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1. Introduction

In recent years a great deal of attention has been paid to the relation between female labour supply, fertility and wage rates (Mincer, 1962; Cain, 1966; Schultz, Maurer and Ratajczak, 1973; Willis, 1973; Cain and Dooley, 1976; Schultz, 1977; Conger and Campbell, 1978; Fleisher and Rhodes, 1979; Carliner, Robinson and Tomes, 1980; Rosenzweig and Wolpin, 1980). Theoretical research has concentrated almost exclusively on single period lifetime models because of the difficulty in specifying a theory of optimal timing and spacing of children.[1] This lifetime nature of the theoretical models is reflected in the empirical work by the use of completed family size as the dependent variable in the fertility equation. The labour supply variable specified by the theory is the fraction of the lifetime supplied to the market and the wage rate is the average wage over the lifetime. While completed family size has been readily available for women over 35, lifetime labour supply and wage measures have been difficult to obtain so that researchers have typically made do with measures of current wage rates and labour supply. However, in the absence of a theory of timing and spacing, the 'new' economic theory of fertility and labour supply provides no <u>direct</u> predictions for the interaction between <u>lifetime</u> fertility and <u>current</u> labour supply and wage rates. The results of studies using this combination of variables thus have to be interpreted under some <u>ad hoc</u> hypotheses regarding the relation between current labour supply and the fraction of the lifetime supplied to the market, and between current and "permanent" wage rates.

In this paper we specify a simple one-period lifetime model which departs from the standard literature in its treatment of schooling and wage rates but includes the "standard" model as a special case. In particular, we allow for the fact that schooling is part of the lifetime period and is in principle endogenous. This implies that the female wage rate is endogenous even in the absence of post-school investment, and that the usual interpretations of regressions of wages on schooling and labour supply on wage rates are inappropriate in the context of this model.[2] It also implies that an adding-up constraint is imposed on the uses of time in the lifetime including schooling, which may induce a <u>negative</u> correlation between years of schooling and years in the market, while at the same time producing a positive correlation between years of schooling and the fraction of the <u>post-school lifetime</u> spent in the market.

The model is used to interpret empirical analyses based on alternative measures of lifetime labour supply, and on alternative specifications of which variables may be treated as exogenous. A recent paper by Rozenzweig and Wolpin (1980) discusses the interpretation of the coefficient on completed family size in a labour supply equation when fertility is endogenous. We take up this discussion within the framework of our simple model and show that the coefficient is in general related to ratios of <u>uncompensated</u> price effects rather than <u>compensated</u> price effects as Rosenzweig and Wolpin stated. This distinction is important for the empirical work, since it can be shown that under plausible assumptions the true coefficient on fertility in a labour supply equation would in fact be zero. Indeed, contrary to their expectations, this result was found empirically by Cain and Dooley (1976) and by Fleisher and Rhodes (1979); the former offered no explanation, while the latter attribute the "surprising" result to poor instruments used for their fertility variable. The basic point made by Rosenzweig and Wolpin, however, that coefficients in so-called "structural" models of labour supply and fertility have interpretations that represent "unusual experiments" is important. We extend their insight to interpret the coefficients in "structural" labour supply equations that include an endogenous wage rate and wage equations which include fertility as a right-hand side variable.[3]

In the empirical analysis, we use the retrospective and longitudinal aspects of the newly available National Longitudinal Survey of Women, 30-44, to construct a measure of the fraction of the lifetime supplied to the market, and measures of the lifetime wage rates of both the husband and wife. Our empirical results take the lifetime model of labour supply seriously in that our empirical measures of labour supply and wage rates bear a much closer resemblance to the theoretical concepts than measures typically employed in the literature. We report estimates of the one-period model, under alternative specifications of the exogenous variables, using "lifetime" variables and thus provide direct tests of restrictions implied by competing versions of the one-period model. The estimates indicate that the "plausible assumptions" required for the true coefficient on fertility in a labour supply equation to be zero are fulfilled. These estimates are compared with those obtained using current measures as proxies for lifetime variables. Based on these estimates, an explanation is offered for the apparent contradiction between the findings of studies using a simultaneous equations approach that report no effect of fertility on female labour supply and the strong depressing effect of children on labour supply obtained from research that treats children as exogenous.

2. A One-Period Lifetime Model

We consider a husband-wife family maximizing a one period lifetime utility function:

(1) $U = U(n,Q,Z)$

where n is the number of children, Q represents average "child-quality" and Z is a composite of other "commodities". Adopting the household production approach, these utility yielding commodities are produced according to the production functions:

(2) $Qn = C(C_f,x)$

(3) $Z = Z(H_f,y)$

where C_f represents female time spent in producing "child services", the product of number of children and their average quality; H_f is female time in the production of other commodities and x and y are purchased inputs. This formulation reflects recent developments in the literature which focus on the distinction between child quantity and quality (Becker and Lewis, 1973; Willis, 1973; De Tray, 1973; Becker and Tomes, 1976). If average quality is exogenous and the same for every family then child-services (nQ) are proportional to the number of children.[4]

In this simplified structure, the male provides only the goods inputs. This allows the model to focus more directly on the allocation of the wife's time, taking the husband's allocation of time as given.[5] Constraints on the inputs are as follows:

(4) $P_x x + P_y y = W_f L_f + W_m L_m + V_m + V_f$

(5) $L_f + C_f + H_f + S_f = T_f$

(6) $L_m + S_m = T_m$

where, as before, the subscripts m and f refer to male and female, respectively; W is the average wage rate defined as total lifetime earnings divided by L, the lifetime labour supply, S is the time spent in school, T is the length of the lifetime and V is non-labour income. Unit prices of x and y are P_x and P_y. The inclusion of S in (5) and (6) is a departure from "standard" models which assume, in effect, that after schooling has taken place (the amount being exogenously determined), the 30-year old physician and the 15-year old school leaver face the same length of <u>remaining</u> lifetime, i.e., total lifespan is increased one for one by years of schooling. We depart from this approach in two ways. Firstly we allow schooling to be endogenously determined[6] and secondly, we do not assume a one-for-one increase in years of lifetime with years of schooling.[7] The latter implies a link between schooling and lifetime labour supply other than through wages (or efficiency in household production of the type discussed in Michael, 1973) via the time constraint. This results in "wage elasticities" which are a mixture of "pure" wage effects (holding the length of working life constant) and "pure" schooling effects (holding the wage rate constant) on labour supply.[8]

The average wage rate is assumed proportional to the average stock of human capital rented by the individual to the market. The factor of proportionality, which is set to unity for convenience, is the market rental rate on human capital. The average wage rates are given by:

$$(7) \qquad W_f = [1 - \gamma(L_f)]\{E_f + h(S_f;E_f)\} \qquad h' > 0, \gamma' < 0$$

$$(8) \qquad W_m = [1 - \gamma(L_m)]\{E_m + h(S_m;E_m)\} \qquad h' > 0, \gamma' < 0$$

where E is the initial endowment of human capital and h is the production function relating the output of human capital to the schooling input. The term $[1-\gamma()]$ is included to ~~(permit)~~ the average wage to depend on the length of time the individual spends in the market, because of post-school investments or depreciation of skills through lack of use (Willis, 1973; Mincer and Polachek, 1974; Rosenzweig and Wolpin, 1980). In the absence of post-school investment and depreciation, $\gamma = 0$. If γ captures depreciation only, then it may be interpreted as the average depreciation rate--converting the average gross stock of human capital $\{E + h(S;E)\}$ into the average net stock. In that case we may impose the restriction $0 \leq \gamma \leq 1$. If γ also reflects post-school investment the interpretation is no longer straightforward, and in particular (7) and (8) have to be interpreted as "reduced form" earnings capacity functions embodying optimal post-school investment. Because it is an average wage, W does not act as a shadow price in this model.[9]

The prices, P_x and P_y, endowments, E_i, and non-labour incomes, V_i, are assumed exogenous. Thus, a married couple choose their optimal time allocation, taking both sets of characteristics, (E_f,V_f) and (E_m,V_m), as given. This is consistent with a marital sort by characteristics involving any degree of correlation. The sort could, for example, be random, or could involve an "optimal sort" by characteristics (Becker, 1974), provided that the time allocation *per se* cannot influence the characteristics of the spouse. In this latter case there is a hierarchical structure in which given characteristics of one spouse imply that certain characteristics are obtainable in the partner and that conditional on both sets of characteristics, time allocations are made.

Husband's time does not enter directly into production; therefore the husband's optimal time allocation problem is solved by maximizing his earnings, or labour income, I_m.

$$\max_{S_m} I_m = W_m(T_m-S_m) = [1-\gamma(T_m-S_m)][E_m+h(S_m;E_m)](T_m-S_m)$$

Assuming an interior solution, necessary and sufficient conditions for a maximum yield a solution for S_m with the following properties:

$$(9) \qquad S_m^* = S_m^*(E_m,T_m) \qquad \partial S_m^*/\partial E_m \gtrless 0$$

$$\partial S_m^*/\partial T_m > 0$$

The male wage rate is obtained by substituting (9) into (8):

$$(10) \qquad W_m^* = [1-\gamma(T_m-S_m^*)]\{E_m+h(S_m^*;E_m)\} = W_m^*(E_m,T_m)$$

The relation between the wage rate and the endowment is ambiguous because of the ambiguity of $\partial S^*/\partial E_m$; the relation between I_m^* and the endowment, however, is always positive.

Conditional on the solution to the husband's time allocation problem, the optimal allocation of the wife's time is obtained by solving:

$$(11) \qquad \max_{\substack{C_f,H_f,S_f \\ x,y}} U = U[C(C_f,x),\ Z(H_f,y)]$$

subject to: (4), (5), (7) and $W_m L_m = I_m^*$.

Assuming interior solutions the constraints may be collapsed into a full income constraint:

$$(12) \qquad P_x x + P_y y + W_f C_f + W_f H_f = W_f(T_f-S_f) + I_m^* + V \equiv F$$

where $\qquad V \equiv V_m + V_f$.

The first order necessary conditions imply reduced form derived demand functions for the alternative uses for the wife's time:

$$(13a) \qquad C_f^* = C_f(P_x,P_y,I_m^*,V,E_f,T_f)$$

$$(13b) \qquad H_f^* = H_f(P_x,P_y,I_m^*,V,E_f,T_f)$$

$$(13c) \qquad S_f^* = S_f(P_x,P_y,I_m^*,V,E_f,T_f)$$ [10]

and these imply a reduced form supply equation of the wife's time to the market:

$$(14) \qquad L_f^* = L_f(P_x,P_y,I_m^*,V,E_f,T_f)$$

Given these optimal time allocations, the female wage rate follows from (7):

$$(7)' \qquad W_f^* = [1-\gamma(L_f^*)]\{E_f+h(S_f^*;E_f)\} = W_f(P_x,P_y,I_m^*,V,E_f,T_f)$$

Similarly, child-services--or number of children when child quality is exogenous--follows from (2):

$$(2)' \qquad n = C(C_f^*,x^*) = n(P_x,P_y,I_m^*,V,E_f,T_f)$$

Restrictions on the parameters of these reduced forms may be obtained from a priori restrictions on the production functions C(), Z() and h() and on the utility function.

3. Interpretation of "Structural" Equations for Female Wage Rate, Labour Supply and Fertility

Given the theoretical framework of the previous section the exogenous variables in the system are the prices, P_x and P_y, the endowments, E_f and E_m, the non-labour incomes, V_m and V_f, and the length of the lifetimes, T_m and T_f. Depending on the error specification, I_m^* may also be considered a truly exogenous variable. A major departure of this system from previous systems is the endogeneity of schooling. The simultaneous approach to female labour supply and fertility has led investigators to specify "structural" equations for the female wage and labour supply which include, for example, fertility as a right-hand-side variable. Similar equations have been estimated by earlier investigators who treated fertility as an exogenous variable (Mincer, 1962; Cain, 1966; Bowen and Finegan, 1969). In this section we examine the interpretation of the coefficients in these labour supply and wage equations when fertility and schooling are endogenous. The simplest case involves identical individuals, exogenous child quality and a deterministic model at the individual level. Consider first the inclusion of fertility in the labour supply equation. If fertility is endogenous the "structural" labour supply equation has to exclude an exogenous variable for identification. The usual choice is P_x--a variable that is presumed to "directly" affect n but not L_f. A linear approximation to this equation is:[11]

$$(15)\quad dL_f = \Big[\frac{\partial L_f/\partial P_x}{\partial n/\partial P_x}\Big]dn + \Big[\frac{\partial L_f}{\partial I_m^*} - \frac{\partial L_f/\partial P_x}{\partial n/\partial P_x}\frac{\partial n}{\partial I_m^*}\Big]dI_m^* + \Big[\frac{\partial L_f}{\partial V} - \frac{\partial L_f/\partial P_x}{\partial n/\partial P_x}\cdot\frac{\partial n}{\partial V}\Big]dV$$

$$+ \Big[\frac{\partial L_f}{\partial E_f} - \frac{\partial L_f/\partial P_x}{\partial n/\partial P_x}\frac{\partial n}{dE_f}\Big]dE_f$$

where the partial derivatives are with respect to the reduced forms. Consider the coefficient on V. The first term represents the "usual" partial effect of V on labour supply, holding the other exogenous variables constant. The second term reflects the fact that when V is changed, n will change. The coefficient on V in (15) is the effect of a change in V on labour supply <u>holding n constant</u>, as well as holding I_m^* and E_f (but not P_x) constant; therefore when V changes, there must also be a compensating change in P_x so as to hold n constant. This is the second term. Similar interpretations hold for the full coefficients on I_m^* and E_f. The experiments represented by those coefficients are thus compound ones involving compensating changes in excluded exogenous variables which may not be the experiments of interest. More importantly, the signs of partial derivatives of the reduced forms may well differ from those of the coefficients in (15). Thus, for example, the "standard" <u>a priori</u> restrictions--that the wife's non-market time is a normal good--would sign the reduced form effect of non-labour income on labour supply as negative, $\partial L_f/\partial V < 0$. However, this will not in general imply that the coefficient on non-labour income in (15) is negative.

The coefficient on fertility in (15) is the ratio of the partial (i.e., uncompensated) effect of P_x on labour supply holding all other exogenous variables (and hence "full" money income) constant to the uncompensated effect of P_x on fertility. In general this ratio cannot be signed. An increase in P_x has several effects: (i) it increases the input price of goods in n and causes a substitution in favour of C_f; (ii) it increases the price of n and causes a substitution in consumption in favour of Z; (iii) it reduces real full income and hence affects n and Z according to their income elasticities. The effect of P_x on n is negative provided n is not inferior, but the effect on labour supply remains unclear, depending on the relative magnitudes of time intensities and substitution elasticities. Thus the sign of the coefficient on fertility in a labour supply equation when fertility is endogenous is ambiguous. Two recent studies (Cain and Dooley, 1976; Fleisher and Rhodes, 1979) reported coefficients insignificantly different from zero, contrary to the authors' expectations. In fact it can be shown that the coefficient would be identically zero under a Cobb-Douglas specification for the production and utility functions, since in this case income and substitution effects are exactly offsetting. A coefficient of zero is therefore not at all inconsistent with the one-period lifetime model.

The fact that the coefficient on fertility in a labour supply equation may be zero does not, of course, mean that fertility and labour supply are unrelated or that an exogenous increase in fertility would not affect labour supply. If, for example, couples faced a binding constraint on family size and the constraint was relaxed, there would be an effect on labour supply given by the ratio of compensated price effects rather than the ratio of uncompensated effects shown in (15).[12]

Next, consider the inclusion of fertility in the female wage equation. Equations of this type have been estimated by several authors including Cain and Dooley (1976), Fleisher and Rhodes (1979) and Heckman (1974). Again we assume that P_x is the omitted exogenous variable to identify the equation. A linear approximation to the average wage rate equation is then:

$$(16)\quad dW_f = \left[\frac{\partial W_f/\partial P_x}{\partial n/\partial P_x}\right]dn + \left[\frac{\partial W_f}{\partial I_m^*} - \frac{\partial W_f/\partial P_x}{\partial n/\partial P_x}\,\frac{\partial n}{\partial I_m^*}\right]dI_m^* + \left[\frac{\partial W_f}{\partial V} - \frac{\partial W_f/\partial P_x}{\partial n/\partial P_x}\cdot\frac{\partial n}{\partial V}\right]dV$$

$$+ \left[\frac{\partial W_f}{\partial E_f} - \frac{\partial W_f/\partial P_x}{\partial n/\partial P_x}\,\frac{\partial n}{\partial E_f}\right]dE_f$$

where, again, the partial derivatives refer to the reduced form equations. The coefficients on the exogenous variables represent compound experiments analogous to those in the labour supply equation. The coefficient on fertility is again a ratio of uncompensated price effects and has an ambiguous sign. The most common form of wage equation encountered in the literature is the familiar regression of wages on exogenous schooling. If schooling is exogenous, the reduced form equations for n and W_f must be amended to include S_f. If, for simplicity of exposition, the other exogenous variables apart from P_x and S_f are constant across the population, the wage equation which includes fertility and schooling as right-hand-side variables becomes:

$$(17) \quad dW_f = [\frac{\partial W_f/\partial P_x}{\partial n/\partial P_x}]dn + [\frac{\partial W_f}{\partial S_f} - \frac{\partial W_f/\partial P_x}{\partial n/\partial P_x}\frac{\partial n}{\partial S_f}]dS_f$$

where the partial derivatives refer to the amended reduced forms. The schooling coefficient is not the partial effect of schooling on wages from the earnings function, but rather is the effect of schooling on wages holding n constant. In order to hold n constant the omitted exogenous variable, P_x, has to change and this has an effect on W_f via altering L_f. Thus even if $\partial W_f/\partial S_f > 0$, the coefficient on schooling in (17) is not necessarily positive. Of course if $\gamma = 0$, $\partial W_f/\partial P_x = 0$, the coefficient on schooling becomes $\partial W_f/\partial S_f = h'$ and the coefficient on n will be zero.

4. Reduced Form Estimation of the One-Period Lifetime Model Using Lifetime Variables

The version of the one period lifetime model presented in Section 2 above suggests that "structural" equations in which, say, fertility enters the equation for female labour supply do not provide answers to experiments of primary interest, and may in fact create the misleading impression that fertility and female labour supply are unconnected. They are equivalent to preferring a "structural" individual household demand equation for apples in which the quantity of oranges, income, and all but one price--say the price of oranges--are included, to a "reduced form" demand equation for apples which contains all prices and income. Under plausible assumptions the coefficient on the quantity of oranges will be zero, even though apple and orange consumption are related and an exogenous increase in orange consumption--say due to a ration ceiling being lifted--will affect the quantity of apples consumed. In this section we estimate reduced form equations for the endogenous variables in the one-period model using "lifetime" measures of the lifetime variables and test *a priori* restrictions on the model. These estimates are then compared with those obtained using "current" measures of the lifetime variables.

The data used are the National Longitudinal Survey of Married Women, 30-44. The first interviews were conducted in 1966. We make use of the initial interview and the follow-up surveys up to and including 1976. The major advantage of this data set is that it provides the best information available to date on the lifetime labour supply of married women. This information is provided in two forms: (i) a retrospective history of labour supply during the pre-survey period; and (ii) labour supply during the survey period. A second advantage is the high quality of wage data for both the males and females. A third advantage is the accurate measure of completed fertility for all members in the sample. In many data sets small sample sizes are encountered because of the necessity of excluding younger women who have not completed child bearing. Typically in these data sets some arbitrary cutoff point, e.g., women aged 35 and older, is chosen in a tradeoff between losing additional observations versus introducing error in completed family size.

a) Estimation of the Reduced Form: Exogenous Schooling

To facilitate comparison with the existing literature, the reduced form is first estimated under the assumption that schooling is exogenous. In this case the reduced form equations for female labour supply, fertility and lifetime average wage rate are given by:

$$(14)' \qquad L_f = L_f(P_x,P_y,I_m,V,E_f,S_f,T_f)$$

$$(2)'' \qquad n = n\,(P_x,P_y,I_m,V,E_f,S_f,T_f)$$

$$(7)'' \qquad W_f = W_f(P_x,P_y,I_m,V,E_f,S_f,T_f)$$

While the households' choice of inputs, labour supply, wage rates and outputs are simultaneously determined, the properties of the system are more apparent when the process is separated into demand and supply (or production) sectors. The family may be viewed as choosing n and z given their shadow prices, Π_n and Π_z and full income constraint on the demand side; on the supply side the process of maximizing output from given resources yields the production possibilities frontier and the shadow prices, Π_n and Π_z. This separation is complete when $\gamma = 0$. In that case W_f is exogenous, and the production possibility frontier is linear:

$$(18) \qquad \Pi_n n + \Pi_z z = F = W_f(T_f - S_f) + I_m + V$$

Maximizing (1) subject to (18) yields demand functions for n and z of standard form:

$$(19) \qquad n = d^n(\Pi_n,\Pi_z,F)$$

$$(20) \qquad z = d^z(\Pi_n,\Pi_z,F)$$

On the production side, cost minimization implies standard derived demand functions for the inputs H_f and C_f in terms of outputs and the input prices, and hence a supply function of time to the market:

$$(21) \qquad L_f = g(n,z,W_f,P_x,P_y)$$

Since the shadow prices and full income depend only on the exogenous variables, the reduced form for n, (2)", follows directly from substituting for Π_n, Π_z, and F in (19). This yields, in elasticity form:

$$(22)\quad d\,\ell n\, n = \{\eta_n[\frac{W_fL_f}{F}\eta_{W_fS_f} - \frac{W_fS_f}{F}] - s_z\sigma(s_c-s_h)\eta_{W_fS_f}\}\, d\,\ell n\, S_f$$

$$+ \{\eta_n \frac{W_fL_f}{F}\eta_{W_fE_f} - s_z\sigma(s_c-s_h)\eta_{W_fE_f}\}\, d\,\ell n\, E_f$$

$$+ \eta_n \frac{W_fT_f}{F}\, d\,\ell n\, T_f + \eta_n \frac{I_m}{F}\, d\,\ell n\, I_m + \eta_n \frac{V}{F}\, d\,\ell n\, V$$

$$- s_x(\eta_n s_n + \sigma s_z) d\,\ell n\, P_x + s_y s_z(\sigma-\eta_n) d\,\ell n\, P_y$$

where η_n is the income elasticity of demand for children, $\eta_{W_fS_f}$ and $\eta_{W_fE_f}$ are the elasticities of the average post-school wage with respect to schooling and endowment, respectively, s_n and s_z are the shares of n and z in total expenditure, s_x and s_c are the shares of x and C_f in the production of n, s_h and s_y are the shares of H_f and y in the production of z, and σ is the elasticity of substitution in consumption.

The reduced form for L_f follows from substituting the reduced forms for n and z into (21). The resulting equation in elasticity form is:

$$(23)\quad d\,\ell n\, L_f = \{\frac{H_f}{L_f}[s_y\Psi\eta_{W_fS_f} - \mathcal{E}_{zS_f}] + \frac{C_f}{L_f}[s_x\Psi\eta_{W_fS_f} - \mathcal{E}_{nS_f}] - \frac{S_f}{L_f}\}\, d\,\ell n\, S_f$$

$$+ \{\frac{H_f}{L_f}[s_y\Psi\eta_{W_fE_f} - \mathcal{E}_{zE_f}] + \frac{C_f}{L_f}[s_x\Psi\eta_{W_fE_f} - \mathcal{E}_{nE_f}]\}\, d\,\ell n\, E_f$$

$$+ [\frac{T_f}{L_f} - \frac{W_fT_f}{F}(\frac{H_f}{L_f}\eta_z + \frac{C_f}{L_f}\eta_n)]\, d\,\ell n\, T_f - \frac{I_m}{F}(\frac{H_f}{L_f}\eta_z + \frac{C_f}{L_f}\eta_n) d\,\ell n\, I_m$$

$$- \frac{V}{F}(\frac{H_f}{L_f}\eta_z + \frac{C_f}{L_f}\eta_n)\, d\,\ell n\, V$$

$$- \{\frac{H_f}{L_f} s_x s_n(\sigma-\eta_z) - \frac{C_f}{L_f} s_x(\eta_n s_n + s_z\sigma) + \frac{C_f}{L_f} s_x\Psi\}\, d\,\ell n\, P_x$$

$$+ \{\frac{H_f}{L_f} s_y(\eta_z s_z - s_n\sigma) - \frac{H_f}{L_f} s_y\Psi - \frac{C_f}{L_f} s_y s_z(\sigma-\eta_n)\}\, d\,\ell n\, P_y$$

where ε_{zS_f} and ε_{nS_f} are the reduced form elasticities of z and n with respect to schooling and ε_{zE_f} and ε_{nE_f} are the endowment elasticities; Ψ is the (common) elasticity of substitution in production.

The effect of schooling on the number of children is ambiguous. If children are time intensive, $s_c > s_h$, then there is a negative substitution effect; if children are "normal" this effect would tend to be opposed by an income effect, but in the present model the income effect is uncertain if schooling is exogenous since the earnings foregone through going to school are not necessarily outweighed by the subsequent gains. The initial endowment also has opposing effects, though in this case the income effect is always positive provided $\eta_n > 0$. T_f, I_m and V all have unambiguously positive pure income effects. The price of child related market goods is unambiguously negative; the price of other market goods is ambiguous, depending on the sign of $(\sigma - \eta_n)$.

Labour supply is also ambiguously affected by schooling and endowment. In addition to the usual effects of schooling on labour supply via wage rate effects represented by the first two terms of the coefficient, there is an additional negative effect of schooling on labour supply representing the fact that time in school reduces the total time available for other activities, including market work. Assuming normality, I_m and V have unambiguously negative effects on labour supply. T_f has an ambiguous effect: an increase in T_f raises real income and hence demands for the time inputs, but at the same time it increases the total amount of time available.

It was noted above that under a Cobb-Douglas specification for utility and production, the implied coefficient on number of children in a labour supply equation would be identically zero. The example given used P_x to identify the equation resulting in a coefficient on n of the ratio of reduced form partial derivatives: $(\frac{\partial L_f/\partial P_x}{\partial n/\partial P_x})$. An inspection of (22) and (23) shows that $\partial L_f/\partial P_x = 0$ when the substitution and income elasticities are unity.

The reduced form average wage equation in the case where $\gamma = 0$ is simply

$$W_f = E_f + h(S_f;E_f) \tag{24}$$

In this case the inclusion of number of children would have a zero coefficient.

The variables used in the estimation are described in Table 1. Completed family size was available directly from the data set with essentially no truncation since the youngest woman at the end of the sample period was 40 years of age. The measure of lifetime labour supply was derived from the limited information on the retrospective work history of the wife and the more detailed information from the survey period, 1967 to 1976. The precise method of construction of this variable is described in Appendix A. The resulting values appear plausible. For example, the mean is 16.4 full-time years (or equivalent) of labour supplied over the lifetime, representing just over one-third of the potential working life; this compares with participation rates of 15.6%-31.7% in the decades 1940-1960, and since some of these participants are less than full-time the values appear quite consistent. Female schooling was available directly from the survey data. The price of child-related commodity inputs is usually proxied by the farm/rural-non-farm/urban residence[13] and the religion of the family--especially the Catholic/non-Catholic distinction. The former is directly available in the data set. The latter is not available directly; however a variable potentially correlated with whether or not the wife is Catholic is whether or not the wife's parents both came from Latin America. Of course, this variable may also be related to other factors in the model and its coefficients should be viewed with especial caution. The female endowment, E_f, is interpreted broadly, following

Table 1

DEFINITIONS OF VARIABLES, MEANS AND STANDARD DEVIATIONS

Variable Name	Definition	Mean	Standard Deviation
FEMYRS	Total lifetime hours supplied to the market/2000	16.4037	10.3750
NKBY76	Completed family size	3.5897	2.4971
ED67	Education of wife	11.3345	2.5607
FARM (a)	Dummy variable = 1 if family has a farm location	.0405	.1972
URB (a)	Dummy variable = 1 if family has a large urban location	.4030	.4906
RURNF (a)	Dummy variable = 1 if family has a rural-non-farm location	.2936	.4555
FARM15	Dummy variable = 1 if wife lived on farm at age 15	.3074	.4615
WHITE	Dummy variable = 1 if wife's race is white	.7837	.4118
BADHLTH	Dummy variable = 1 if wife has poor health	.1632	.3696
FORBORN	Dummy variable = 1 if wife was foreign born	.0462	.2099
FORNAT	Dummy variable = 1 if wife has a foreign nationality	.3244	.4683
FOCCPRO	Dummy variable = 1 if wife's father was in a managerial or professional occupation	.3491	.4768
PBLA (b)	Dummy variable = 1 if wife's parents were born in Latin America	.0089	.0940
PBO (b)	Dummy variable = 1 if wife's parents were not born in Europe, USA or Latin America	.0142	.1182
SUB15	Dummy variable = 1 if wife's parents lived in a suburb when she was 15	.0450	.2073
STPAR15 (c)	Dummy variable = 1 if wife lived with one natural and one stepparent at age 15	.0446	.2064
SPAR15 (c)	Dummy variable = 1 if wife lived with one natural parent only	.1337	.3404
NPAR15 (c)	Dummy variable = 1 if wife lived with neither parent at age 15	.0725	.2594
FCOLL (d)	Dummy variable = 1 if wife's father went to college	.0782	.2685
FHS (d)	Dummy variable = 1 if wife's father was a high school graduate	.2203	.4146
FGD8 (d)	Dummy variable = 1 if wife's father completed grade 8	.2220	.4156
MWKD15	Dummy variable = 1 if wife's mother worked when wife was aged 15	.3252	.4686
MCOLL (e)	Dummy variable = 1 if wife's mother went to college	.0689	.2533
MHS (e)	Dummy variable = 1 if wife's mother was a high school graduate	.2645	.4411
MGD8 (e)	Dummy variable = 1 if wife's mother completed grade 8	.2066	.4049
LWR	Natural log of wife's discounted annual wage rate*	6.9826	.4146
EARNH	Husband's discounted lifetime earnings per annual hour of work	49.1090	23.1061
CEARNH	Husband's discounted current earnings: same units as EARNH	51.7517	38.9447
CURPAR	Dummy variable = 1 if wife participated in 1967	.5570	.4965
CURHRS	Current hours of work of wife: same units as FEMYRS	17.0212	19.6187

Notes: Omitted categories in the dummy variable sets are:

a) Small urban location
b) Wife's parents born in Europe or North America
c) Wife lived with both parents when she was aged 15
d) Wife's father has less than grade 8 education
e) Wife's mother has less than grade 8 education

*Computed over non-zero values only.

The location and health variables are measured in 1967.

Becker and Tomes (1979), to include a wide variety of background characteristics: race or ethnic background, education and birthplace of the wife's parents, and characteristics of the household the wife was living in when she was 15 years of age--whether one or both parents were present, farm/rural-non-farm/urban location, work status and occupation of parents.

Non-labour income measures are available in the data set, but they present many problems. The theoretically appropriate asset or non-labour income variable is the "permanent" amount of goods and services that could be purchased in each period by the family in the absence of market work. This will be determined by the value of receipts of inheritances and other "outside" sources of income flow. There are two types of variables available to measure this. Firstly, there are asset stock variables. There are measures for 1967, 1971 and 1972 of the estimated value of the family's assets, both 'total' and specific categories such as real estate, autos, etc. The major problems with these variables are that (a) they are usually grossly underestimated and (b) they represent only three points in a lifetime path of asset stocks which will be dependent both on the "permanent" asset level and the optimal lifetime path of consumption. Even if perfectly measured this variable would only correspond to the theoretical variables under extreme assumptions --for example, if everyone consumes all their current income and receives all their "permanent" assets before 1972. More generally, the different path of "permanent" asset receipts (i.e., other than from saving) and consumption paths will cause these measured asset variables to diverge from the "permanent" asset level.

Secondly, there are income flow variables--measures over several years of income from sources such as pensions. These suffer from two problems. (a) If they are flows from assets, they suffer from the problems mentioned above. (b) If they are pensions they suffer from the fact that they measure the <u>receipt</u> of the pension rather than the <u>eligibility</u> for the pension. This introduces the general problem of some non-labour income receipts being dependent on labour market behavior. It is clear, however, that if all people are entitled to a pension, but only some choose to receive it (e.g., by retiring), those in receipt of it should not be assumed to have a higher "permanent" non-labour income.

Many previous investigators have found insignificant effects from non-labour income which are probably due to above-mentioned problems with the available direct measures. Because of these problems we prefer an indirect measure of inheritances in the form of the characteristics of the parents. In particular, the wife's parents' wealth was assumed to be higher if the wife's father's occupation was professional or managerial and if the wife's family lived in a suburb when she was aged 15. The education of the wife's parents is also likely to be relevant. However, because parental education and occupation are also proxies for E_f, it is not possible to seperately identify the affects of non-labour income.[14]

The price of commodity inputs, P_y, for non-child related commodities is not measured except possibly by regional location. It is thus assumed to be constant across the population. Previous studies have also treated the length of life as constant across the population. However there is a considerable body of evidence (Hauser and Kitigawa, 1973) that suggests that this is not true. In particular, there appears to be a substantial difference in life expectancy between black and white women in the U.S. after adjusting for "socioeconomic-status". Life expectancy also depends on the cohort since there has been a steady increase in life expectancy during the 20th century. However this effect will be small in our sample because of the small cohort spread. Poor health will also, in general affect life expectancy. Assuming that this is exogenous to the individual we include as proxies for T_f the health status and race of the women.

Finally, measures of the male and female lifetime earnings are required. Lifetime earnings may be calculated from individual current wage profiles. These individual profiles will differ in their starting point for individuals of the same age because of differences in schooling, reflecting the fact that some lifetime hours are given up when schooling is undertaken.[15] The characteristics of the husband's profile, assuming exogenous schooling, may be obtained from standard current wage regressions on the panel data in the manner of Lillard and Weiss (1979) and Carliner (1980). An important feature of the panel data is that it permits the wage profile to differ for each individual according to omitted endowment (or lifetime market luck) variables. The semi-logarithmic functional form of Mincer (1974) and Heckman and Polachek (1974) is adopted. The present value (evaluated at the beginning of the lifetime) of each individual's earnings profile is computed using a real discount rate of three percent. (It was also computed using a rate of two percent with no changes in the results reported below.) The computation of I_m is described in detail in Appendix A. Computation of the wife's lifetime earnings is more complicated than that of the husband because of two main differences: (a) experience is no longer linked to calendar time since females do not always work in the market hence an experience profile is required; and (b) experience is no longer exogenous even if schooling is exogenous. The precedure used is based on the same principle as that employed for the husband and is described in Appendix A.

Estimates of the parameters of (14)', (2)", and (7)" are presented in Table 2 below. In the labour supply equation, husband's earnings (EARNH) have a significant negative effect--a ten percent increase in lifetime earnings of the husband decreases the number of hours the wife supplies to the market by two percent. The wife's schooling (ED67) has a significant positive effect on the wife's labour supply--a ten percent increase in her schooling increases her labour supply by about two percent. The proxies for non-labour income (SUB15, FOCCPRO) both exert negative effects, as expected, though

Table 2

REDUCED FORM ESTIMATION: EXOGENOUS SCHOOLING

INDEPENDENT VARIABLE	FEMYRS Coefficient (t-value)	FEMYRS (elasticity)	NKBY76 Coefficient (t-value)	NKBY76 (elasticity)	LWR Coefficient (t-value)	LWR Coefficient (t-value)
			DEPENDENT VARIABLE			
ED67	.3314 (3.54)	(.229)	-.1477 (6.61)	(-.466)	.0652 (7.94)	.0596 (12.27)
EARNH	-.0634 (6.54)	(-.190)	.0030 (1.28)	(.040)	-.0004 (0.21)	.0033 (5.97)
FARM	-1.7992 (1.62)		1.1760 (4.42)		-.2422 (2.37)	-.0662 (1.25)
URB	.1412 (0.27)		-.2798 (2.22)		.1699 (7.26)	.1657 (7.10)
RURNF	-.1357 (0.25)		.2175 (1.66)		.0135 (0.55)	.0212 (0.88)
WHITE	-2.7908 (4.80)		-1.0546 (7.61)		.0405 (1.13)	.0933 (3.79)
BADHLTH	-2.9712 (5.31)		-.0594 (0.44)		-.1008 (1.92)	-.0088 (0.33)
FORBORN	.2318 (0.22)		-.1445 (0.56)		.0251 (0.43)	.0805 (1.57)
FORNAT	-.5545 (1.13)		.1417 (1.21)		-.0084 (0.34)	.0123 (0.55)
FARM15	1.0079 (1.89)		.0992 (0.78)		-.0080 (0.32)	-.0201 (0.84)
FOCCPRO	-.9093 (1.86)		-.1506 (1.29)		-.0404 (1.69)	-.0226 (1.02)
SUB15	-2.3665 (2.37)		.1169 (0.49)		-.2300 (3.42)	-.1469 (2.75)
PBIA	1.3333 (0.60)		1.2166 (2.30)		.1218 (1.21)	.0687 (0.71)
PBO	-.4448 (0.24)		-1.3254 (2.98)		.1146 (1.34)	.1345 (1.58)
STPAR15	.6689 (0.67)		.2112 (0.89)		.0684 (1.43)	.0286 (0.66)
SPAR15	-.8320 (1.23)		.1567 (0.97)		-.0377 (1.16)	-.0132 (0.44)
NPAR15	-.4592 (0.54)		.8276 (4.12)		-.0712 (1.90)	-.0661 (1.77)
FCOLL	-.2256 (0.25)		.3326 (1.53)		.0388 (0.94)	.0328 (0.79)
FHS	.5613 (0.96)		.0580 (0.42)		.0958 (3.57)	.0785 (3.09)
FGD8	-.3543 (0.62)		.1589 (1.17)		.0225 (0.90)	.0267 (1.07)
MCOLL	-.6136 (0.64)		.3859 (1.67)		-.0456 (1.04)	-.0282 (0.67)
MHS	-.4453 (0.74)		.2009 (1.40)		-.0599 (2.25)	-.0566 (1.96)
MGD8	-.3660 (0.59)		.2381 (1.62)		.0015 (0.05)	-.0217 (0.81)
MWKD15	1.4636 (3.22)		.2278 (2.10)		.0182 (0.89)	.0093 (0.46)
CONSTANT	18.6110 (15.39)		5.5740 (19.32)		5.8957 (47.11)	6.1239 (113.78)
λ	-		-		-.5003 (2.02)	-
R^2	.066		.082		.267	.265
N	2469		2469		1607	1607
F	7.19		9.14		23.01	23.75

Note: Absolute value of t-statistic in parentheses.

since these variables may also influence E_f, the results should be interpreted with caution. Poor health (BADHLTH) depresses labour supply. White women supply fewer hours--a result that consistently appears in labour supply studies. Race plays several roles in the one period lifetime model. Firstly, it may affect the true value of husband's lifetime earnings if there is greater marital instability in black families.[16] Secondly, black women will generally be from less well-off families, other things equal, and may therefore have lower non-labour income. Both this, and the effect on husband's earnings would increase the labour supply of black families via a pure income effect. Thirdly, black women have a lower value of T_f, which again exerts an income effect on labour supply, though as noted above, the overall effect of T_f is ambiguous. The labour supply of the wife is also increased if her mother worked when the wife was aged 15 (MWKD15). This variable was included as an endowment control and we offer no explanation for the direction of its effect.

Completed family size is lower, the higher is the wife's education, in common with other studies. This implies that children are time intensive and that the income effect is small, or even negative. Husband's earnings, which has a pure income effect, has a positive coefficient, but it is insignificantly different from zero. This may be the result of a small or zero true income elasticity, or may reflect a downward bias induced because of the quality-quantity interaction (Becker and Lewis, 1973). The proxies for p_x operated in the expected directions: being in a farm location increased completed family size the most; a rural-non-farm location had the next strongest effect and an urban location reduced family size--relative to location in a small urban area. Family size is increased if both the wife's parents were born in Latin America compared to women with parents born in the U.S. or Europe: this is consistent with wives with a Latin American background being Catholic, although other explanations are possible. If both parents of the wife were both outside of

Europe, U.S.A. and Latin America, family size is increased. Family size is also increased for wives coming from homes in which neither natural parent was present when the wife was aged 15, and for wives who lived with only one natural parent at age 15, though the latter is not significant. One explanation for this finding is that wives in these categories relative to those from homes in which both natural parents are present have lower initial endowments which reduce their wage rate. Consistent with this interpretation is the fact that education is lower for these wives--see Table 4 below.

The last two columns of Table 2 report estimates of $(7)''$. Since the wife's lifetime wage rate could only be computed for families with wives that participated at least twice during the survey period, the regression reported in Table 2 is a censored regression. We correct for the resulting selection bias by applying the well-known procedure of Heckman (1976, 1979). The last column reports the results with no correction for censoring, while the third column includes the constructed regressor, λ. An interesting result concerns the effects of race: without the correction for censoring being white increases the lifetime average wage rate by an amount greater than an additional year's schooling whereas when the censoring is taken into account there is no wage differential by race. Similarly, the effect of husband's earnings is to increase the wife's wage rate in the uncorrected case, but the effect disappears when the correction factor is included. The effect of the health variable is only noticeable in the corrected case. As expected, wife's education increases the wage rate and the urban, rural-non-farm, and farm location variables operate in the usual manner. Of the remaining variables the most significant is the crude proxy for (actual or anticipated) bequest size--the dummy variable indicating residence in a suburb at age 15; as expected the effect of this is negative. This result is confirmed by the sign of the point estimate of the other non-labour income proxy FOCCPRO but this variable is only significant at the 10% level (t=1.69).

b) Estimation of the Reduced Form: Endogenous Schooling

In principle, schooling is endogenous since planned labour market behavior will influence the optimal level of schooling. The reduced forms for this case are given in Table 3. The results for labour supply and fertility equations are very similar to the exogenous schooling case. The schooling equation shows significant effects for a large number of background or endowment variables. The lifetime earnings of the husband exerts a statistically significant, but very small positive effect on the wife's education. Area of married residence has no effect, but as expected if the wife lived on a farm when she was aged 15 her schooling was reduced--in fact by over half a year. A wife with poor health also had fewer years of schooling; this suggests that the health variable is measuring, albeit imperfectly, lifetime health effects rather than just current health status. Of particular importance is the education level of the parents which has a strong positive effect on the wife's schooling: for example if both parents went to college, wife's schooling is increased by four years compared to the case where both parents had less than a grade eight education. Moreover, it should be noted that for each of the parent's schooling dummy variables, mother's education has a larger effect than father's schooling. This is consistent with the findings of Liebowitz (1974). There appears to be no detrimental effect on the wife's schooling if her mother worked when she was aged 15. Having a father with a professional or managerial occupation also increases the wife's education, though only by one quarter of a year. Wives who lived with neither natural parent or with one natural and one step parent had a half a year less schooling than those who lived with both natural parents.

Table 3

REDUCED FORM ESTIMATION: ENDOGENOUS SCHOOLING

INDEPENDENT VARIABLES	FEMYRS Coefficient (t-value)	(elasticity)	NKBY76 Coefficient (t-value)	(elasticity)	ED67 Coefficient (t-value)	(elasticity)
EARNH	-.0591	(-.177)	.0010	(.014)	.0129	(.056)
	(6.13)		(0.45)		(6.21)	
FARM	-1.8479		1.1976		-.1467	
	(1.66)		(4.47)		(0.61)	
URB	.1902		-.3016		.1479	
	(0.36)		(2.37)		(1.30)	
RURNF	-.1513		.2244		.0469	
	(0.27)		(1.69)		(0.39)	
WHITE	-2.6478		-1.1182		.4316	
	(4.56)		(8.02)		(3.45)	
BADHLTH	-3.1942		.0400		-.6728	
	(5.73)		(0.30)		(5.61)	
FORBORN	-.0718		-.0092		-.9161	
	(0.07)		(0.04)		(3.97)	
FORNAT	-.4723		.1052		.2476	
	(0.96)		(0.89)		(2.33)	
FARM15	.8162		.1846		-.5785	
	(1.53)		(1.44)		(5.05)	
FOCCPRO	-.8203		-.1903		.2686	
	(1.68)		(1.62)		(2.55)	
SUB15	-2.4045		.1338		-.1146	
	(2.40)		(0.56)		(0.53)	
PBLA	.9121		1.4042		-1.2709	
	(0.41)		(2.63)		(2.66)	
PBO	-.0434		-1.5042		1.2111	
	(0.02)		(3.36)		(3.01)	
STPAR15	.5179		.2785		-.4556	
	(0.52)		(1.16)		(2.12)	
SPAR15	-.8590		.1687		-.0814	
	(1.26)		(1.03)		(0.56)	
NPAR15	-.6550		.9148		-.5908	
	(0.78)		(4.51)		(3.25)	
FCOLL	.3405		.0803		1.7082	
	(0.38)		(0.37)		(8.84)	
FHS	.8600		-.0750		.9013	
	(1.49)		(0.54)		(7.23)	
FGD8	-.1873		.0845		.5037	
	(0.33)		(0.62)		(4.11)	
MCOLL	.0669		.0826		2.0531	
	(0.07)		(0.36)		(10.05)	
MHS	.0692		.0333		1.1346	
	(0.12)		(0.23)		(8.90)	
MGD8	-.1432		.1388		.6722	
	(0.23)		(0.94)		(5.07)	
MWKD15	1.4748		.2228		.0336	
	(3.24)		(2.04)		(0.34)	
CONSTANT	21.7655		4.1687		9.5175	
	(26.58)		(21.20)		(53.97)	
R^2	.061		.066			
N	2469		2469			
F	6.93		7.51			

Note: Absolute value of t-statistics in parentheses.

Quite strong effects are found for variables relating to the birthplace of the wife or her parents. Being foreign born, for example, reduces the wife's education by one year. If her parents were born in Latin America, her schooling is again reduced by a year. If the wife, herself, has a foreign nationality however, her years of schooling exhibit a small increase; and if her parents were born outside of Europe, U.S.A. and Latin America her schooling increases by over a year. Finally, in common with previous studies we find white women have more schooling--in the present case a little under one half a year additional schooling over non-white wives.

c) Estimation of the Reduced Form: Current vs. Permanent Variables

The estimation thus far has used lifetime measures of the husband's earnings and the wife's labour supply in order to provide a direct test of the one period lifetime model. In this section these results are compared with those obtained when current measures are used. Table 4 presents the reduced form estimates using a current measure of husbands earnings (CEARNH) and alternative measures of female labour (CURHRS and CURPAR). CEARNH is a measure of husband's earnings in 1967 designed for direct comparison with the lifetime measure EARNH. It represents the discounted value of lifetime earnings accruing from one hour per year at the 1967 wage rate. CURHRS is current (1967) female hours in units comparable with FEMYRS--i.e., current hours scaled up by the length of the lifetime and measured in full year equivalents. Estimates of the current hours of work equation for the wife are given in columns (3)-(4), (7)-(8). Since about one half of the sample had zero hours of work, this equation was estimated by a tobit procedure. Finally, CURPAR is a dummy variable equal to one if the wife participated in the market in 1967. The probability of current participation by the wife was estimated by probit analysis and the results are presented in columns (1), (2), (5), and (6).

Table 4

REDUCED FORM ESTIMATION OF FEMALE HOURS OF WORK
AND PARTICIPATION USING CURRENT MEASURES

	DEPENDENT VARIABLES							
	(Exogenous Schooling)				(Endogenous Schooling)			
	CURPAR*		CURHRS**		CURPAR		CURHRS	
INDEPENDENT VARIABLES	$\frac{\partial P}{\partial X_i}$	β_P (t-value)	$\frac{\partial H}{\partial X_i}$	β_H (t-value)	$\frac{\partial P}{\partial X_i}$	β_P (t-value)	$\frac{\partial H}{\partial X_i}$	β_H (t-value)
ED67	.0139	.0354	.3960	.6716	--	--	--	--
		(2.86)		(2.22)				
CEARNH	-.0027	-.0058	-.0960	-.1628	-.0018	-.0047	-.0923	-.1566
		(7.32)		(7.76)		(6.06)		(7.53)
FARM	.1205	.3061	.8880	1.5060	.1696	.4298	.8513	1.4437
		(2.09)		(0.43)		(2.99)		(0.41)
URB	.0182	.0463	1.4479	2.456	.0381	.0966	1.5344	2.6022
		(0.70)		(1.45)		(1.47)		(1.53)
RURNF	.0309	.0785	.6850	1.1617	.0491	.1245	.7073	1.1996
		(1.13)		(0.65)		(1.81)		(0.67)
WHITE	-.1959	-.4977	-5.0774	-8.6112	-.2293	-.5810	-4.9421	-8.3814
		(6.52)		(4.74)		(6.66)		(4.62)
BADHLTH	-.0374	-.0950	-2.3609	-4.0040	-.0452	-.1145	-2.6074	-4.4220
		(1.34)		(2.20)		(1.62)		(2.44)
FORBORN	-.0291	-.0739	-1.1639	-1.9739	-.0392	.0994	-1.5081	-2.5576
		(0.55)		(0.55)		(0.76)		(0.72)
FORNAT	-.0635	-.1612	-3.0417	-5.1587	-.0610	-.1546	-2.9479	-4.9993
		(2.62)		(3.20)		(2.52)		(3.11)
FARM15	.0097	.0754	.9504	1.1612	.0798	.0962	.7053	1.1961
		(1.11)		(0.94)		(1.45)		(0.70)
FOCCPRO	.0164	.0416	.7764	1.3170	.0289	.0733	.9033	1.5320
		(0.67)		(0.83)		(1.19)		(0.97)
SUB15	-.0765	-.1943	-2.8750	-4.8759	-.0694	-.1760	-2.9361	-4.9793
		(1.53)		(1.43)		(1.38)		(1.46)
PBLA	.1002	.2544	3.4314	5.8195	.0876	.2220	3.0491	5.1709
		(0.92)		(0.83)		(0.81)		(0.74)
PBO	-.0611	-.1552	1.6029	2.7186	-.0723	-.1836	1.9604	3.3247
		(0.67)		(0.45)		(0.79)		(0.55)
STPAR15	.1018	.2585	4.0964	6.9474	.1222	.3096	3.9451	6.6906
		(1.97)		(2.20)		(2.39)		(2.12)
SPAR15	-.0526	-.1337	-2.4599	-4.1719	-.0502	-.1272	-2.4927	-4.2274
		(1.54)		(1.91)		(1.46)		(1.93)
NPAR15	-.0351	-.0891	-1.8422	-3.1243	-.0310	-.0787	-2.0721	-3.5141
		(0.82)		(1.14)		(0.72)		(1.28)
FCOLL	-.1057	-.2685	-5.1751	-8.7769	-.0809	-.2051	-4.4995	-7.6309
		(2.32)		(2.87)		(1.80)		(2.53)
FHS	.0065	.0164	.0706	.1198	.0247	.0627	.4470	.7581
		(0.22)		(0.06)		(0.85)		(0.41)
FGD8	-.0426	-.1082	-1.3701	-2.3246	-.0373	-.0945	-1.1737	-1.9905
		(1.51)		(1.27)		(1.32)		(1.09)
MCOLL	-.0265	-.0673	-2.4286	-4.1189	.0034	.0086	-1.6049	-2.7217
		(0.55)		(1.29)		(0.07)		(0.87)
MHS	-.0290	-.0737	-1.6657	-2.8251	-.0099	-.0251	-1.2372	-2.0982
		(0.97)		(1.42)		(0.33)		(1.11)
MGD8	.0021	.0053	-.9257	-1.5700	.0183	.0465	-.6723	-1.1402
		(0.07)		(0.79)		(0.60)		(0.58)
MWKD15	.0368	.0936	1.3262	2.2492	.0523	.1323	1.3074	2.2172
		(1.62)		(1.55)		(2.33)		(1.52)
CONSTANT	.1915	.4864	9.9652	16.9008	.0825	2.0899	13.8254	23.4468
		(3.16)		(4.39)		(7.21)		(9.43)
N	2518	2518	2518	2518		2518		2518
$-2\ln R$	219.80	219.80		213.17		193.32		208.25

Notes: *The coefficients β_P refer to the probit index; the partial derivatives $\partial P/\partial X_i$ are the partial effects on the probability of participation of the independent variable X_i, evaluated at the means.

**The coefficients β_H refer to desired labour supply; the partial derivatives, $\partial H/\partial X_i$ refer to the partial effect of X_i on hours including the effect on the probability that the hours are greater than zero.

Comparing the results in Tables 2 and 4 reveals some interesting differences. Current female hours appear more responsive to husbands' current earnings (Table 4, column 4) than is the case with the lifetime variables (Table 2, column 1). Similarly, current hours are more responsive to female education than lifetime hours. In general although the significance levels of variables differ between equations,[17] there is a clear tendency for the point estimates of coefficients to be larger (in absolute value) in the current labour supply equation.[18] For example, there are marked differences in the effects of race: the lifetime hours of white women are 2.79 full year equivalents lower than black women, while the current measure implies a difference of 8.61 years using the tobit coefficient. Having a family of orientation with only one natural parent (STPAR15 and SPAR15) or a father with a college education (FCOLL) produce more dramatic effects on current hours than on lifetime hours.

In the absence of a dynamic life cycle model nesting both the one-period lifetime model of Section 2 and "current" period labour supply functions it is not possible to provide a consistent explanation of the observed differences. However, the existence of these differences are sufficient to refute the notion that the lifetime quantities are distributed randomly across the "current" periods. Family background characteristics appear to affect labour supply more in the prime age phase of the life cycle than in the lifetime as a whole. This suggests that the effects of family background are permanent rather than decaying over time. However, as noted above, great caution is required in drawing inferences from the current-lifetime differences and an adequate explanation awaits future research.

5. <u>"Structural" Equations and the Relation Between Completed Family Size, Female Labour Supply, and Earnings</u>

a) Fertility and Labour Supply

In Section 3 it was noted that the coefficient on completed family size in a just identified female labour supply equation would be $\frac{\partial L_f/\partial P_x}{\partial_n/\partial P_x}$ where P_x is the omitted exogenous variable. Typically some proxy for the price of children is used as the identifying variable. Cain and Dooley (1976) use farm/urban status and Catholic/non-Catholic status; Fleisher and Rhodes (1979) use the husband's education which is assumed to reduce the cost of effective contracepting and hence to increase the price of children. In the present case P_x is proxied primarily by farm/urban (FARM or URB) status; it may also, however, be affected by whether or not both the husband and wife's parents were born in Latin America (PBLA) since this is more likely to make the family Catholic than other families in the sample. Consider first the use of FARM or URB. In both the endogenous and exogenous schooling cases FARM and URB are significantly different from zero at the 5 percent level in the fertility equation, i.e., $\partial n/\partial P_x \neq 0$; however, in the labour supply equation they are both insignificant, i.e., $\partial L_f/\partial P_x = 0$. Hence the coefficient on fertility in the implied "structural" labour supply equation is zero. Identical results obtain using PBLA as the identifying variable.

The above results suggest that the apparent contradiction between the findings of studies using a simultaneous equations approach (Cain and Dooley, 1976; Fleisher and Rhodes, 1979) which reveal no effect of children on female labour supply, and the single equation approaches that treated number of children as given (Gronau, 1973; Heckman, 1974; Heckman and Willis, 1977; Spencer, 1973) and find a substantial depressing effect of children on labour supply may be resolved as follows. The labour supply of wives and completed family size are related to one another in the same sense that any two goods in a demand system are related to one another. For example a doubling in the number of years the wife went to school results in both a halving of the completed family size and an increase in the lifetime labour supply of about 25%. At the same time a simultaneous equations approach that uses conventional proxies for P_x will fail to find any relation between completed family size and labour supply because empirically the uncompensated cross price effects are zero. On the other hand the single equation studies are typically picking up timing factors. This is particularly noticeable in studies that contrast the effects of the presence of children under six years of age with other fertility measures included in the labour supply equation, where the effect is much stronger for the former measures. This is particularly evident in Nakamura and Nakamura (1981). These authors treat fertility as exogenous and estimate labour supply functions for U.S. and Canadian women for seven age groups. In equations including the number of children under six years old this variable is negative and significant at the 5% level in 50% of the regressions [Nakamura and Nakamura, 1981, Table IX, pp. 478-79]. Variables representing the number of children in older age categories are significant much less frequently. The point estimates on these variables imply that the effect of older children on labour supply may be positive, depending on the age configuration of children. Similarly in Heckman's (1974) study, while children under 6 years old had a significant "constraining" effect, the effect of an additional child aged between 6 and 18 was zero. Thus, not surprisingly, while they are bearing and rearing young children women tend to withdraw from the labour market.

These results obtained from the lifetime data are replicated in the current data: in the female hours equation the location dummy variables FARM, URB and RURNF and the proxy for likelihood of catholic status PBLA are all insignificant as in the lifetime case. Thus, in general the implied coefficient on numbers of children in the female labour supply equation appears to be zero whether current or lifetime data is used. The only exception to this result is in the current participation equation where farm is significantly positive (t = 2.09). However, this result yields an implied positive coefficient on fertility in the female labour supply equation--i.e., the "wrong sign"--as found for example, by Cain and Dooley (1976).

b) Female Wage Rates and Fertility

When female wage rates and fertility are endogenous, the "structural" coefficients--wage coefficient in the fertility equation and fertility coefficient in the wage equation--are again, in the case of a just identified system, given by a ratio of uncompensated cross effects with the omitted exogenous variable. These implied "structural" coefficients may, as in the case of the labour supply and fertility interaction, be retrieved from the reduced forms. Thus, for example, if fertility is included in the wage equation and the omitted variable is husband's earnings, the implied coefficient on fertility is the ratio of the coefficients on EARNH in the reduced form wage and fertility equations. The denominator is positive, though insignificant; the numerator is either zero or negative, depending on whether censoring is taken into account. Thus it is possible for children to depress or increase the female wage rate depending on the sign of the effect of husband's earnings on the female wage rate.

6. Conclusions

Coefficients in "structural" models of female labour supply wage rates and fertility may be interpreted as ratios of uncompensated cross price effects when wages and fertility are endogenous. The sign of these ratios depend on the choice of the exogenous variables omitted to "identify" each "structural" equation. Recent investigators have obtained "wrong signs" on fertility in the female labour supply equation when compared with the expected effect of an exogenous increase in fertility. However, there is no paradox since these effects are the results of different experiments. Using both lifetime and current measures our reduced form estimates show that these "wrong signs" obtained from "structural" estimates may be expected given the traditional choice of identifying variables.

Lifetime constructs are computed to provide a direct test of the one-period model of female labour supply and fertility. The estimates are consistent with the model. They differ, however, from estimates obtained using current data. An adequate explanation for these differences requires a life cycle model that yields predictions for both current and lifetime measures.

FOOTNOTES

[1]Recent papers by Razin (1978) and Hotz (1981) have attempted to fill this gap with limited success.

[2]See MacDonald (1981) for a full discussion of the interpretation of wage regressions when schooling is endogenous.

[3]For example, Cain and Dooley (1976), Fleisher and Rhodes (1979).

[4]In this case it is more convenient to specialize the utility function also to $U = U[(nQ),Z]$. For the remainder of the paper we assume that (1) has this form.

[5]This assumption is commonly employed in the literature (Willis, 1973; Fleisher and Rhodes, 1979; Rosenzweig and Wolpin, 1980).

[6]Davis and Bumpass (1976) report that in the 1970 U.S. National Fertility Study over 20% of all women have attended high school or college since marriage. Thus if spouses are assumed at the date of marriage to maximize a utility function defined over their remaining lifetimes it appears inappropriate to assume that the schooling of spouses is predetermined.

[7]There is some evidence that schooling and life span are positively related (Hauser and Kitigawa, 1973). To deal with this completely would require an analysis of investment in health that is beyond the scope of this paper. (See Grossman, 1972, for the basis for such an analysis.) A simple way to allow for this relationship is to set $T(S) = T' + \delta S$, where T' is the life span in the absence of any schooling and δ is a constant. The "standard" models follow from setting $\delta = 1$ while (5) and (6) are obtained from setting $\delta = 0$. If, in fact, δ is between zero and one, then the coefficient on S_f in (5) and (6) becomes $(1-\delta)$ and T' replaces T as the exogenous time constraint.

[8]See Robinson (1981) for a detailed discussion of this issue.

[9]Willis (1973) discusses this point at greater length.

[10]Note that female schooling depends on the income of the spouse and prices not because of any capital market imperfections, but because returns to schooling depend on future labour supply which is determined simultaneously with the allocation of non-market time and which depends on total family resources and prices.

[11]Assume $dp_y = dT_f = 0$ for convenience.

[12]See Rosenzweig and Wolpin (1980) for estimates of this effect using twins data.

[13]Of course, in principle this may be endogenous--parents desiring large families moving to low cost areas. We ignore this problem.

[14]See Becker and Tomes (1979) for a discussion of the relation between parental characteristics and bequests.

[15]They will finish at the same point, however, unless $\delta > 0$ (see footnote 6).

[16]We attempted to test for this possibility by constructing a marital stability variable from the marriage history but the results were inconclusive.

[17]The effects of being resident in the suburbs at age 15 (SUB15) and having a working mother at age 15 (MWKD15) are significant at the 5% level in the lifetime regression. Having a current or past farm residence (FARM and FARM15, respectively), or a father with a professional occupation are significant at the 10% level in the lifetime regression. These variables are not significant in the current labour supply equation. Conversely, having a father with a

college education, or being raised with only one natural parent significantly affect current, but not lifetime, labour supply.

[18]One exception to this pattern is that FARM location <u>reduces</u> lifetime labour supply by 1.8 years (t=1.62), while current labour supply is increased by 1.5 years (t=0.43) and current participation is also increased (col. 2, t=2.09). We note also, that the coefficient on FOCCPRO also changes sign between the two regressions.

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Appendix A

Construction of the Lifetime Variables

1. Female Labour Supply

The retrospective history is divided into three intervals: date of leaving school to date of first marriage (SM); date of first marriage to date of first child (MC); and date of first child to the beginning of the survey period (CP). In each of these intervals the respondent was asked how many years she worked for six months or more. It is therefore necessary to introduce some assumptions in order to construct the retrospective labour supply from this information. The assumptions employed here were as follows. In the intervals (SM) and (MC), all women who indicated that they worked six months or more were assumed to be full-time, full-year workers. In the interval between the first child and the survey period (CP) a woman who indicated that she worked 6 months or more in a given year was assumed to have supplied the average number of hours she supplied in the survey period when she worked 6 months or more. For the years in which she did not work 6 months or more she was assumed to have supplied the average number of hours she supplied in the labour force when she worked less than 6 months.

The hours of labour supply thus computed from the retrospective history are added to the observed hours for the survey period plus projected hours beyond the survey period, to form total lifetime labour hours. The projected hours beyond the survey period are a projection of labour supply in the post-child rearing interval (youngest child 6 years or older) up to an assumed retirement age of 60. (Since the model does not yield a common retirement age this is assumed to take place because of institutional constraints in the form of mandatory retirement and pension rules.) Thus total hours beyond the survey period are obtained by multiplying the length of the period by the average hours worked per year since the end of the child rearing period.

The measure of lifetime labour supply obtained by the above procedure suffers from a variety of problems. In particular it emphasizes the variation in hours brought about by varying the number of years of participation rather than by varying hours within a given year. However, it has the merit of incorporating both the relatively crude retrospective information and the more detailed information in the survey period while at the same time retaining simplicity. It also yields plausible values of lifetime labour supply (see p. 16 above).

2. Husband's Lifetime Earnings

Husband's lifetime earnings, I_m, are calculated from individual current wage profiles. These profiles are computed from school leaving for each individual and finish at the same point unless $\delta > 0$ (see footnote 6 above). This reflects the fact that some lifetime hours are given up when schooling is undertaken. The characteristics of these profiles are obtained from standard wage regressions on the panel data, in the manner of Lillard and Weiss (1979) and Carliner (1980), i.e., under an assumption of exogenous husband's schooling. An important feature of the panel data is that it allows each profile to differ for each individual according to different endowment (or market luck) variables.

The semi-logarithmic functional form of Heckman and Polachek (1974) and Mincer (1974) is adopted. Measuring the dependent variable in real terms the specification of individual i's current wage in period t is:

$$\text{(A1)} \qquad \ell n\, W_{it} = \alpha_o + \alpha_1 S_{it} + \alpha_2 E_{it} + \alpha_3 E_{it}^2 + \alpha_4 t + u_i + v_{it}$$

$$\equiv \underline{\alpha}\, \underline{Z}_{it} + u_i + v_{it}$$

where S_{it} is schooling, E_{it} is experience, t is a trend term, representing capital improvements in the economy, u_i is an unobserved individual component of permanent market luck or endowment, assumed to be uncorrelated across individuals, but constant over time; finally v_{it} is a disturbance representing temporary phenomena such as measurement error, temporary market luck, etc., which is uncorrelated across time periods.

Consistent estimates (assuming exogeneity of schooling and experience) of the coefficients in (A1) are obtained from an ordinary least squares regression on all individuals over all time periods.

The individual components, u_i, are estimated by:

$$\text{(A2)} \qquad \hat{u}_i \equiv \frac{1}{T} \sum_{i=1}^{T} (\ell n\, W_{it} - \hat{\underline{\alpha}}\, Z_{it})$$

where $\hat{\underline{\alpha}}$ is the vector of estimated wage coefficients. The estimated earnings profile for individual i is thus:

$$\text{(A3)} \qquad A_{it} e^{\hat{\underline{\alpha}}\, \underline{Z}_{it} + \hat{u}_i}$$

where A_{it} is annual hours of individual i in period t. By assumption A_{it} is full-time hours (2000) between schooling and retirement for all individuals. Finally, I_m is obtained by discounting (A3) back to age zero for each individual.

The average value of I_m reported in Table 1 of 49.1 represents the present value in 1967 dollars of the earnings obtained from working <u>one</u> hour per year; it must be multiplied by annual hours to yield lifetime earnings. Multiplying by

2000 yields \$98,200. Blinder (1974) computed lifetime earnings for a younger cohort (25-29) vs. (35-44) using approximately the same rate of economic growth but a higher real discount rate (6%) and obtained estimates ranging from \$107,941 - \$129,939. Allowing for the difference in cohort age and discount rate puts our estimate within this range providing an outside check on the plausibility of our measure.

A complication introduced by the data is that separations occur in a variety of ways so that the fraction of the lifetime for which a husband is present varies across individuals. Moreover, because some women marry more than once, there arises a problem of more than one husband's characteristics. There are no completely satisfactory ways of dealing with these complications. The procedure adopted here was to assume identical characteristics of all the husbands of a given wife to those of the husband we observed in the initial survey year. Regarding the fact that a husband may not be present for the complete lifetime, two alternatives were adopted. Under the first, all women are assumed to expect to have a husband for the same fraction of the lifetime so that transitory deviations from the expected value will exert little influence on the woman's observed decisions. Under the second, those women who experience a lower fraction of their lifetime with a husband present on the average expected it so that this will influence the woman's decisions. The random separations approach suggests that I_m may be used, unadjusted, for all women, while the foreseen separations approach suggests that I_m should be multiplied by the fraction of the lifetime that the husband is present. In practice there was little difference in the results whatever measure was used. However, the relatively crude nature of the measure of the fraction of the lifetime married led us to prefer the unadjusted measure of I_m.

3. Wife's Experience Path and Lifetime Earnings

The wife's experience path and lifetime earnings cannot be computed in the same way as the husband's because of three main differences between the two cases: (i) not all females worked during the survey period hence $\hat{u}_i$ is not available for the whole sample; (ii) experience is no longer a simple linear function of calendar time since hours for the female are not generally full-time and participation is not continuous; (iii) experience is not exogenous even in the case of exogenous schooling.

Consider first construction of the experience profile of an individual woman. This profile is computed by allocating the total lifetime hours of labour supply calculated above to specific calendar years. For the survey period this is straightforward since the appropriate allocation is specified by the data. For the post-survey period, total hours are allocated equally in all years up to refinement. Finally for the pre-survey period the total hours in each of the two intervals: school to first child; and first child to initial survey are allocated evenly within the interval. Clearly the latter imparts some error to the calculation but no obvious simple improvement is apparent.

Using the calculated experience series pooled current wage regressions for all women working in the survey period were computed. Because of the potential exogeneity of schooling and experience, both ordinary least squares (OLS) and instrumental variable (IV) methods were used. The possibility of sample selection bias was also investigated, but in common with Heckman (1974) we found no evidence of bias in the wage equation due to the selection on the basis of women working in the survey period.

The wife's lifetime earnings are given, as in the case of the males, by the discounted profile (A3). The computation is complicated because A_{it}

is no longer zero or full-time, but otherwise is analogous to the male case. The average wage rate, W_f, as defined in the text, follows from dividing these lifetime earnings by lifetime labour supply, L_f. The average value implies that female lifetime earnings are about 20% of male lifetime earnings. Given the female working hours estimate of 30% of female working life and a female wage rate below that of males, the constructed lifetime proxies appear to produce "reasonable" values and to be internally consistent.