Transactions Time and the Demand for Non-Market Time

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Introduction

Individuals today spend only about one-third of the total time available in market work. The view taken in the present study is that the remaining two-thirds of total time should be brought under analysis. This analysis is accomplished by studying the individual's demand for non-market time.

Historically, with recent exceptions, economists have been interested primarily in the individual's allocation of time between labor time and leisure time. Leisure time has been treated as a good which enters the utility function directly.

The present study divides total time available into four uses rather than the usual two uses and analyzes how the individual decides to allocate the time available. In the model presented below, the individual is assumed to produce all consumption items by combining non-market time and goods purchased in the market in a non-market production function.

The traditional approach[1] has been to view the individual's utility attainment as depending upon his wage income and leisure time. In this type of analysis the individual maximizes utility attainment by alloting time between market production (i.e., selling labor time) and leisure. In equilibrium the ratio of marginal utility of leisure time to the marginal utility of income equals the wage rate. When the equilibrium conditions are totally differentiated and optimum quantities of labor time are solved for, income and substitution terms can be identified. The traditional analysis generates an income and a substitution effect. It is shown in the present study that additional substitution effects are generated when transactions time is included in the analysis.

Recent studies[2] do not include transactions time in their analysis, nor do they rigorously derive total effects (i.e., income and substitution effects) in their models. It is shown, for example, that a change in the individual's wage rate produces two substitution effects and an income effect. Additionally, it is shown that the net substitution effect and the income effect are of opposite sign, if non-market time is a normal input.

The present study represents a more complete model of the individual's choices between market and non-market allocations of the time available to the individual. The present model is more complete since transactions time is included in the formal model and implications of this inclusion are derived.

The Model

It is assumed that the individual engages in market activity for two reasons: to sell labor time and to purchase goods. Market time is defined here as the sum of time used in market work (i.e., the time for which a wage is paid), transactions time associated with selling labor time, and transactions time associated with the purchases of goods. Non-market time is defined as time used in non-market production. Total time is assumed to be exhausted by these uses of time. It is further assumed that a positive amount of time is allocated to all uses.

The choice problem facing the individual is to maximize utility by allocating time between market production (i.e., selling labor time) and non-market production and by purchasing goods. Note that transactions time is not independent of these choices by (4) below. It is assumed that the individual behaves so as to maximize,

$$U = U(C) \qquad (1)$$

where U is total utility attainment and C is real consumption. The utility function is assumed to have the usual properties of curvature and to be twice differentiable. The individual produces the consumption bundle (C) by combining goods purchased in the market (G) with non-market time (N) in a non-market production function, which is assumed to have the usual characteristics of curvature and differentiability. The production function for (C) is then,

$$C = C(G, N); \qquad C_G > 0, C_N > 0 \qquad (2)$$

where (G) is the composite of goods purchased in the market and (N) is non-market time.[3] All consumption items are produced in (2). For example, in producing transportation, the individual chooses various combinations of market purchases and non-market time. That is, the individual can purchase an old automobile for, say, two hundred dollars, and provide maintenance and repairs himself. Alternatively, he can purchase a new automobile every year and purchase maintenance and repairs in the market. We can say that the first choice implies that the individual has chosen to combine a relatively large amount of non-market time with market purchased goods in the production of transportation. Between these two extremes (i.e., purchasing new car every year and purchasing all maintenance and repairs needed, or purchasing an old car and providing all maintenance and repairs himself), various combinations of non-market time and goods can be used to produce transportation. Many additional examples, illustrating the wide range of choices open to the individual respecting combinations of non-market time and purchased goods used to produce his consumption bundle, are possible.

As a final example, consider the production of health care. The individual can consult a medical doctor each time he detects a symptom indicating the possibility of ill health. Additionally, he can purchase the services of a dietician to insure proper diet. Alternatively, the individual can purchase a medical book, and inform himself as to symptoms and indicated cures, and he can use over-the-counter medicines to treat himself. The first choice indicates a decision to produce health care by combining a large input of goods purchased in the market (i.e., the physician and dietician), with a relatively small input of non-market time. The second choice indicates a decision to produce health care by combining a relatively large amount of non-market time with a relatively small amount of purchased goods (i.e., a medical book and over-the-counter drugs).

All these illustrations indicate what might be called technological possibilities. The

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[1] See for example Hicks (1946)

[2] See Cairncross (1958), Mincer (1962), Becker (1965), Muth (1966) and DeSeyra (1971).

[3] See Hicks (1946) for a discussion of composite goods. He demonstrates that if the prices of a group of goods change in the same direction, the group can be treated as if it were a single good.

individual's choice of a particular combination of purchased goods and non-market time in the production of his consumption bundle, depends upon economic variables (e.g., wage rate, income tax, etc.), as will be shown. The individual faces an income constraint (3) and a time constraint (4).

$$w(1-t)L + \gamma = PG(1+\sigma) \qquad (3)$$

$$1 = L + N + T \qquad (4)$$

$$T = T^L + T^G \qquad (5)$$

$$T^L = T^L(L,\alpha); \qquad T^L_L, T^L_\alpha, \alpha > 0 \qquad (6)$$

$$T^G = T^G(G,\beta); \qquad T^G_G, T^G_\beta, \beta > 0 \qquad (7)$$

where (w) is the wage rate, (t) is income tax rate on wages, L is labor time sold in the market, (γ) is an income shift parameter, P is a price index of goods purchased, (σ) is a general sales tax on goods, N is non-market time and T is total transaction time, T^L is a positive function of (L) and a constant (α), where (α) is a shift parameter used to indicate changes in the efficiency of transactions time associated with selling labor time. A positive change in (α) indicates a decrease in efficiency, since a given number of labor hours sold are now associated with a larger transactions time. Additionally, (α) is assumed to be a function of conditions in the labor market (e.g., information costs).[4] Additionally, variables affecting transportation time to and from work would be important (e.g., congestion on roads). However, all variables affecting (α) are assumed to be exogenous to the model in this paper. T^G is transactions time associated with purchases of goods, where T^G is a positive function of goods purchased and a constant (β), where (β) is a shift parameter used to indicate changes in the efficiency of transactions time associated with purchases of goods. A positive change in (β) indicates a decrease in efficiency, since a given amount of goods are now associated with a larger transactions time. Also, (β) is assumed to be a function of conditions in the market, (e.g., the cost of information).[5] However, all variables affecting (β) are assumed to be exogenous to the current model.

The constraints (3–7) can be combined to form one constraint equation. In order to do this, we assume that the different uses of time are all non-negative. Combining the constraints (3–7) we get,

$$w(1-t)\{1 - N - [T^L(L,\alpha) + T^G(G,\beta)]\} + \gamma - PG(1+\sigma) = 0 \qquad (8)$$

In order to maximize utility, the individual maximizes the augmented function,

$$U[C(G,N)] + \lambda\{w(1-t)[1 - N - [T^L(L,\alpha) + T^G(G,\beta)\} + \gamma - PG(1+\sigma) = 0, \qquad (9)$$

which is the usual Lagrangian function, where the choice variables are N, G, and L. It must be noted that N, G, and L are not independent by equation (3), so that only G and N need appear in the objective function.

The first order conditions for maximization of (9) are the following:

$$U_C C_G = \lambda[P(1+\sigma) + w(1-t)T^G_G] \qquad (10)$$

$$U_C C_N = \lambda[w(1-t)] \qquad (11)$$

$$w(1-t)\{1 - N - [T^L(L,\alpha) + T^G(G,\beta)]\} + \gamma - PG(1+\sigma) = 0 \qquad (12)$$

where (10) indicates that a first order condition for utility maximization is that the marginal utility derived from goods through their effect on consumption must equal their marginal opportunity cost in terms of the market price of goods, including the sales tax, plus forgone earnings due to transactions time associated with purchases valued in terms of the marginal utility of income. Equations (10), (11), (12) provide three equations and three unknowns (G, N, λ) with seven parameters from which the following demand function for non-market time can be solved,[6]

$$D_N = D_N(w, t, \alpha, \beta, \sigma, P, \gamma). \qquad (13)$$

The partial derivatives of (13) can be derived by totally differentiating the system of equations (10), (11), (12). Then solving for changes in the demand for non-market time (D_N) with respect to changes in the parameters, gives us equations (14a-g), where H is the bordered Hessian determinant of the utility function and where the first derivatives of the constraint (12) are the border. For utility to be maximized, it is necessary and sufficient that the elements of H be associated with a quadratic form which is negative difinite under one constraint. This means that $H > 0$ is a necessary and sufficient condition for utility maximization.[7] Hij is the cofactor of the ith row and jth column, where $i = (G, N, \lambda)$, and $j = (G, N, \lambda)$.

Identification of Income and Substitution Terms

The problem now is the determination of the direction in which the demand for non-market time will change as the parameters change. In order to accomplish this, income and substitution effects must be identified and signed for the partial derivatives (14a–g), (see figure 1),

$$\text{(a)}\ \frac{\partial D_N}{\partial w} = \frac{\lambda H_{GN}(1-t)T^G_G}{H} + \frac{\lambda H_{NN}(1-t)}{H} + \frac{H_{YN}\{-(1-t)[1-N-[T^L(L,\alpha)+T^G(G,\beta)]\}}{H}$$

$$\text{(b)}\ \frac{\partial D_N}{\partial t} = \frac{\lambda H_{GN}(-w)T^G_G}{H} + \frac{\lambda H_{NN}(-w)}{H} + \frac{H_{YN}\{-(w)[1-N-[T^L(L,\alpha)+T^G(G,\beta)]]\}}{H}$$

$$\text{(c)}\ \frac{\partial D_N}{\partial \alpha} = \frac{H_{YN}[-w(1-t)(-T^L_\alpha)]}{H} \qquad (14)$$

$$\text{(d)}\ \frac{\partial D_N}{\partial \beta} = \frac{\lambda H_{GN}\cdot w(1-t)T^G_{G\beta}}{H} + \frac{H_{YN}[-w(1-t)(-T^G_{G\beta})]}{H}$$

$$\text{(e)}\ \frac{\partial D_N}{\sigma} = \frac{\lambda H_{GN}(P)}{H} + \frac{H_{YN}(PG)}{H}$$

$$\text{(f)}\ \frac{\partial D_N}{\partial P} = \frac{\lambda H_{GN}(1+\sigma)}{H} + \frac{H_{YN}\cdot G(1+\sigma)}{H}$$

$$\text{(g)}\ \frac{\partial D_N}{\partial \gamma} = \frac{-H_{YN}}{H}$$

Note that (14g) is derived by taking partial derivatives of equations (10), (11), (12) with respect to the income shift parameter (γ), while holding labor time constant. Then Cramer's rule is used to solve for $\frac{\partial D_N}{\partial \gamma}$.

Equation (14f) is derived by taking the partial derivatives of (8), (9), (10) with respect to the price index for goods. Then $\frac{\partial D_N}{\partial P}$ is solved for using Cramer's rule. Note that the last term in (14f) is exactly equivalent to (14g) except that (14g) does not contain the element $G(1+\sigma)$. Thus, the last

[4] Note that α could be made endogenous to the present model. The exogenous variables determining would include such things as the level of unemployment in the labor market, and the degree of competitiveness in the labor market. See Alchian (1969).

[5] We could make β endogenous to the present model. The exogenous variables affecting β would include such things as the quantity and quality of advertising. See Stigler (1961).

[6] Note that the demand function (13) is homogenous of degree zero in the monetary variables. That this is the case can be seen by changing w, and P uniformly in constraint (12). The constraint remains unchanged so that the equilibrium conditions remain unchanged.

[7] See Hicks (1946).

$$\begin{bmatrix} U_{GG} & U_{GN} & -w(1-t)T^G_G+P(1+\sigma) \\ U_{NG} & U_{NN} & -w[(1-t)] \\ -w(1-t)T^G_G+P(1+\sigma) & -w[(1-t)] & 0 \end{bmatrix} \cdot \begin{bmatrix} dG \\ dN \\ d\lambda \end{bmatrix} = \begin{bmatrix} \lambda(1-t)T^G_G & \lambda(-w)T^G_G & 0 & \lambda w(1-t)T^G_{G\beta} & \lambda(P) & \lambda(1+\sigma) & 0 \\ \lambda(1-t) & \lambda(-w) & 0 & 0 & 0 & 0 & 0 \\ -(1-t)\left[1-N-(T_L(L,\alpha)+T_G(G,\beta))\right] & -(-w)\left[1-N-(T_L(L,\alpha)+T_G(G,\beta))\right] & -[w(1-t)(-T^L_\alpha)] & -w(1-t)(-T^G_{G\beta}) & (PG) & G(1+\sigma) & -1 \end{bmatrix} \cdot \begin{bmatrix} dw \\ dt \\ d\alpha \\ d\beta \\ d\sigma \\ dP \\ d\gamma \end{bmatrix}$$

Figure 1. Matrix

term in (14g) indicates the effect of a change in the income shift parameter (γ), weighted by $G(1+\sigma)$. We can identify this last term in (14f) as an income effect of a change in the price index of goods. The first term in (14f) is identified as a cross substitution term which indicates the effect of a change in the price index for goods, on the demand for non-market time holding utility constant. Therefore, equation (14f) is identified as the usual Slutsky type equation.

Now that the terms in (14f) have been identified, it remains to determine their sign. Let us assume temporarily that goods and non-market time are both normal inputs in the production of the consumption bundle (C).[8] Also, normality of the consumption bundle is assumed. The assumption that goods and non-market time are normal inputs, along with the second order condition for maximization of utility, allows us to sign the term, $\frac{H_{YN}}{H}$. By normality, an increase in income will have a positive effect on the demand for goods and non-market time. From equation (14g), $\frac{\partial D_N}{\partial \gamma} = -\frac{H_{YN}}{H}$ and by the normality assumption, we know that $\frac{\partial D_N}{\partial \gamma} > 0$; therefore, it must be the case that $\frac{H_{YN}}{H} < 0$. Since $G > 0$, and $\sigma \geqslant 0$ by assumption, the income effect in (14f) is negative.

The income effect has now been identified and signed. It now remains to sign the cross substitution terms in (14f). Since non-market time and goods are substitutes, $H_{GN} > 0$. By second order, conditions for utility maximization we know that $H > 0$, since $\lambda > 0$ and the general sales tax rate (σ) is assumed to be positive or zero, we know that $\frac{H_{GN}}{H} > 0$.

The sign of (14f) can now be evaluated since its component parts have been identified and signed. Because the income and substitution terms are of opposite sign, the sign of (14f) depends upon their relative magnitudes, which are not known *a priori*.

In terms of an intuitive explanation, an increase in the price index of goods produces an income and a substitution effect on the demand for non-market time. The negative income effect is produced by a parallel shift in the constraint (12). That is, real income falls as the price index of goods rises, given initial labor time sold. The positive cross substitution effect is produced by the change in the price index of goods relative to the price (i.e., opportunity cost) of non-market time. The net effect of a change in the price index of goods on the demand for non-market time depends upon the relative importance of goods and non-market time as inputs in the consumption bundle. The importance of these income and substitution effects depends upon the proportions in which goods and non-market time are being used. The extent to which the individual is made worse off by a rise in the price index of goods depends upon the size of the goods input he is initially using. If G is large relative to N, the individual is made much worse off when the price index of goods rises, and, therefore, the income effect will be very important (i.e., large). The sign of (14f) will be negative when the goods (G) input share relative to the non-market time share is so large that the income effect dominates the cross substitution effect.

Effects of a Change in Wage Rate

The effect on the demand for non-market time of a change in the wage rate is given by

[8] It should be noted that, if non-market time is an inferior input, the non-market production function is not homogenous of any degree. See Ferguson (1968).

equation (14a). In order to sign $\frac{\partial D_N}{\partial w}$, income and substitution terms must be identified and signed. The first term in (14a) is identified as a cross substitution term by reference to (14f). We know that $H_{GN} > 0$ since G and N are substitutes, and by the second order condition for maximization of utility, $H > 0$; therefore, $\frac{H_{GN}}{H} > 0$. Since λ, $T_G^G > 0$ by equation (5) and $(1 - t) > 0$ by assumption, the first term in (14a) is identified as an own substitution effect by reference to (15) below. Taking the derivative of equation (11) with respect to the price of non-market time (i.e., with respect to $w(1 - t)$, and solving by Cramer's rule for the change in non-market time with respect to the net wage rate $w(1 - t)$, gives us,

$$\frac{\partial N}{\partial w(1-t)} = -\frac{H_{NN}}{H}. \qquad (15)$$

By second order conditions for maximization of utility, $H > 0$, and since H_{NN} is a main diagonal term we know $H_{NN} < 0$, thus $\frac{H_{NN}}{H} < 0$. The component $(1 - t)$ is positive by assumption and $\lambda > 0$; therefore, the second term in (14a) is negative. The last term is identified as an income effect by reference to equations (14g, f). This term is positive since, as shown in (14g), $\frac{H_{YN}}{H} < 0$, and $(1 - t) > 0$ so that $-(1 - t) < 0$, and the remaining portion of this term, $[1 - N - [T_{GL}^L, \alpha) + T_{(G,\beta)}^G])$, is positive by assumption. Note that this portion of last term in (14a) is equivalent to (L), labor time by reference to equations (4–7). The last term in (14a) is, therefore, positive.

The net effect on the demand for non-market time of a change in the wage rate depends upon the relative magnitudes of the two substitution effects and the income effect since their signs differ. The two substitution terms are of opposite sign. However, the net substitution effect is negative, given the assumptions we have made. This result can be shown by dividing equation (10) by equation (11) to get equation (16) as follows:

$$\frac{w(1-t)T_G^G + P(1+\sigma)}{w(1-t)} = \frac{U_C C_G}{U_C C_N} = MRS_{GN}. \qquad (16)$$

Equation (16) expresses the marginal rate of substitution of goods for non-market time. Now taking the derivative of (16) with respect to the wage rate, where we let $\phi = (1 - t)$, gives us the following:

$$\frac{\partial MRS_{GN}}{\partial w} = \frac{\phi[w\phi T_G^G - [w\phi T_G^G + P(1+\sigma)]]}{(w\phi)^2} < 0, \qquad (17)$$

since $\phi, P, w > 0$, by assumption, and $\sigma \geqslant 0$ by assumption, and $T_G^G > 0$ by (5) thus, (17) is negative. Therefore, a rise in the wage rate results in a decrease in the price of goods relative to the price (i.e., opportunity cost) of non-market time. Additionally, an increase in the wage rate raises the transactions time cost associated with purchasing a given composite of goods. However, notice that the absolute magnitude of the ratio of determinants $\frac{H_{NN}}{H}$ is greater than the absolute magnitude of the ratio of determinants $\frac{H_{GN}}{H}$. Expanding the determinants H_{NN} and H_{GN} and subtracting the absolute value of H_{GN} from the absolute value of H_{NN}, we see that $| H_{NN} | > | H_{GN} |$. We note from the system of equations, (Figure 1),

$$H_{NN} = [w(1-t)T_G^G + P(1+\sigma)]^2,$$

$$H_{GN} = [w(1-t)T_G^G + P(1+\sigma)]\, w(1-t)$$

Taking the difference we have,

$$H_{NN} - H_{GN} = (\phi + \psi)[\phi + \psi - [w(1-t)]],$$

where

$$\phi = w(1-t)T_G^G, \quad \psi = P(1+\sigma), \quad P \geqslant 0.$$

Since $(\phi + \psi) > [w(1 - t)]$ per unit of time, we have $| H_{NN} | - | H_{GN} | > 0$. It was shown in Section I that $H_{NN} < 0$ and $H_{GN} > 0$; thus, $(H_{NN} + H_{GN}) < 0$. Note that in (14a) the cross substitution term (i.e., the first term) is weighted by T_G^G. The difference in the absolute magnitude of the own substitution and cross substitution terms can be expressed as, $(\phi + \psi)[(\phi + \psi) - (\phi)]$. Since $\phi, \psi > 0$ by assumption, $| H_{NN} | > | H_{GN} |$, that is, the own substitution term continues to dominate the cross substitution term. For future reference we can identify this relationship as equation (18).

$$| H_{NN} | > | H_{GN} |. \qquad (18)$$

We have established the dominance of the own substitution effect, so that the net substitution effect of an increase in the wage rate is negative.

Recall that the bracketed portion of the third term in (14a), $[1 - N - [T^L(L, \alpha) + T^G(G, \beta)]]$, is identical to labor time sold in the market (L). An increase in the wage rate at the initial consumption bundle would increase income by the increase in net wage (i.e., the change in the wage rate less income tax) multiplied by labor time sold in the market. Note that the third term in (14a), the income effect, is weighted by labor time sold in the market. Additionally, note that the magnitude of the positive cross substitution term is directly related to the size of L. This is the case since the larger the initial L, the larger the initial G is by (3) and a larger G implies a greater transaction time associated with goods purchased by (7). A greater transaction time (T^G) means that the magnitude of the cross substitution term is now larger by reference to the discussion of (18) above. Therefore, the positive effects of an increase in the wage will be larger, the larger the goods input. However, the relative sizes of the positive income effect and the negative net substitution effect can not be determined *a priori*.

In terms of an intuitive explanation, an increase in the wage rate produces two substitution effects and an income effect. The positive cross substitution effect is produced by changing the price of goods relative to the price of non-market time. An increase in the wage rate raises the implicit component of the price of goods since transaction time (T^G) is now valued at a higher wage rate. This increase in the implicit price of goods causes a substitution away from goods and toward non-market time. The negative own substitution effect is produced by changing the price (i.e., opportunity cost) of non-market time relative to the price of goods. An increase in the wage rate raises the price (i.e., opportunity cost) of non-market time relative to the price of goods as shown in (17). The net effect of these two substitution terms is negative, by reference to (18) above. Since goods and non-market time are substitutes, the signs of the two substitution terms are the expected signs. If we assume that non-market time is a normal input, then the income effect of an increase in the wage rate is positive. The positive income and cross substitution effects are of larger magnitude the larger the goods input. However, the net substitution effects are not known ***a priori;*** it is, thus, an empirical question whether the positive income effect or the negative net substitution effect will dominate. If these magnitudes are similar in value, we expect to find that measured wage elasticities of demand for non-market time are not very sensitive to a change in the wage rate.

From casual observation of trends in the U.S. economy, an inverse relationship between real wage rates and the average amount of labor time sold in the market can be noted. Additionally, in countries having relatively low per capita incomes, we note that, as the real wage rate rises, labor time sold in the market begins to fall sooner than we might anticipate. This is, it appears that individuals in countries having relatively low per capita incomes, begin to substitute non-market production for market production at a wage rate lower than the wage rate at which individuals in countries having relatively high per capita incomes begin to substitute non-market production for market production.[9]

In terms of our model, these observations imply that, for individuals in countries having relatively low per capita income, as the wage begins to rise, the negative own substitution effect initially dominates the positive income and cross substitution effects. Then, beyond some wage rate, the positive income and cross substitution effects begin to dominate. The model explains that the cross substitution and income effects appear to dominate the own substitution effect at a lower wage rate in countries having relatively low per capita income, as compared to countries having relatively high wage rates.

If relatively low average income reflects relatively low market productivity, we can say that individuals in countries having relatively high per capita income are more productive in market work than are individuals in countries having relatively low per capita income. However, this does not explain why individuals in countries having low per capita income apparently substitute non-market production for market production at a lower wage rate. The explanation must be that the difference in market productivity and non-market productivity is less in countries having relatively low per capita income and that the difference between market productivity and non-market productivity is greater in countries having relatively large per capita income.

It should be noted that, in general, traditional labor supply theory attributes the change in the individual's hours of market work, due to an increase in the wage rate, to the net effect of a positive income and a negative own substitution effect (i.e., an increase in the wage rate produces a positive income effect since, real income increases at the given number of labor hours sold. The negative own substitution effect is produced, since an increase in the wage rate raises the price of leisure).[10] However, the present model indicates that three effects are operative when we account for transactions time. Note that if transactions cost are not accounted for, the first order conditions for maximization of utility are changed. Equations (1–3) continue to apply, but equation (4) becomes $1 - (L + N)$, and equations (5–7) drop out of the model. Equation (8) becomes $w(1 - t)[1 - N] + \gamma - PG(1 + \sigma) = 0$, and the individual maximizes the augmented function,

$$U[C(G, N)] + \lambda\{w(1 - t([1 - N] + \gamma - PG(1 + \sigma)\}$$

Equations representing first order conditions for maximization of this augmented function are now the following:

$$U_C C_G = \lambda[P(1 + \sigma)] \qquad (10')$$

$$U_C C_N = \lambda[w(1 - t)] \qquad (11')$$

Where (10′) indicates that a first order condition for utility maximization is that the marginal utility derived from goods through their effect on consumption must equal their marginal opportunity cost in terms of the market price of goods including the general sales tax. Equation (11′) indicates that in order to maximize utility it is necessary that the marginal utility derived from non-market time, through its effect on consumption, must equal forgone earnings valued by the marginal utility of income. Comparing first order conditions (10) and (11) with (10′) and (11′), we note that the price of goods relative to the price of non-market time is understated when transactions costs are ignored. Additionally, when transactions costs are not included in the model, equations (14c) and (14d) drop out and the cross substitution terms (i.e., the first terms) in equations (14a,b) drop out. The exclusion of transactions cost means that the magnitude of the negative net substitution term in (14a) will appear to be more significant and that the positive net substitution term in (14b) will also appear to be more significant. Thus, if transactions cost is ignored, net substitution effects will appear to be more important to the total effect of a parameter shift than they actually are.

In the present model, a change in the wage rate produces three effects, since total time is not assumed to be exhausted by work and leisure. Moreover, since the present model explicitly incorporates transactions time cost, cross substitution effects of a change in wage rate are produced. We expect, for example, that individuals whose consumption bundle is being produced with a large goods input relative to non-market time input, will increase their demand for non-market time by a larger amount than will individuals whose consumption bundle is being produced with a small goods input relative to non-market time input. That is, in the case where the positive effects of an increase in the wage rate are dominant (i.e., if both groups are on the negative segment of their individual labor supply curves). If the negative effect is dominant (i.e., if both groups are on a positive segment of their individual labor supply curves), we expect individuals, whose consumption bundle is being produced with a large goods input relative to non-market time input, to decrease their demand for non-market time by a smaller amount than individuals whose goods input into their consumption bundle is relatively small. These differences in sizes of response are attributable to the differences in transactions costs—that is, the differences in magnitudes of the cross substitution terms.

In terms of labor supply (i.e., labor time sold in the market), as the wage rate rises we expect individuals with a large goods input relative to non-market time, to decrease labor time sold in the market by a larger amount than individuals with relatively small goods input, when positive effects dominate (i.e., when they are on negative segments of their individual supply curves). In the event that the negative effect is dominant for both groups (i.e., they are on positive segments of their individual labor supply curves), we expect individuals with relatively large goods input to increase labor time sold in the market by a smaller amount than individuals with relatively small goods input.

Note that if transactions time is ignored, the distinction between magnitudes of response by those with large goods input and those with relatively small goods input, when both respond in the same direction, is obscured. We suggest not only that the inclusion of transactions time in the present model means that a change in the wage rate not only affects the individual's location on his individual supply curve, but also, that inclusion of transactions time affects the wage rate elasticity of individual labor supply between two groups (or wage rate elasticity of demand for non-market time). This

[9] See H.G. Lewis (1952).

[10] See any intermediate microeconomic theory textbook.

is the case since the inclusion in the model of transactions time results in three effects on the demand for non-market time (supply of labor) when the wage rate changes.

In the present model, the impact on individual labor supply of a change in the wage rate will, in general, be consistent respecting directional responses, with the traditional labor supply model, but not respecting the magnitude of the response, since additional cross substitution effects are generated by the present model and these effects compete with the traditional own substitution effects. This means that the income effect becomes more significant since the net substitution effect is smaller as indicated above.

The effects on the individuals demand for non-market time of a change in the income tax rate (t), the efficiency of transactions time associated with selling labor time (α), the efficiency of transactions time associated with purchases of goods (β), and the general sales tax (σ) were derived in the original study. However, due to spatial constraints these effects are not included here. It should be noted that the same procedure used in identifying and signing partial derivatives for changes in the wage rate was used to identify and sign partial derivatives for these parameters.

Section V. An Empirical Note

This section provides a summary of some relevant empirical studies. Additionally, results of a simple test are presented.

In cross-sectional studies, the empirical procedure usually involves the estimation of the parameters of a single equation which relates labor force participation rates to a set of independent variables. The primary independent variables are taken to be the wage rate and total (family) income.

Cain[11] found a large negative relation between labor force participation and unemployment. For the entire labor force, the regression coefficient of unemployment was found to be −.68, which means that a 1% increase in the unemployment rate was associated with over two-thirds of a percentage point decrease in total labor supply. This finding can be interpreted, in terms of our model, as evidence that individuals are responsive to changes in transactions time efficiency, since there is evidence that a positive relationship exists between the level of unemployment and search time required to sell a given amount of labor time.[12] Additional evidence indicating that individuals are responsive to transactions time cost is found in a study by Moses and Williams.[13] Their purpose is to determine what price changes are required in order to get individuals to change the mode and/or route of the work trip. Empirical data are taken from the Chicago area. Their model includes, as arguments in the demand function for mode or route, the wage rate, trip time, and explicit costs associated with the trip. It should be noted that Moses and Williams do not derive a demand function; however, a demand function can be derived from their indifference curve analysis. Their results provide additional evidence that individuals respond as if they considered transactions time cost to be an important variable in the choice process.

Wage Rate:

Evidence indicating that individuals do make choices based upon the relative value of their time in market and non-market production is also offered by Mincer.[14] In the production of children, individuals were found to behave as if they were responsive to the opportunity cost of non-market time valued at the wage rate (of the wife). An increase in the wage rate, and therefore, an increase in the price of non-market time relative to market time, resulted in a decrease in the demand for children (non-market time). In another study, Owen finds evidence that individuals, in producing recreation are responsive to changes in the relative prices of the inputs leisure and market purchased recreation goods.[15] Demand functions for leisure and for market purchased goods are estimated. Owen finds that leisure time and market purchased recreation goods are substitutes, since the ratio of leisure time to market purchased recreation goods is found to be inversely related to the ratio of the price of leisure (i.e., wage rate) to the price of market recreation goods. In terms of our model, we can say that Owen finds that an increase in the price (i.e., opportunity cost) of non-market time relative to the price of goods purchased in the market, produces a substitution effect which causes goods to be substituted for non-market time in the production of a recreation commodity. Additionally, Owen's finding indicates that the negative own substitution term dominates the positive income and cross substitution terms of equation (14a).

In a simple test, data used to estimate the demand function for non-market time were taken for the fifty states from 1970 observations.[16]

The following procedure was used to arrive at values for non-market time. From the model, non-market time is equal to total time less the sum of labor time sold in the market, transactions time associated with selling labor time and transactions time associated with purchases (i.e., $N = 1 - L - T$). Additionally, total transactions time is positively related to income, by the analysis above. In order to derive an index for the relative amounts of transactions time for the fifty states, the state of Mississippi was chosen as the base since this state had the lowest average income and since we were concerned with relative transactions time among states. The index for transactions time was computed as follows: the reciprocal of average annual wage earnings of employees in manufacturing in Mississippi was multiplied by average annual wage earnings of employees in the state whose transactions time was being computed. This ratio was then multiplied by one thousand hours. The figure one thousand hours. The figure one thousand hours was chosen since it was felt that one thousand hours per year was a reasonable estimate of the minimum transactions time actually used by employed individuals. Note that this is equivalent to approximately 2.7 hours per day. The figure 2.7 hours per day seems reasonable since transactions time includes preparation for the day's work, such as commuting time, etc. Additionally, this figure includes transactions time associated with goods purchases (e.g., search time, travel time, etc.). This procedure provided us with a measure of relative transactions time among the states. Because data were available for average labor time sold in the market (L) and relative transactions time among the states could be computed by the procedure indicated above, non-market time could then be determined from the relation ($N = 1 - L - T$), equation (4).

The test was made on individuals employed in manufacturing in the fifty states, because data were available. Therefore, the population tested consisted of individuals employed in manufacturing in the fifty

[11] See Cain (1964).

[12] See Alchian (1969) and Stigler (1961).

[13] See Moss and Williams (1963).

[14] See Mincer (1962).

[15] See Owen (1971).

[16] The data were taken from Department of Commerce's Annual Report, State Tax Collections in 1970 (14). Wage and income data were taken from U.S. Bureau of Economic Analysis Survey of Current Business, August 1971 (15). Population data were taken from Department of Labor's Monthly Reports on Employment and Earnings (16).

TABLE I
Results of Regression Analysis

Variable	*Mean*	*Coefficient*	*T-Value*
Wage Rate (w)	3.28	−208.02	14.59
Assets (A)	29564.68	− .00	2.08
Income Tax (TI)	179.67	.18	2.06
General sales Tax (TS)	259.86	.05	.56
Non-Market Time (N)	5300.00		
Constant/Beta (0)	= 6663.70		
Multiple R^2	= 83.60		
F	= 57.36		

states.[17] Table I above summarizes the results of the test.

Elasticities

$$e_w = \frac{\partial N}{\partial w}\frac{\overline{w}}{\overline{N}} = -408.02\left(\frac{3.28}{5300}\right) \approx -.24$$

$$e_A = \frac{\partial N}{\partial w}\cdot\frac{\overline{A}}{\overline{N}} = -.0025\left(\frac{29{,}564.}{5300}\right) \approx -.01$$

$$e_{TI} = \frac{\partial N}{\partial TI}\cdot\frac{\overline{TI}}{\overline{N}} = +.1885\left(\frac{179.}{5300}\right) \approx +.06$$

Further empirical research at a more disaggregated level seems to be indicated. It is suggested that in testing hypotheses respecting the individual's demand for non-market time, two groups of individuals be distinguished by wage rates. These two groups should consist entirely of married men or entirely of unmarried men. If one group consists primarily of married individuals, our results will be biased.[18] Additionally, these groups should be similar as to age composition.

Summary and Conclusions

The intent of this paper has been to show that the inclusion of transactions time in the model of individual behavior provides deeper insight into the individual's behavior. The inclusion of transactions time resulted in substitution effects which were additional to the substitution effects produced by the traditional model.

It was shown that cross substitution and income effects work in the same direction so that own substitution effects are not as important to the total effect when transactions time is included in the model.

[17] Since no data were available, α and β are dropped as arguments in the demand function.
[18] See Mincer (1962) for a discussion of the wife's productivity in the home.

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