1 = \beta_1 = 0$. Under H_0 in Table 3, for example, the maximum of the log-likelihood function is reached at -13408 ; under the alternative hypothesis, the maximum is -10161.2 . The chi-square statistic for the likelihood ratio (LR) test (see Lindgren, 1976) takes the value of 6494 versus the critical value of 35.74 at the significance level of 0.005 and with 17 degrees of freedom. In each of the models the chi-square statistic for the LR test takes a value greater than the critical value at the usual levels of significance. Hence, for each, the LR test clearly favors rejection of the null hypothesis.

⁷ AGEYGT is zero if there is no child present in the home.

⁸ Conceptually, T_H should include all time that (1) does not confer direct utility of itself, and (2) is spent on the production of goods or services that are not traded in the market. Application of these criteria to actual allocations, of course, is not an easy matter. Excluded are leisure, or consumption time, which is too hard to define and time spent in truly job-related activities, even if performed at home.

⁹ These regressions can be obtained from the senior author upon request.

A battery of other diagnostic tests was designed to check the plausibility of the results. The first test appraises the ability of the model to correctly predict group (I, II, III) membership. Taking expectations in (10) and substituting estimates for the unknown parameters, a value of T_H^* is computed for, and a group assigned to, each observation. Recall that the basis for the assignment is the characterization of Group I, Group II and Group III individuals by the conditions $0 < T_H^* < T-L$, $T_H^* \leq 0$, and $T_H^* \geq T-L$, respectively. The model correctly classifies (ranging from about 69 percent to 98 percent) Group I and Group III individuals, but does not handle Group II individuals very well, an outcome that is understandable for women.

A related test ascertains the severity of the errors by contrasting at the sample mean the actual and predicted allocations of time to the non-market sector. For all of the Group I and Group II individuals the predictions compare favorably to the observed means, with 'incorrect' predictions ranging from 1 hour per week to less than 5 hours. The Group II predictions are less reliable, and for women probably meaningless because of the sample size.

Of course, a comparison of means can be misleading because prediction errors of opposite sign tend to offset each other. Accordingly, perhaps a better means of diagnostic might employ the coefficient of correlation of projected and observed allocations. Goodness of fit requires that the correlation be positive and statistically significant. Time in the market can also be predicted simply by subtracting predicted T_H from the (known) non-leisure time. Obviously, prediction errors in the market and non-market sectors will be perfectly, and negatively, correlated. When the latter test was performed on each of our models the hypothesis of zero correlations was rejected at no worse than the 0.001 level in standard tests.

Turning now to the non-market 'wage' equation in Table 3, it appears that the returns to formal education in the non-market sector are lower than in the marketplace.¹⁰ To the extent that age is a valid proxy for accumulation of human capital, the marginal return to general experience in the non-market sector approaches 1 percent. Other things equal, the value of time is 12 percent higher for whites than non-whites, and 16 percent higher for SMSA residents than dwellers of rural and less urbanized areas.

As to household attributes, the value of time is 11.5 percent higher for married than for non-married individuals and an additional child increases the value of the parent's time by 4.7 percent. It was suggested earlier that marriage and parenthood enlarge the scope of non-market production,

¹⁰ Because the dependent variable is in natural logarithms, the coefficients of dummy variables are interpreted as percentage wage effects associated with the particular attribute. Letting D denote a dummy variable and d its coefficient, $\exp(d) - 1$ would be a more correct measure of the percentage change associated with the presence of the characteristic associated with D . The correction was not followed here merely for the sake of easier reference of the discussion to the numbers shown in the tables. For supporting evidence on the relation between the returns to education in the market sector and non-market sector, see Michael (1973) and Gronau (1980).

TABLE 3
Full Information Maximum Likelihood Estimates Full Sample

Variable	Market wage equation		Non-market 'wage' equation	
	Coefficient	t-ratio	Coefficient	t-ratio
Intercept	-0.341	-8.72	0.188	3.21
EDUC	0.085	28.50	0.078	22.43
TEN/10	0.531	19.65	—	—
TEN2/100	-0.124	-14.86	—	—
EXP/10	0.149	12.34	—	—
EXP2/100	-0.019	-6.41	—	—
AGE/10	—	—	0.108	18.37
MALE	0.355	20.77	-0.168	-4.00
MARRIED	—	—	0.115	7.83
WHITE	0.128	7.20	0.122	5.75
SMSA	0.133	7.59	0.159	7.81
UNION	0.106	7.76	—	—
NCHILD	—	—	0.047	9.74
AGEYGST	—	—	-0.001	-0.62
TH/1000	—	—	-0.526	-16.64
s_2^2	0.416	24.92		
s^2	0.143	8.24		
r	-0.569	-24.12		
Log-likelihood	-10,161.2			
N	6,929			

allowing the individual to produce and consume goods and services for which market substitutes are expensive and of poor quality; the estimates just mentioned are a measure of this effect. The statistical evidence does not support the hypothesis that parents value their time differently with the age of their children, or, at least, with the age of the youngest.¹¹

Two of the most interesting findings concern the parameter associated with gender and the coefficient on the variable representing returns to scale in the use of time for non-market purposes. The former indicates that men, when compared to women, are at a disadvantage of about 17 percent in their value of non-market time. This finding confirms the predictions advanced by Becker (1981, p. 26) about sex differences in patterns of specialization, in particular his assertion that 'the productivity of household time is presumably greater for women'. This is the case, he adds, 'partly because they invest more

¹¹ This should not be construed to mean that, counter to the generality of published results (Gronau, 1976, Leibowitz, 1974), younger children do not require greater allocations of time to home production. Under decreasing returns, this fact will of itself drive the marginal value of time downwards. The result presented simply negates support for the existence of effects other than those brought about via adjustments in T_H .

than men in household capital'. The finding is particularly interesting because the estimate does not rely on any outside measure of productivity, but simply on observed market wages and on a mechanism that rationalizes the allocation of time between competing productive activities. This finding is in sharp contrast to conventional regressions of wage earnings on a set of explanatory variables that includes a gender dummy, which almost invariably have produced a positive coefficient for males. Here, a positive differential favoring males in the market, and a negative differential outside it, are generated from essentially the same body of data.

The coefficient on T_H reveals that the value of non-market time decreases by more than 50 percent with each increase of one unit (1,000 annual hours) in T_H , *ceteris paribus*. Ignoring the discrete nature of the approximation, the difference between the Group I and Group III averages of T_H (nearly 676 hours) translates into a 35 percent difference in the valuation of the marginal unit of non-market time, other things equal.

Referring to the market wage equation, we find the following. The union-non-union wage differential is estimated to be about 11 percent. Estimated returns to schooling are 8.5 percent, a result frequently reported for selectivity-corrected earnings regressions. The tenure-earnings and the experience-earnings profiles peak at 21 and 39 years, respectively, and the marginal returns, evaluated at the sample means of labor force participants, are 3.9 percent for tenure and 1.1 percent for other job market experience.

These estimates of the returns to investments in schooling, tenure and experience are, thus, sizably higher than those obtained by standard approaches.¹² The methodology proposed here, allowing for the disentanglement of the effects of investments in human capital upon market and non-market productivity, clearly suggests that confusion of these effects may be responsible for a non-negligible underestimation of the labor market returns to these investments in human capital.

The regressions in Table 3 and the descriptive statistics in earlier tables allow us to value the time of individuals devoted to market work and non-market work. Since policy considerations involving the use of time allocations and valuation of non-leisure time usually require gender-specific estimates, the full sample is partitioned by gender and allocations and valuations by sex are reported and discussed.

Estimates of the expected market and 'home' wages are computed from the formulae.

$$E(w) = \exp(Y\alpha + 0.5 s_1^2) \quad (14)$$

$$E(h) = \exp(Z\beta + \gamma T_H + 0.5 s_2^2) \quad (15)$$

where $E(\bullet)$ is the mathematical expectation operator, and use was made of a well-known relation between the parameters of the normal and lognormal distributions (Lindgren, 1976). In the estimation, w and h have been denoting

¹² See, for example, Mincer (1974) and Abraham and Farber (1987).

the natural logarithm of market and non-market wages; to avoid introduction of new symbols, w and h reappear in the two equations expressed in the original units. The unknown parameters in (14) and (15) are replaced by the ML estimates of Table 3 to yield the values reported in Tables 4-7.¹³ Recall that the values are expressed in 1976 dollars.

We first consider the 'average' female across all three groups. The 'average' woman actually supplies 948 hours to a job, and 1,297 to the household (Table 5). The model predicts a wage of \$3.25 (Table 4) and an hours distribution of 725 to the market and 1,521 to household services (Table 5). Non-market work is valued at \$7.73 at zero hours, \$3.91 at 1,297 and \$3.48 at 1,521 hours (Table 4). Annual earnings are estimated by the model (at the predicted allocations) to be \$10,454, \$2,357 in the market plus \$8,098 at home (Table 7). An average value of time (AVT) of \$4.66 results (Table 6).

A better comparison is possible for the 'average' Group I woman. Wage rates are observable at \$3.71; the model would have assigned an hourly wage

TABLE 4
Marginal Values of Time

Group	w	$E(w)$	$E(h(0))$	$E(h(T_H))$ (o)	$E(h(T_H))$ (p)
Women					
Total	—	3.25	7.73	3.91	3.48
Group I	3.71	3.66	7.80	4.29	3.91
Group II	4.06	1.69	4.83	4.83	1.98
LFP	3.71	3.64	7.77	4.30	3.89
Group III	—	2.64	7.67	3.32	3.32
Men					
Total	—	6.10	6.82	5.72	6.53
Group I	5.87	6.35	6.97	5.67	6.79
Group II	5.73	5.76	6.32	6.32	6.16
LFP	5.84	6.22	6.82	5.80	6.65
Group III	—	4.18	6.79	4.85	4.85

NOTES: Observed averages in the first column. All others are estimates derived from the parameters in Table 3, evaluated at the mean characteristics of individuals in the relevant grouping:

(o) Using observed wages and allocations of time.

(p) Using predicted wages and allocations of time.

LFP: Labour force participants.

¹³The estimates of s_1 are not directly available from the estimation results, but can be generated from the estimates of the variances and correlation coefficient displayed in the tables:

$$s_1^2 = s^2 - s_2^2 + 2 s_1^2.$$

TABLE 5
Observed and Predicted Allocations of Time

Group	T_M (obs.)	T_M (pred.)	T_H (obs.)	T_H (pred.)	T_H^* (pred.)
Women					
Total	948	725	1,297	1,521	1,521
Group I	1,496	1,318	1,136	1,313	1,313
Group II	1,695	0	0	1,695	1,868
LFP	1,497	1,307	1,127	1,317	1,317
Group III	0	0	1,591	1,591	1,897
Men					
Total	2,062	2,311	333	84	84
Group I	2,215	2,557	393	51	51
Group II	2,308	2,262	0	46	46
LFP	2,235	2,495	308	48	48
Group III	0	0	639	639	795

NOTES: See Table 4.

TABLE 6
Average Values of Time

Group	AVT_M (o)	AVT_M (p)	AVT_{II} (o)	AVT_{II} (p)	AVT (o)	AVT (p)
Women						
Total	—	3.25	5.61	5.32	—	4.66
Group I	3.71	3.66	5.87	5.63	4.64	4.64
Group II	4.06	1.69	0	3.20	4.06	3.20
LFP	3.71	3.64	5.86	5.61	4.64	4.65
Group III	—	2.64	5.20	5.20	5.20	5.20
Men						
Total	—	6.10	6.26	6.67	—	6.12
Group I	5.87	6.35	6.30	6.88	5.93	6.36
Group II	5.73	5.76	0	6.24	5.73	5.77
LFP	5.84	6.22	6.30	6.74	5.89	6.23
Group III	—	4.18	5.77	5.77	5.77	5.77

NOTES: AVT_M is average value of time in the labor market.
 AVT_{II} is average value of non-market time.
 AVT is average value of total time in production.
 See also the Notes of Table 4.

TABLE 7
Total Values of Time

Group	TVT_M (o)	TVT_M (p)	TVT_H (o)	TVT_H (p)	TVT (o)	TVT (p)
Women						
Total	—	2,357	7,273	8,098	—	10,454
Group I	5,549	4,820	6,671	7,398	12,220	12,218
Group II	6,884	0	0	5,418	6,884	5,418
LFP	5,558	4,753	6,611	7,387	12,169	12,140
Group III	0	0	8,267	8,267	8,267	8,267
Men						
Total	—	14,097	2,087	564	—	14,661
Group I	12,997	16,223	2,473	351	15,469	16,574
Group II	13,223	13,033	0	288	13,223	13,321
LFP	13,048	15,516	1,939	326	14,987	15,842
Group III	0	0	3,686	3,686	3,686	3,686

NOTES: Headings same as in Table 6, with T (for total) replacing A (for average).
See also Table 4.

of \$3.66. Also, predicted allocations are 1,318 to T_M and 1,313 to T_H while actual allocations are 1,494 and 1,136. Home wages decrease from \$7.80 at zero hours to \$4.29 at 1,136 and \$3.91 at 1,313 hours. Relying on the woman's information regarding wage rates and allocations, she should be earning \$5,549 in her job and \$6,671 at other work, yielding a total of \$12,220 (Table 7). Relying on the model-inferred figures for w , T_M , and T_H , the sum is virtually the same, \$12,218, albeit the composition is different: \$4,820 from market work and \$7,398 from other work.

There is scarcely an 'average' Group II woman, since only 18 women failed to work in the home. With caution due to the smallness of the sample, the results treat the group very poorly: predicted wages are \$1.69, reported wages are \$4.06. Women in this group spend 1,695 hours per year in productive activities; the model predicts these hours would be devoted entirely to T_H , but they are supplied instead to the market. Their reported AVT is \$4.06, which generates an income of \$6,884. With the characteristics these women report, the model would predict all of them to be full-time housewives, with a lower AVT (\$3.20) yielding some \$5,419 per year.

The 'average' full-time housewife of Group III is more accurately described by the model. If she were in the labor force, she could expect a wage of \$2.64. In the home, her marginal product declines from a maximum of \$7.67 to \$3.32 corresponding to an input of 1,591 hours. Average hourly home wage is \$5.20 and home earnings are \$8,267.

Owing to the size of the 'workaholic' subsample, the 'average' woman in the labor force (LFP) is virtually the same as the one described above for Group I. Hence, the results of evaluating time are similar.

We now focus on the subsample of men, and deal first with the 'average' male in the sample. His wage is estimated to be \$6.10 with an estimated allocation of 84 hours to housework, in contrast to the actual value of 333 hours. The behavior of his h -curve is summarized by the values \$6.82, \$6.53, and \$5.72, corresponding to zero, 84 and 333 hours, respectively. Imputed AVT is \$6.12, which amounts to a total value of time of \$14,661 per year; of this amount, \$14,097 would originate in the model-derived T_M .

For Group I men, a comparison figure for wages is available: they report \$5.87, the model predicts \$6.35. They earn \$15,469 annually at their actual wages and allocations, whereas the model would have them transferring 342 hours from the non-market to the market sector for total annual earnings of \$16,574. AVT is \$5.93 at the actual values, and \$6.36 at the model's allocations and presumed wages.

For Group II men, the average observed wage is \$5.73, a figure close to the model-predicted wage of \$5.76. A modest input of 46 hours per year to non-market production was expected from these individuals. Avoiding completely non-market work, they report earnings of \$13,223; the model's higher wage and 46-hour-smaller allocation to the market would place them at annual earnings of \$13,321, drawing \$288 from non-market activities.

Among non-participant men, estimated wages are \$4.18. Their h -curve starts at \$6.79, and is down to \$4.85 by the time they reach their 639 hours of input to non-market endeavors. Total product is evaluated at \$3,686, and the AVT is \$5.77.

Finally for all labor force participants (LFP), estimated and reported wages are \$6.22 and \$5.84, respectively. They were expected to split their non-leisure time between 2,495 hours of market work and 48 hours of non-market work; they selected instead 2,235 and 308 hours. AVT is \$5.89 under their actual choices and \$6.23 at the model's predictions. Similarly, annual income would range from \$14,987 to \$15,842.

Several interesting patterns can be gleaned from the preceding discussion and the information in Tables 4 through 7. The four most striking ones are the following.

First, it appears that reasons for non-participation are more closely associated with disadvantages in the market sector than with a sizeable non-market advantage. Group III individuals seem to be about as productive in the home as labor force participants, but they suffer from a disadvantage in marketable skills which is substantially more pronounced.

Second, tastes for leisure do not appear to be appreciably different between sexes. Casual reading of the tables may indeed suggest that men are more work-oriented than women: they spend an average of 2,395 hours in production (slightly more than one quarter of their annual endowment of time) versus only 2,245 for women. In fact, however, LFP women work on average 80 more hours than their male counterparts and non-LFP women work (in the home) 950 hours more than non-LFP men. It is only the different sex composition of participation that allows men to have the larger full-sample averages.

Third, although tastes for leisure may differ between LFP and non-LFP agents (housewives, retired individuals, students, chronically unemployed or underemployed, etc.), since the latter's time at work falls short of the former's, non-LFP individuals have room to expand their production time (at the expense of leisure consumption) by 300 hours in the case of women and 150 in the case of men, before a job in the labor market becomes attractive.

Fourth, although women on average are more efficient at home production than men (as is the stylized perception), the findings of this study are surprising in that their advantage is not as large as was expected *a priori*. To wit, male valued marginal productivity in the non-market sector peaks in the range of \$6.80 to \$7.00, and the female peak is between \$7.65 and \$7.80 — ignoring the generally unreliable results for Group II individuals. Indulging in speculation, one might propose that the high price conferred to services in which women have a production monopoly on biological grounds (e.g., childbearing) has been compensated in part by the price exacted by men for the goods and services in which they historically have gained monopoly (e.g., defense).¹⁴

Comparisons of the value of time can hardly be read off the tables. No control is made for diverse characteristics or endowments across gender, tastes for leisure and time in production, and the mix of the latter. Recall that evidence was found that men enjoyed a positive differential over women in market activities, but a negative one in non-market activities. An obvious question is how do these differentials balance in the aggregate? Consider for purposes of answering this question two individuals who have exactly identical attributes but are of opposite sex. The first question is how would the allocation of T_H differ in the presence of the gender differentials? Using once again the mean T_H^* from equation (10), it turns out that they are different enough to suggest that the woman should devote 995 more annual hours to non-market production than her male counterpart.¹⁵ A second question is how would total income differ? Let M denote the woman's market annual income and N her non-market income. Her male replica will have market and non-market incomes of approximately $1.427 M$ and $0.846 N$, respectively.¹⁶ If $M = N$, that is, the woman's income comes in equal proportions from the two sectors, the aggregate gender differential will favor the male by 13.6 percent. Suppose now that two thirds of the woman's income are earned in the market; the male's advantage climbs above 23 percent. Reversing the proportions ($M = 0.5 N$), the man benefits from a differential of less than 4 percent. For the sake of concreteness, let the women and the

¹⁴ Dissimilar patterns of investment in market- and non-market-oriented human capital may have worked to the advantage of women simply by permitting them to counter sharp declines in the returns to scale of time inputs utilization that men are unable to escape. Evidence in favor of this effect of investments on the steepness (rather than on the level) of the h -curve can be found later in the paper.

¹⁵ In the sample, the average difference is 964. Estimates for the year 1979 in Fuchs (1984) place the difference at 902.

¹⁶ These are $\exp(0.355)$ and $\exp(-0.168)$, from the coefficients of MALE in Table 3.

identical man have the mean attributes of LFP in the sample. At the allocation these have chosen (1,900 hours of T_M and 580 for T_H), the model estimates M as \$7,655 and N as \$4,535, summing to \$12,190. The income of a man with the same characteristics and *who opted for the same allocations of time* would be \$14,756, or an additional 21 percent. In fact, both can do better by choosing an allocation more in line with their comparative advantages. Shifting 481 hours from market to non-market chores, the woman will end up with an income of \$12,611, of which \$5,717 are estimated pay for 1,419 hours in a job, and \$6,894 correspond to 1,161 hours of T_H . The male reduces his supply of time to the non-market sector to 166 hours, for which he gets \$1,066, and earns \$13,876 from 2,414 hours of market work; the new total is about \$14,942, and exceeds by 18.5 percent the female's income. These market figures are not too far off from reported annual earnings of LFP in the sample, which average \$5,558 for women and \$13,048 for men.

The results presented so far are derived from a model in which gender differences in productivity are assessed by allowing the level, but not the slopes, of the marginal product functions to vary across sex groups. It can be argued that a more realistic approach would lift that restriction. Although biological differences may go part of the way toward explaining the diverse patterns of time use and investments in human capital of women and men, the trend may have been reinforced historically by social and cultural factors.

TABLE 8
Sample Means, by Gender

<i>Variable</i>	<i>Women</i>	<i>Men</i>
w	3.712(a)	5.838(a)
EDUC	11.368	11.750
TEN	2.493	6.386
TEN2	28.989	100.442
EXP	7.559	12.740
EXP2	146.923	341.597
AGE	40.131	39.295
MARRIED	0.677	0.859
WHITE	0.637	0.702
SMSA	0.700	0.672
UNION	0.093	0.242
NCHILD	1.315	1.245
AGEYGST	3.890	3.639
T_H	1,297.277	333.478
T_M	948.426	2,061.781
Number of observations:	3,795	3,134

NOTES: (a) Average for labor force participants, only.
See Table 1 for the definition, and units of measurement, of the variables.

Stylized perceptions of gender roles have young women helping their mothers with the household chores, choosing educational fields (e.g., teaching) which are known to be less 'profitable' in the market, but may have a valuable potential for homemakers, and selecting less demanding occupations with fewer opportunities for career advancement. It must be recognized that data collection is very often tilted towards the quantification of marketable skills, and neglects skills which may have a bearing upon productivity in non-market activities. Helping in the rearing of younger siblings constitutes veritable on-the-job training for a future parent. Service in the armed forces and other civic associations is a form of education in the production of the commodity 'defense' or 'citizenship'. Emergency first-aid courses teach survival and prevention. Unpleasant physical exercise for the sake of health or fitness is sometimes unrelated to the acquisition, or preservation, of market productivity. Yet, these and many other forms of investment in non-market-oriented human capital totally escape detection by conventional statistical apparatuses, and measures comparable to schooling or job experience are not readily available for studies of non-market production. If women indeed invest more than men in household capital, solace for the imperfection of our measurements can be sought in a separate analytical

TABLE 9
Full Information Maximum Likelihood Estimates (Subsample of Women)

<i>Variable</i>	<i>Market wage equation</i>		<i>Non-market 'wage' equation</i>	
	<i>Coefficient</i>	<i>t-ratio</i>	<i>Coefficient</i>	<i>t-ratio</i>
Intercept	-0.475	-7.91	-0.0461	-0.62
EDUC	0.0999	21.16	0.0836	15.30
TEN/10	0.583	13.87	—	—
TEN2/100	-0.151	-11.07	—	—
EXP/10	0.0989	5.54	—	—
EXP2/100	-0.0151	-2.96	—	—
AGE/10	—	—	0.0996	12.17
MARRIED	—	—	0.184	8.51
WHITE	0.0992	3.94	0.128	4.38
SMSA	0.123	4.80	0.115	3.96
UNION	0.137	6.42	—	—
NCHILD	—	—	0.0710	9.15
AGEYGST	—	—	-0.00101	-0.71
TH/1000	—	—	-0.423	-12.53
s_2^2	0.421	21.78		
s^2	0.120	6.25		
r	-0.510	-16.67		
Log-likelihood - 5,605.4				
Sample size: 3,795				

treatment of the sexes. Accordingly, the model was reestimated for gender-homogeneous subsamples.¹⁷ The means for the subsample are given in Table 8 and the regression results reported in Tables 9 and 10.

In the market equation all coefficients are again statistically significant and differences by gender are not striking. There is some indication, however, that for women the returns to educational investments are larger and racial differentials narrower than for males. The results are widely dissimilar for the non-market sector: returns to education are essentially the same, non-market productivity is not significantly different between white and non-white men, and white females retain an edge on some 13 percent over non-white women. Still more marked are gender discrepancies attributed to household characteristics. Married men have lower 'home wages' than their single counter-

TABLE 10
Full Information Maximum Likelihood Estimates (Subsample of Men)

Variable	Market wage equation		Non-market 'wage' equation	
	Coefficient	t-ratio	Coefficient	t-ratio
Intercept	0.163	3.06	0.676	5.21
EDUC	0.0686	17.91	0.0834	11.56
TEN/10	0.509	14.38	—	—
TEN2/100	-0.109	-8.89	—	—
EXP/10	0.200	8.73	—	—
EXP2/100	-0.0422	-7.57	—	—
AGE/10	—	—	0.130	7.74
MARRIED	—	—	-0.231	-3.96
WHITE	0.179	7.24	-0.0480	-0.90
SMSA	0.145	6.22	0.315	6.86
UNION	0.133	5.84	—	—
NCHILD	—	—	-0.00474	-0.34
AGEYGST	—	—	-0.00645	-1.50
TH/1000	—	—	-1.864	-9.64
s_2^2	1.057	6.27		
s^2	0.809	4.78		
r	-0.881	-42.91		
Log-likelihood	-3,879.8			
Sample size:	3,134			

¹⁷ It would have been desirable to contrast statistically the hypothesis of equal coefficients by gender to the alternative. ML estimation of the model under the latter would have to deal with about twice as many parameters as in Table 3 and proved to be beyond available computer facilities. Moreover, the assumption of independence of the samples of women and men is untenable in this study, because households, rather than individuals, were the primary sampling units.

parts, perhaps the outcome of specialization in market production. The same explanation can be offered for the advantage of married over non-married women. The regressor AGEYGST fails to attain conventional levels of statistical significance in either case, confirming earlier indications. The returns to scale coefficient, finally, reveals a huge sex differential, the marginal value of the 1,000th hour of non-market work for women is about 65 percent of the value of the first hour while the analogous figure for men is 15 percent. The non-market marginal productivity curve for men is so steep that it takes about 500 hours of inputs for the women's marginal productivity to overtake the men's, in spite of the fact that the initial level of the latter is 2.13 times that of the former.

Comparisons of the value of time with the new estimates are presented in Tables 11 through 14. They appear to improve slightly upon previous estimates with regard to the fit of adjusted wages and allocations of time to the observed average counterparts. Rather than discussing them in detail, we emphasize here only the discrepancies between the two sets of tables. Major differences are apparent in the valuation of non-market time, and of men's time in particular. While the estimates of women's value of non-market time are lower than before, the magnitude of the downward adjustments does not

TABLE 11
Marginal Values of Time

<i>Group</i>	<i>w</i>	<i>E(w)</i>	<i>E(h(0))</i>	<i>E(h(T_H))</i> (o)	<i>E(h(T_H))</i> (p)
Women					
Total	—	3.25	6.62	3.83	3.44
Group I	3.71	3.73	6.71	4.15	3.94
Group II	4.06	1.56	4.06	4.06	1.98
LFP	3.71	3.71	6.68	4.15	3.91
Group III	—	2.56	6.52	3.33	3.33
Men					
Total	—	6.10	14.10	7.57	9.20
Group I	5.87	6.30	14.49	6.97	9.50
Group II	5.73	5.86	12.29	12.29	8.84
LFP	5.84	6.21	13.98	7.88	9.37
Group III	—	3.83	15.53	4.72	5.78

NOTES: Observed averages in the first column. All others are estimates derived from the parameters in Table 9 (for women) or Table 10 (for men), evaluated at the mean characteristics of individuals in the relevant grouping:

(o) Using observed wages and allocations of time.

(p) Using predicted wages and allocations of time.

LFP: Labor force participants.

TABLE 12
Observed and Predicted Allocations of Time

Group	T_M (obs.)	T_M (pred.)	T_H (obs.)	T_H (pred.)	T_H^* (pred.)
Women					
Total	948	693	1,297	1,553	1,553
Group I	1,496	1,372	1,136	1,260	1,260
Group II	1,695	0	0	1,695	2,132
LFP	1,497	1,358	1,127	1,266	1,266
Group III	0	0	1,591	1,591	2,084
Men					
Total	2,062	2,166	333	229	229
Group I	2,215	2,381	393	226	226
Group II	2,308	2,131	0	177	177
LFP	2,235	2,328	308	215	215
Group III	0	109	639	530	530

NOTES: See Table 11.

TABLE 13
Average Values of Time

Group	AVT_M (o)	AVT_M (p)	AVT_H (o)	AVT_H (p)	AVT (o)	AVT (p)
Women						
Total	—	3.25	5.10	4.86	—	4.36
Group I	3.71	3.73	5.33	5.20	4.41	4.44
Group II	4.06	1.56	0	2.90	4.06	2.90
LFP	3.71	3.71	5.32	5.18	4.40	4.42
Group III	—	2.56	4.75	4.75	4.75	4.75
Men						
Total	—	6.10	10.50	11.47	—	6.62
Group I	5.87	6.30	10.27	11.82	6.53	6.78
Group II	5.73	5.86	0	10.47	5.73	6.22
LFP	5.84	6.21	10.64	11.52	6.42	6.66
Group III	—	3.83	9.07	9.86	9.07	8.84

NOTES: AVT_M is average value of time in the labor market.

AVT_H is average value of non-market time.

AVT is average value of total time in production.

See also the Notes of Table 11.

TABLE 14
Total Values of Time

Group	TVT_M	TVT_M	TVT_{II}	TVT_{II}	TVT	TVT
	(o)	(p)	(o)	(p)	(o)	(p)
Women						
Total	—	2,255	6,614	7,542	—	9,796
Group I	5,549	5,116	6,052	6,554	11,601	11,671
Group II	6,884	0	0	4,909	6,884	4,909
LFP	5,558	5,035	5,994	6,554	11,552	11,589
Group III	0	0	7,552	7,552	7,552	7,552
Men						
Total	—	13,225	3,501	2,626	—	15,851
Group I	12,997	15,009	4,032	2,675	17,029	17,684
Group II	13,223	12,496	0	1,853	13,223	14,349
LFP	13,048	14,466	3,275	2,476	16,322	16,942
Group III	0	417	5,799	5,229	5,799	5,647

NOTES: Headings same as in Table 13, with *T* (for total) replacing *A* (for average).
See also Table 11.

bear any resemblance to the magnitude of the upward change in men's. For the latter, the value of small inputs of time is more than doubled with respect to earlier estimates, and a sizeable difference is still visible at the average values. Of course, these differences extend to the estimates of the total value of time.

V. CONCLUSION

Marginal returns to non-market production were found to be diminishing with hours devoted to non-market production, thus confirming predictions advanced by Gronau (1977). For relatively small inputs, however, allocations of time to non-market endeavors has an advantage over market production, thus explaining the preference for composite allocations exhibited by two-thirds of the individuals sampled. The gender pattern elicited from the estimates strongly suggests that the advantage in home production which stylized perceptions attribute to women stems more from an ability to ward off steep declines in non-market productivity than from an absolute advantage over men at all levels of time inputs. Apparently, women's higher specificity of human capital and increased scope for non-market production are the factors underlying their less markedly declining productivity. Gender comparisons provided evidence strongly supportive of the propositions advanced by Becker (1981) with regard to patterns of specialization within family communities.

The value of non-market time of women was found to compare favorably with their potential or actual labor market earnings. Non-market-generated income was usually greater than market income, the proportionate advantage varying with the degree of commitment to market and non-market work. By contrast, labor earnings of the typical male exceed by far the value of his non-market production. Men's edge in full income relative to women's appears to be strongly diminished when the latter's comparative advantage in non-market activities is considered.

Caution must always be exercised when generalizing empirical findings. While every study has its limitations, several problems with this one require elaboration.

A major limitation is the treatment of joint production. Work in the marketplace or in the home may produce both goods and direct utility (or disutility); a mother can cook and at the same time answer a spelling question of her school-age child. There has been no satisfactory way of treating joint production and the analysis here, of course, is no exception. Another kind of joint production arises from the cooperation of household members. Ultimately, the question at issue is whether individuals or households are the proper decision-making unit in matters of the allocation of time. Extension of the framework developed here to the household decision process is a topic left for future research.

Other limitations of the analysis originate in the data set we use. Ideally, one would like to track every minute of the respondents' time in specific non-market uses, and at the same time, benefit from the vast array of demographic and economic variables collected in public-use data sets. The PSID, however, does not contain specific time uses in non-market work. Another problem is the existence of institutional constraints that limit the timing and amount of market work one can do. If the individual is so constrained, observed allocations will not satisfy the optimality principle on which the present work rests and the information they convey about the value placed by economic agents on their time will have been interpreted in a distorted light. We attempt to minimize the problem by opting for a time framework in which those constraints are supposedly less effective. As long as there is a margin for individual choice, observed allocations of time of rational economic agents will always convey insights and information about the relevant behavioral parameters. Probably, the more free is one's choice the more informative is his observed behavior and the more accurate will be the results of the analysis. Between the two extremes of totally constrained behavior and the one adopted here of completely unrestricted choice there is a wide range of unexplored possibilities.

Another weakness of our study is in the omission of taxes and fringe benefits. In theory, returns to market work and non-market production should be compared net of taxes and inclusive of fringe benefits. Rather than taking the approach of imputing tax rates under a series of assumptions (on tax incidence, single or joint filing, deductions, exemptions, income

averaging, state and local income tax rates, etc.), we ignore taxes in the hope that other factors might offset the bias imparted by the use of gross earnings. While taxation of market earnings clearly diminishes the attractiveness of market work, especially in the case of married women, availability of pension plans, health insurance and other benefits that are usually attached to market work increase its appeal relative to non-market production. One can only hope that the biases incurred by omission of both taxes and fringe benefits will cancel each other on average.

University of South Carolina, Columbia
Universidade do Porto, Portugal

Date of Receipt of Final Manuscript: October 1989

REFERENCES

- Abraham, Katharine G. and Farber, Henry S. (1987). 'Job Duration, Seniority, and Earnings', *American Economic Review*, Vol. 77, No. 3, June, pp. 278-97.
- Becker, Gary S. (1965). 'A Theory of the Allocation of Time', *Economic Journal*, Vol. 75, No. 299, September, pp. 493-517.
- Becker, Gary S. (1981). *A Treatise on the Family*. Cambridge, Mass.: Harvard University Press.
- Borjas, George (1980). 'The Relationship Between Wages and Weekly Hours of Work: The Rate of Division Bias', *Journal of Human Resources*, Vol. 15, No. 3, Summer, pp. 409-23.
- Chiswick, Carmel U. (1982). 'The Value of a Housewife's Time', *Journal of Human Resources*, Vol. 17, No. 3, Summer, pp. 413-15.
- Ferber, Marianne A. and Birnbaum, Bonnie G. (1980). 'Housework: Priceless or Valueless?' *Review of Income and Wealth*, Vol. 26, No. 4, December, pp. 387-400.
- Ferber, Marianne A. and Greene, Carole A. (1983). 'Housework versus marketwork: Some Evidence How the Decision is Made', *The Review of Income and Wealth*, Vol. 29, No. 2, June, pp. 147-59.
- Fuch, Victor R. (1984). 'His and Hers: Gender Differences in Work and Income, 1959', National Bureau of Economic Research Working Paper no. 1501, December.
- Gronau, Reuben (1973). 'The Effect of Children on the Housewife's Value of Time', *Journal of Political Economy*, Vol. 81, No. 2, Part 2, March/April, S168-99.
- Gronau, Reuben (1974). 'Wage Comparisons — A Selectivity Bias', *Journal of Political Economy*, Vol. 82, No. 6, December, pp. 1119-43.
- Gronau, Reuben (1976). 'The Allocation of Time of Israeli Women', *Journal of Political Economy*, Vol. 84, No. 4, Part 2, August, S201-20.
- Gronau, Reuben (1977). 'Leisure, Home Production, and Work — The Theory of the Allocation of Time Revisited', *Journal of Political Economy*, Vol. 85, No. 6, December, pp. 1099-123.
- Gronau, Reuben (1980). 'Home Production — A Forgotten Industry', *Review of Economics and Statistics*, Vol. 62, No. 3, August, pp. 408-16.

- Gronau, Reuben (1986). 'Leisure Home Production, and Work — The Theory of the Allocation of Time Revisited', in Ashenfether, O. and Layard, R. (eds.), *Handbook of Labour Economics*, Amsterdam: North-Holland.
- Hawrylyshyn, Oli (1976). 'The Value of Household Services, A Survey of Empirical Estimates', *Review of Income and Wealth*, Vol. 22, No. 2, June, pp. 101–30.
- Heckman, James (1974). 'Shadow Prices, Market Wages, and Labour Supply', *Econometrica*, Vol. 42, No. 4, July, pp. 679–94.
- Heckman, James (1976). 'The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models', *Annals of Economic and Social Measurement*, Vol. 5, No. 4, Fall, pp. 475–92.
- Heckman, James and Polachek, Solomon (1974). 'Empirical Evidence on the Functional Form of the Earnings-Schooling Relationship', *Journal of the American Statistical Association*, Vol. 69, No. 346, June, pp. 350–54.
- Leibowitz, Arleen (1974). 'Education and Home Production', *American Economic Review*, Vol. 64, No. 2, May, pp. 243–50.
- Lindgren, Bernard W. (1976). *Statistical Theory*, 3rd ed., New York, MacMillan.
- Michael, Robert T. (1973). 'Education in Non-market Production', *Journal of Political Economy*, Vol. 81, No. 2, Part 1, March/April, pp. 306–27.
- Mincer, Jacob (1974). *Schooling, Experience and Earnings*. National Bureau of Economic Research, New York, Columbia University Press.
- Mincer, Jacob and Polachek, Solomon (1974). 'Family Investments in Human Capital: Earnings of Women', *Journal of Political Economy*, Vol. 82, No. 2, Part 2, March/April, S76–108.
- Schultz, T. Paul (1980). 'Estimating Labour Supply Functions for Married Women', In Smith, James P. (ed.), *Female Labour Supply: Theory and Estimation*, Princeton, New Jersey: Princeton University Press, pp. 25–89.
- Survey Research Center, University of Michigan (1972), (1985). *A Panel Study of Income Dynamics*. Ann Arbor, Mich.: Institute for Social Research.