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FEMALE LABOR SUPPLY BEHAVIOR OVER THE LIFE CYCLE: AN ECONOMETRIC STUDY

by

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Female Labor Supply Behavior Over the Life Cycle: An Econometric Study

A. Introduction:

We focus on two aspects of women's allocation of time over the life cycle: First, we attempt to explain the determinants of female labor supply at the various stages of the life cycle, and second, we explore the impact of women's market work on the inequality of the income distribution across families. Microeconomic data from the 1973 National Survey of Family Growth are employed in both analyses.

Our work builds on a fairly large body of literature, which, following Mincer's (1962) pioneering paper, recognizes that the allocation of women's time is a substantially more complex phenomenon than that of men's time. Some representative studies include: Cain (1966), Bowen and Finegan (1969), and Sweet (1973).

More recent studies inspired by the work of Becker (1965), have emphasized the notion of the value of the wife's time at home. This is determined by variables such as the woman's education, the number of children in the family and the husband's income. Then the decision as to whether or not to participate in the labor market depends on the difference between this shadow value of time and the wage the wife could command in the market. (Gronau (1974), Schultz (1975)). Some attempts have also been made to estimate the shadow and market wage equations jointly (Heckman (1974), Olsen (1977)).

Largely because of deficiencies in the data, most of these studies follow Mincer (1962) and focus on female labor force participation as observed at the time of the survey. In Mincer's words (p. 68):

> In a broad view, the quantity of labor supplied to the market by a wife is the fraction of her married life during which she participates in the labor force. Abstracting from the temporal distribution of labor force activities over a woman's life, this fraction could be translated into a probability of being in the labor force a given period of time for an individual, hence into a labor force rate for a large group of women.

In this paper, we are able to deal with the timing of labor supply and to analyze women's market work in several dimensions. In the theoretical model presented in Section B the family life cycle is divided into three periods: the pre-first birth interval, the child-rearing stage, and a final period which begins when all the children have reached school age. In Section C, using the retrospective information contained in our data, we examine the determinants of female work in each of these three periods. The empirical results suggest that, as expected, the impact of exogenous variables changes as the family moves from one stage of the life cyle to the next.

In Section D, we analyze the impact working wives have on the inequality of the income distribution across households. The first important attempt to understand this issue is due to Mincer (1974), who suggests that the work of married women will decrease income inequality. In recent years, the most rapid increases in female labor-force participation rates have occurred among women from high-income families. This has caused some speculation that women's market activity may accentuate inequality (Thurow (1975), cited in Danziger (1978)). Using data from the Current Population Surveys of March 1968 and March 1975, the latter author presents some evidence against this presumption. He finds that working wives improve the distribution by a small amount. Tests of significance are not presented, however.

Our data also indicate that the labor supply of married women tends to decrease inequality. We interpret this as reflecting, in part, a relatively low correlation between the husband's and wife's earnings. This effect is significant at the 10% level in periods 1 and 3, and insignificant in period 2 at all conventional levels.

B. Analytical Framework

This section presents a three-period theoretical model for the analysis of fertility behavior, female investment in human capital, labor supply and wages. This provides a general framework within which to analyze the interactions among these various aspects of family decision-making.

To reduce the problem to manageable proportions, several simplifying assumptions are made. We assume the life cycle can be divided into three periods: The first one covers the wife's life between age 6 and the time when her first child is born; then comes the child-rearing stage, and, finally, the post child-rearing interval, which starts when all of the children have reached school age and ends with the mother's retirement. This is certainly a crude specification, which abstracts from the problem of spacing and the timing of the first birth; however, it constitutes an improvement over the one-period static models encountered in the literature to date.[1]

The focal point of this model is the wife and the possible endogeneity of many of the husband's actions is neglected. We assume his earnings plus any other family income in each period is fixed and known (for period i we denote it by H_i).[2] This is perhaps not a very restrictive assumption, since husbands usually do work full-time, and exhibit little responsiveness to changes in their wives' wages [Ashenfelter and Heckman (1974)]. We also assume perfect capital markets in which unlimited lending and borrowing is possible.

The utility function is postulated to be inter-temporally separable. In the first period, utility is derived from the consumption of market goods (x_1) and the wife's leisure (ℓ_1). We assume the wife allocates her time among three competing activities: work in the labor force (L_1) which yields market goods; leisure, which directly yields utility and the production of human capital (k). We assume she has a natural endowment of human capital of K_o.[3] Then, she can increase this stock by spending time in education. The production of new capital follows the function $h(k, K_o)$, where the first and second partial derivatives are positive and negative, respectively. Also, the magnitude of $\partial h/\partial k$ varies positively with K_o. At the end of the first period, the wife's human capital stock is $K = K_o + h\ (k\ ,\ K_o)$. We assume the wife's average wage in the first period may be expressed as some increasing function of the initial and final stocks of human capital: $w_1(K)$.

In the second period, the household derives utility from market goods (x_2), the wife's leisure (ℓ_2) and child services. These absorb market goods (x_2^c) and the wife's time (t_2^c) according to a specified constant returns to scale production function, $f(x_2^c, K^\alpha t_2^c)$, where $\alpha \geq 0$. This function allows the possibility that the efficiency of the wife's time in the production of child services may be enhanced by her stock of human capital.

The wife may also spend some time working in the market in the second period. We denote this by L_2. The wage she can earn in this period is a function of her stock of human capital, K, and the amount of experience accumulated at the beginning of the period. Thus, her wage is $w_2(K, L_1)$, where the first partial derivatives are positive and the second ones are negative.[4] We further assume that the extent to which work experience raises the price of the wife's labor resources varies positively with the level of K. Thus, for very low levels of K, $\partial w_2/\partial L_1$ would be close to zero, whereas for high levels of K, $\partial w_2/\partial L_1$ would be very large.[5]

This assumption is based on Jusenius' (1977) observation that those occupations which require a low skill level offer little reward to experience and little penalty to discontinuous labor-force participation. Thus, wages for occupations such as waitress, elevator operator or sales clerk are likely to be quite insensitive to variations in the employees' experience. On the other hand, those occupations such as University professor, doctor or lawyer which demand a high skill level are likely to require continuous maintenance and updating of knowledge and skills, to reward strongly those enriched by the experience and know how acquired through on the job training and to penalize similarly those whose skills have depreciated or suffered atrophy because of discontinuous labor force participation.

In the last period, the arguments of the utility function are leisure (ℓ_3) market goods (x_3) and child services. These are produced according to the constant returns to scale function $g(x_3,\ K^{\alpha}t_3^c)$. We assume that the following inequalities hold:

$$\frac{\partial f}{\partial K^{\alpha}t^{c}} > \frac{\partial g}{\partial K^{\alpha}t^{c}} \quad \text{for each level of } t^{c}$$

$$\frac{\partial f}{\partial x^{c}} < \frac{\partial g}{\partial x^{c}} \quad \text{for each level of } x^{c}$$

These inequalities say that an increase in the amount of time, in efficiency units, devoted to the production of child services in the second period raises output more than a similar increase in the third period, whereas the opposite is true for increases in the market goods input. This assumption is inspired by the well-known fact that the most important input that children demand when they are young is time, whereas they become increasingly more goods intensive as they grow up.

The amount of time the wife devotes to the labor market in the third period is denoted by L_3. The wage she obtains is assumed to be $w_3(K, L_1 + L_2)$. This function shares the characteristics described above for w_2.

We assume that w_3 is substantially larger than w_2, specifically, that $w_3 > (1+r)w_2 + L_3\frac{\partial w_3}{\partial L_2}$. Although this appears to be a strong assumption, it is not an implausible one. The relevant wage to the wife is that net of child care costs. While these are often negligible in the third period, they may be very large in the child-rearing stage. The upward long-term trend in wages lends some additional support to this assumption.

To conclude, we assume that all the conditions necessary to guarantee the negative definiteness of the bordered Hessian are satisfied. This involves, aside from the usual requirements that the second derivatives of the utility functions with respect to their arguments be negative, that diminishing returns be eventually encountered when the arguments of the w and h functions increase.

B.1. Mathematical Formulation

The model we have described can be formally written as follows:

Maximize $\quad U(x_1, \ell_1) + U(x_2, \ell_2, f(x_2^c, K^\alpha t_2^c)) + U(x_3, \ell_3, g(x_3^c, K^\alpha t_3^c))$

Subject to (i) $(1 + r)^2 px_1 + (1 + r)\, p(x_2 + x_2^c) + p(x_3 + x_3^c) =$

$$(1 + r)^2 L_1w_1 + (1 + r)\, L_2w_2 + L_3w_3 + (1 + r)^2 H_1 + (1 + r)H_2 + H_3$$

$$\text{(ii)}\ \ell_1 + k + L_1 = 1$$

$$\ell_2 + t_2^c + L_2 = 1$$

$$\ell_3 + t_3^c + L_3 = 1$$

$$\text{(iii)}\ L_1 \geq 0$$

$$L_2 \geq 0$$

$$L_3 \geq 0$$

where: $w_1 = w_1(K)$

$$w_2 = w_2(K, L_1)$$

$$w_3 = w_3(K, L_1 + L_2)$$

$$K = K_o + h(k, K_o)$$

B.2. Implications of the Model.

B.2.(a) The Optimal Level of Human Capital Accumulation.

As shown in the Appendix, part A, the first-order condition for k, the time allocated to the production of human capital is the following:

$$(1)\qquad \frac{\partial U}{\partial f}\,\frac{\partial f}{\partial K^\alpha t_2^c}\,\alpha K^{\alpha-1}\,\frac{\partial h}{\partial k}\,t_2^c + \frac{\partial U}{\partial g}\,\frac{\partial g}{\partial K^\alpha t_3^c}\,\alpha K^{\alpha-1}\,\frac{\partial h}{\partial k}\,t_3^c$$

$$-\lambda_1 + \lambda_4[(1 + r)^2 L_1 \frac{\partial w_1}{\partial K}\,\frac{\partial K}{\partial k} + (1 + r)L_2\,\frac{\partial w_2}{\partial K}\,\frac{\partial K}{\partial k} + L_3\,\frac{\partial w_3}{\partial K}\,\frac{\partial K}{\partial k}] = 0\,,$$

where λ_1 is the opportunity cost of the time employed in the production of K and λ_4 is the marginal utility of market goods.

Equation (1) says that k should be chosen so as to equalize the marginal costs associated with an additional unit of capital, λ_1, with the incremental returns. These are represented by the first two and the last terms. The former indicate the marginal benefits of investment in human capital in the production of child services, which work through the enhanced productivity of the wife's time in that activity. The latter indicates the increase in market goods the household can command throughout the life cycle due to the positive impact of K on the wife's wage in each period, weighted by the marginal utility of market goods. Thus, the optimal k must be such that these costs and benefits are balanced in the margin.

Equation (1) predicts that women with a high human capital endowment will invest heavily in their education, because all the terms which measure the benefits associated with such investment are larger the bigger K_o is.

Another implication of equation (1) is that the wife's optimal level of investment in human capital is a function of the extent to which this capital is utilized in the various stages of the life-cycle. Taking first the case in which $\alpha = 0$, we see from (1) that the larger the proportion of time the wife spends in the labor market rather than on children or consuming leisure, the greater becomes the last term which measures the benefits from investment in human capital; thus the larger becomes the optimal level of accumulation, <u>ceteris paribus</u>.

The same conclusion would follow if α were positive but very small.

If increases in K raise the productivity of the wife's time in the child-rearing activity, then it can easily be seen that the optimal k will be larger than in the case in which α is zero, for given paths of the other endogenous variables. This is shown in the Appendix, Section B. If this case is a realistic one, the college education acquired by many women who then become full-time mothers and housewives does not appear irrational.

This analysis has some bearing on the problem of determinism in the human capital models encountered in the literature. As Lydall (1976) remarks, referring to these models:

> The only reason for differences in lifetime earnings is differences in 'ability', which affect both the earnings of those who have no human capital and the rate of return of those who have such capital. Paradoxically, therefore, a theory which purports to be 'economic' rather than sociological leads inexorably to the conclusion that the really significant differences in earnings, i.e. differences in lifetime earnings, are not the result of 'choice' but are entirely a reflection of differences in exogenously given 'abilities'.

In our model (assuming α is zero or close to zero), if we compare two women with the same ability, one who plans to devote a substantial proportion of her life to rearing children, and one who intends to spend most of her time actively participating in the labor force, the latter will find it optimal to invest more in human capital in the first period, and will hence command a higher wage. Thus it is not only ability that matters; there is some room for personal choice. The effect this has on the interpretation of the empirical results is discussed in Section C.

B.2.(b) The Optimal Level of Labor Supply

(i) The Participation Decision

In this section, we focus our attention on the dichotomous variables related to the wife's decision in each period as to whether to participate in the labor market or not.

As can be seen from the Appendix, Section A, the conditions which must be satisfied for an optimal level of L_1, L_2 and L_3, respectively, are the following:

$$(2) \qquad \lambda_1 - \lambda_4 \left[(1+r)^2 w_1 + (1+r)L_2 \frac{\partial w_2}{\partial L_1} + L_3 \frac{\partial w_3}{\partial L_1}\right] \geq 0$$

$$(3) \qquad \lambda_2 - \lambda_4 \left[(1+r)w_2 + L_3 \frac{\partial w_3}{\partial L_2}\right] \geq 0$$

$$(4) \qquad \lambda_3 - \lambda_4 w_3 \geq 0 .$$

Let us consider equation (2). As stated before, λ_1 represents the opportunity cost of the wife's time in the first period. This can be measured in terms of the marginal utility of leisure or the value of an extra unit of time spent investing in human capital. The second term measures what we might call "the value of the wife's working." This is equal to the value, at the end of the third period, of the wife's wage in the first stage, plus the increase in future earnings caused by the additional experience accumulated, all of this weighed by the marginal utility of market goods. If the shadow wage exceeds the "value of working," the wife will not participate in the labor force in the first period. Otherwise, she will choose a level of labor supply such that (2) holds as an equality.

A similar interpretation can be given to equations (3) and (4). These conditions appear to be more general than those found in the literature. They suggest, for example, that a woman may work in the labor market in the second period even if her current wage is small compared to the shadow price of her time at home, due to the presence of small children, if the increase in future earnings that she would otherwise sacrifice is sufficiently large. This, in turn, is higher the larger the wife's human capital stock and the larger her labor supply in the third period.

(ii) The Impact of Changes in K_o

A change in K_o induces the usual income and substitution effects in each period. If K_o increases, for example, the former would induce the wife to supply less labor. It can be seen in equations (2), (3) and (4) that, given diminishing marginal utility of goods, λ_4 would fall, thereby decreasing the benefits from participating in the labor force. A substitution effect also arises, as can be seen from the above-mentioned equations, since a higher K_o leads to an increase i wages and also to an increase in the value of acquiring additional experience.

In our model, a change in K_o affects not only the benefits from working but also the costs. In the first period, an increase in K_o implies that the returns from investing in additional human capital become larger. In the second and thir periods, the costs increase because as the capital stock rises, the wife becomes more efficient in the production of child services. This latter result may be referred to as a "child effect".

Due to the influence of these opposing effects, the outcome remains ambiguous *a priori*.

(iii) The Impact of Changes in Exogenous Income.

We briefly consider here the impact of changes in the husband's earnings or other family income on the wife's labor supply. It is clear that changes in this "outside " income cause a pure income effect, so that if it increases, for example, the wife's labor supply will diminish, everything else being held constant.

This unambiguous effect can be seen from equations (2), (3) and (4). A rise in exogenous income increases the cost of working, since the value of the wife's non-market time rises as more complementary goods become available to the household. Thus, λ_1, λ_2 and λ_3 rise. Further, the value of working declines, since λ_4 decreases in the presence of diminishing marginal utility of income. Since perfect capital markets have been assumed, changes in H_1, H_2 and H_3 play a parallel role.

Thus , we expect a negative sign on the coefficient of exogenous income in the equations explaining female labor supply.

(iv) Relationship between L_2 and L_3.

In Section C of the Appendix, we show that, assuming an interior solution for L_2 and L_3, the wife will devote a smaller fraction of her time to market activity in the second period than in the post child-rearing stage.

B.3. Summary of Conclusions

The major implications of this model are the following:

(1) Women with a large human capital endowment will invest more time in the acquisition of formal education in the first period than their more poorly-endowed counterparts. This result follows from the fact that the benefits derived from the acquisition of human capital, namely, an increased efficiency in the production of child services and in the performance of market activity, vary directly with the level of the original endowment.

(2) The wife's optimal level of human capital accumulation is a function of the extent to which this capital is utilized throughout the life cycle. If α is small or zero, the larger the proportion of time she devotes to market activity rather than to children or leisure, the more she has to gain from investing in human capital.

(3) If increases in human capital augment the efficiency of time spent on children, the optimal level of investment in education will be larger than in the case in which α is zero, for given paths of the other endogenous variables.

(4) The traditional models in the literature suggest that the wife's labor force participation decision depends on whether her market wage exceeds the shadow price of her time. Our analysis implies that a woman may supply labor to the market in any given period

even if her current wage is smaller than the price of her time at home, if the increase in future earnings that she would otherwise forego is large enough.

(5) Since changes in the husband's earnings are associated with a pure income effect, an increase in these earnings will have an unambiguous negative impact on female labor supply in each period.

(6) Women tend to spend a larger proportion of their time in the labor market in the post child-rearing period than in the child-rearing stage. If we look at a cross-section, we expect to find a greater percentage of women working outside the home in the former than in the latter period.

C. The Determinants of Women's Time Allocation: An Econometric Model.

We now turn to the empirical counterpart of the model presented above. In this section we obtain quantitative measures for the influence of various factors on the household's fertility and on female labor supply behavior over the life cycle. First, we present our criteria for inclusion in the sample and the definitions of the variables; then we discuss the estimated model and empirical results.

C.1. Selection of Sample

In our analysis, we have restricted the sample in several ways: We have only considered women who were formally married, with at least one child and in the third stage of the life cycle at the time of the survey. Thus, all the respondents in our sample had completed the formation of their families and none of them had children under six years of age. Further, we eliminated all those cases in which the wife had been married more than once, as well as those in which twins or adopted children were reported. Cases in which the wife had raised the children of her husband from a previous marriage were also excluded. The sample size resulting was 1485.

C.2. Definitions of Variables

Female Labor Supply Variables: L1A, L1B, L2, L3

Since the richness of our data enables us to subdivide the first period into 2 parts, we do so in our econometric model. Period 1A begins when the woman reaches school age and ends with her marriage; period 1B covers the interval between marriage and first birth; period 2 corresponds to the child-rearing stage, as defined in Section B, and period 3 represents the post child-rearing interval. L1A, L1B, L2 and L3 indicate the proportion of time the wife worked in the market in the corresponding period. For example, if period 2 lasted 8 years,an the wife reports that she worked 2 years in that time interval, L2 would be 0.25.[7]

Fertility Variable: NUM

NUM represents the number of children born alive to the household. Abstracting from infant and child mortality considerations, this measure indicates complete family size for the respondents in our sample.

Husband's Permanent Income: PERMINC

In order to avoid the confounding effect of transitory income components, we use an instrumental-variable estimator as a proxy for the husband's permanent income. This is based on the equation on Table 1.

The endogenous variable is the husband's income as observed at the time of the survey. Some respondents reported an exact figure when asked about their spouse's earnings. Those who did not wish to do so were shown a card containing various income categories and asked to select the most appropriate one. For these latter cases, we follow Schultz (1969), who, instead of using the midpoint as the average income level in each closed income interval, employs the geometric mean, in accordance with the approximately log-normal distribution of income. For the open-end interval ($25,000 or more), we follow Miller's (1963) suggestions by fitting a Pareto curve to the data.[8]

Turning to the exogenous variables, the husband's education variable is measured in terms of years of regular schooling. The median income earned on his occupation is based on figures reported in the 1970 Census (U.S. Summary, part 1, p. 1-766). The experience variable is computed by subtracting 6 and the years of schooling from the husband's age at the survey date. The underlying assumption behind this procedure is that men work continuously after completing their education, a valid one in most cases. We also control for race and for residence in the South or outside a Standard Metropolitian Statistical Area. All the coefficients have the expected signs.

Following Willis (1973), we use the estimated coefficients to obtain the husband's predicted income at age 40. We divide this by 1,000 to obtain our variable, PERMINC, measured in thousands of dollars.

TABLE 1

Dependent Variable: Husband's Income as Observed at the Time of the Survey (Standard errors in parentheses)

Constant	-10195.0
	(2425.6)
Husband's Education	1014.0
	(87.239)
Median Income Earned in his Occupation	.68836
	(.10884)
Experience	447.62
	(160.05)
$(\text{Experience})^2$	- 6.2312
	(3.1745)
Non-white Race	- 2915.9
	(559.51)
Residence in South	- 863.75
	(442.36)
Residence outside SMSA	- 2116.7
	(468.65)
R^2	.2621
N	1485

Wife's Education: WEDUC, WED1

Because of the way the questionnaire was designed, we have two variables to represent the wife's education. WEDUC indicates the number of years of regular schooling completed by the wife. WED1 is a dummy variable which equals 1 if the wife had some other training such as technical education. These variables are treated as exogenous in the econometric model, due to data limitations.

Background Variables: SOUTHC, LIVPAR, SIBL1

SOUTHC is a dummy variable which equals 1 if the respondent lived in one of the southern states most of the time during her childhood and adolescence. LIVPAR is a dummy variable which takes the value 1 if at the age of 14 the respondent was not living with her own father and mother, due to death, separation or divorce. Finally, SIBL1 is the number of siblings in the woman's family plus 1, i.e., the total number of children in her home.

Religion Variables: RELED, CATH

RELED is a dummy variable which takes the value 1 to indicate that the wife received at least some of her education in a religious school. CATH equals 1 if she is Catholic.

Biological Variables: CONTR, SUBF

CONTR is a dummy variable which equals 1 if the respondent ever used the pill or IUD since the last pregnancy. SUBF equals 1 if the wife reports it would be difficult or impossible for her to have another child, provided she had not reached the age of menopause, and had not had an operation for contraceptive purposes.

Demographic Variables: RACE, AGE

RACE equals 1 to indicate that the respondent is non-white. AGE is a continuous variable which controls for the wife's age at the time of the survey.

C.3. Empirical Findings

Table 2 presents the reduced-form equations of our model, in which the labor supply and fertility variables are regressed against all the exogenous variables of the system. The equations for L1A, L1B, L2 and L3 are estimated using the Tobit procedure, since these dependent variables are truncated at 0 with many observations at that point. The equation for NUM is estimated by OLS. Our results are summarized below.

Husband's Permanent Income

Inspection of the first column of Table 2 indicates that while the husband's income has an insignificant effect on female labor supply prior to the birth of the first child, it has a strong negative impact on the wife's market work in periods 2 and 3.

Our results also indicate that the husband's permanent income exerts a significant negative influence on fertility. This finding has emerged in a number of other studies. In a review article, Birdsall (1977, p. 76) notes that "high fertility. . . exacerbates the inequality of income distribution among families. . . To the extent that there are social or economic restrictions on upward mobility, the relatively more rapid

TABLE 2: Reduced Form Equations
(Standard Errors in parentheses, elasticities in brackets)

	PERMINC	WEDUC	WED1	SOUTHC	LIVPAR	SIBL1	CATH	RELED	CONTR	SUBF	RACE	AGE	CONST	R^2	Percentage of Observations at Limit point
	.0008918	.003280	.009129	- .06053	.01508	- .0005344	.02907	.001229	- .003037	.01394	- .011 15	.005822	- .1361		22%
L1A	(.001575)	(.002721)	(.01414)	(.01152)	(.01164)	(.0007660)	(.01257)	(.01409)	(.01096)	(.01172)	(.01521)	(.001174)	(.05347)		
	[.0784]	[.262]													
	.0005050	.1552	.7331	- .08840	- .2825	- .01219	.3079	- .07924	.1367	.02703	- .05245	.03319	- .3626		42%
L1B	(.02409)	(.04213)	(.2102)	(.1752)	(.1799)	(.01242)	(.1902)	(.2120)	(.1664)	(.1779)	(.2366)	(.01801)	(.8235)		
	[.0127]	[3.55]													
	- .01001	.02739	.07814	.07589	.01786	- .0005727	.02121	.0003093	.07125	.06312	.1182	- .009543	.1008		46%
L2	(.003530)	(.006173)	(.03151)	(.02545)	(.02593)	(.001714)	(.02865)	(.03222)	(.02437)	(.02617)	(.03259)	(.002595)	(.1180)		
	[- .755]	[1.88]													
	- .01057	.02938	.1084	.07815	- .002262	.001500	.03843	- .0005863	.05328	.03946	.2027	- .01019	.5157		26%
L3	(.004725)	(.008133)	(.04230)	(.03421)	(.03469)	(.002166)	(.03800)	(.04258)	(.03275)	(.03505)	(.04454)	(.003480)	(.1584)		
	[- .256]	[.647]													
	- .04630	- .08658	- .1549	- .1952	.01774	.01027	.2661	.1813	.02152	- .1987	.7803	.08072	1.587	.1957	
NUM	(.01079)	(.01841)	(.09733)	(.07828)	(.07950)	(.00[illegible]4)	(.08676)	(.09748)	(.07501)	(.08025)	(.1026)	(.008004)	(.3611)		
	[- .190]	[- .321]													

n = 1485

increase in numbers of the poor constitutes a drag on any income redistribution effort." A paper by Cramer (1974) using the Panel Study of Income Dynamics, presents some surprising evidence indicating that most low income families who fall into poverty by having large numbers of children do so voluntarily, not by having accidental births. Although on the surface this would seem to imply that no policy action is therefore required (since what really matters is utility, not income), this argument ignores the welfare of the children who did not choose to be born into a large, poor family. Thus, even if further research with other bodies of data were to confirm Cramer's results, a policy issue would remain.

Wife's Education

The wife's education variables have insignificant coefficients in the L1A equation, reflecting the fact that at least in part of this period, investment in formal education and labor force participation are competing activities. In all the other stages, WEDUC and WED1 have a strong, positive influence on female work. The magnitudes of both coefficients are somewhat smaller in the child-rearing period than in the final stage.[9] This may be due to the fact that the "child-effect" associated with changes in the wife's education is stronger in the former period. As noted in the previous section, this effect leads mothers to supply less labor as their human capital rises, because of the resulting increase in non-market productivity.

As expected, the wife's education has a significant negative impact on the number of children. Thus, WEDUC and WED1 strongly influence fertility and female labor supply in opposite directions.

A Comparison between the Elasticities of the Husband's Income and the Wife's Education

An examination of columns 1 and 2 of Table 2 reveals that in every equation, the elasticity associated with the wife's education is larger than that associated with the husband's income. To the extent that the former variable is a good proxy for her potential market wage, we may conclude that this is a more potent force than the husband's income in both the fertility and labor supply decisions.

This result must be qualified in two important respects. First, our measure of the husband's income reflects only permanent income. Thus, our coefficients do not capture possible "additional worker" effects.

Second, holding constant the husband's education, the omission of tastes from our equations leads to a positive and negative bias, respectively, in the coefficients associated with the wife's education in the labor supply and fertility equations (See Nerlove (1974)). As noted in this paper, the difference in educational attainment of husband and wife partly reflects the couple's preferences for children. Positive assortative mating by education in the marriage market leads men with very high education to marry women who also have high levels of schooling. Differences in tastes are not likely to be reflected in the educational attainment of men; however, it is very plausible that women with low tastes for market activities and high preferences for children will tend to seek smaller amounts of formal education, whereas those women with opposite preferences will tend to invest more in acquiring human capital. Given positive assortative mating by preferences for children, men with a given educational attainment with high preferences for children will tend to marry women with less schooling than the average associated with the level these men have achieved. If the husband's schooling level is associated primarily with an income effect, while his wife's eudcation is associated mostly with a substitution effect, it follows that the negative impact of her opportunity cost of time on fertility will be exaggerated, holding male educational attainment constant, if tastes are not explicitly included in the statistical analysis. A similar argument holds for the labor supply equations.

Background Variables

As expected, SOUTHC has a negative effect on L1A, indicating the smaller opportunities for market work in the period before marriage. Curiously, this variable has a significant positive effect on L2 and L3, and a negative impact on NUM.

LIVPAR has a weak, positive coefficient in the L1A equation. This probably reflects the fact that girls who are not brought up by both parents have greater financial needs in the pre-marriage stage.

SIBL1 has a significant positive effect on NUM: women who come from large families tend to form large families themselves.

Religion Variables

As expected, the coefficients of RELED and CATH have positive signs in the fertility equations. The positive sign of CATH on female work in the pre-first birth years is a puzzling result.

Biological Variables

Disappointingly, CONTR has an insignificant impact on our fertility variable.[10] It has, however, a strong positive effect on L2 and a weak, positive effect on L3, suggesting that women who have used modern contraceptives tend to work more in the market, perhaps because they have more liberal attitudes toward the role of women.

The subfecundity variable behaves as expected. It has a strong negative impact on fertility. It also has a strong positive effect on L2 and a weak positive influence on L3, reflecting the indirect impact through the number of children variable.

Demographic Variables

RACE has a strong positive impact on both fertility and labor supply in the second and third periods. Its influence on female work prior to the first birth is insignificant, however.

The age variable displays a puzzling pattern of coefficients. It has a positive influence on L1A and L1B, as expected, but a very strong negative impact on L2 and L3. Its effect on fertility is positive, as expected.

Timing of Female Labor Supply

The last column of Table 2 reports the percentage of observations on the labor supply variables at the truncation point. These figures can be translated into percentages representing the fraction of women who supplied some positive amount of labor to the market in each stage. These are 88%, 58%,54% and 74% , for periods 1A,1B, 2 and 3, respectively. The lowest percentage is associated with the child-rearing period ; the peak participation rate occurs in the pre-marriage stage. As our model predicts, the percentage is higher in the third than in the second period.

Another dimension of the timing of labor supply may be obtained by examining some cross-section information contained in our data. Each respondent was asked whether or not she had worked in the market in the past twelve months. The answers to this question indicate participation rates of 85%, 84%, 44% and 64%, in the corresponding periods. These statistics are rather different from the former ones, reflecting in part a cohort effect; however, the qualitative conclusions stated above remain unchanged.

Analysis of Residuals

Table 3 presents the simple correlations of the residuals from the reduced-form equations.

As expected, the correlations among the residuals from the labor supply equations are positive. This suggests that those unobserved variables which influence female work positively in one period, operate in the same way in the other stages. The correlation between the residuals of the L2 and L3 equations is particularly large in magnitude and strong in significance. This is probably due to the fact that many of the women who work in the child-rearing period do so precisely because they intend to engage in market activity in the third period, and, therefore, wish to maintain their skills and wage levels.

The residual of the fertility regression is negatively correlated with the residual of L1A, L1B and L2; the unobserved forces which tend to increase fertility also decrease female work in these periods. This negative sign disappears in the third stage; the relationship becomes positive, but insignificant at conventional levels. This lends some additional support to the findings for Québec reported in Lehrer (1978), which show that the negative association between fertility and female work vanishes when the children reach school age. This result probably reflects the fact that as children grow, they become more goods intensive; thus, the income effect associated with them increases in importance.

TABLE 3

Correlation Matrix of Residuals

(p-values in parentheses)*

	L1A	L1B	L2	L3	NUM
L1A	1.00	.1939	.0695	.0228	- .0778
		(.001)	(.007)	(.381)	(.003)
L1B		1.00	.0269	.0174	- .0526
			(.300)	(.503)	(.043)
L2			1.00	.5591	- .0336
				(.001)	(.196)
L3				1.00	.0228
					(.381)
NUM					1.00

*A p-value indicates the probability of obtaining a sample value as extreme as that actually observed, assuming the null hypothesis (coefficient = 0) is true. The reported p-values are based on two-sided tests.

D. The Impact of Female Work on the Inequality of the Income Distribution.

D. 1. Analytical Model

This section presents a simple framework within which one can analyze the impact married women's market work has on the inequality of the income distribution across households.

Considering only income from employment, we can write:

(1) $Y_T = Y_M + Y_F$, where

$Y_T =$ total family earnings

$Y_M =$ husband's earnings

$Y_F =$ wife's earnings

Thus, the following equality holds:

(2) $$\frac{Y_T}{\bar{Y}_T} = \frac{\bar{Y}_M}{\bar{Y}_T}\frac{Y_M}{\bar{Y}_M} + \frac{\bar{Y}_F}{\bar{Y}_T}\frac{Y_F}{\bar{Y}_F}$$, or,

simplifying the notation:

(3) $$\frac{Y_T}{\bar{Y}_T} = \alpha\frac{Y_M}{\bar{Y}_M} + \beta\frac{Y_F}{\bar{Y}_F}$$

The coefficient of variation of family earnings can be written as the square root of var $\left(\frac{Y_T}{\bar{Y}_T}\right)$. The latter may be expressed as follows:

(4) $$\operatorname{var}\left(\frac{Y_T}{\bar{Y}_T}\right) = \operatorname{var}\left(\alpha\frac{Y_M}{\bar{Y}_M}\right) + \operatorname{var}\left(\beta\frac{Y_F}{\bar{Y}_F}\right) + 2\operatorname{cov}\left(\alpha\frac{Y_M}{\bar{Y}_M}, \beta\frac{Y_F}{\bar{Y}_F}\right)$$

After some manipulations, this may be rewritten as :

$$(5)\quad \mathrm{var}\left(\frac{Y_T}{\bar{Y}_T}\right) = \alpha^2\ \mathrm{var}\left(\frac{Y_M}{\bar{Y}_M}\right) + \beta^2\ \mathrm{var}\left(\frac{Y_F}{\bar{Y}_F}\right) + \frac{2}{\bar{Y}_T^2}\ \mathrm{cov}\ (Y_M, Y_F)$$

This equation says that, as one would expect, the smaller the variability of male earnings on the one hand and female earnings on the other, the more equal the distribution of family earnings will be. It also suggests that this variable will have a smaller dispersion the closer to zero, or the more negative, the covariance between husband's and wife's earnings. We examine below the factors which influence this covariance.

Assuming monotonicity, the sign of cov (Y_M, Y_F) is the same as that of cov $(\ln Y_M, \ln Y_F)$. We can express $\ln Y_F$ as $\ln w_F + \ln H_F$, where w_F is the wife's wage and H_F is the number of hours she works in the year under consideration. We do not decompose $\ln Y_F$, under the assumption that most husbands work full time. Thus

$$(6)\quad \mathrm{cov}\ (\ln Y_M, \ln Y_F) = E\ (\ln Y_M \ln w_F) + E\ (\ln Y_M \ln H_F) - E\ (\ln Y_M)\ E(\ln Y_F)$$

$$= \mathrm{cov}\ (\ln Y_M, \ln w_F) + \mathrm{cov}\ (\ln Y_M, \ln H_F)$$

It follows that the distribution of family earnings will tend to be more equally distributed than that of husband's earnings if:

(a) the (positive) association between husband's earnings and wife's wage is small. (A negative relationship is ruled out by the economic theory of marriage.)

(b) the association between husband's earnings and female labor supply is strongly negative.

The above decomposition of the covariance between the logs of husbands' and wives' earnings is useful because it calls attention on the role of the association between husbands' earnings and wives' wages on the one hand, and and that between husbands' earnings and female labor supply on the other. This approach, however, shares with Mincer's (1974) the problem that it cannot be empirically implemented, unless cases in which H_F is zero are excluded from the sample.

D. 2. Empirical Results.

In this section we present our empirical findings. In Section D. 3 we interpret these results within the context of our analytical model.

Table 4 presents the distribution of income according to ordinal groups.[11] Individuals are ordered from poor to rich, and then the income shares accruing to the various groups are computed. We follow Kuznets (1963, p. 31), who exploits the linearity of the graph of the cumulative number of units against their cumulative income on a double log scale for interpolation purposes. Happily, as comparison of columns 2 and 4 indicates, the Lorenz curves do not intersect in any of the three periods. In each case, the curve corresponding to the joint income of husband and wife reflects greater equality than the curve associated with the husband's earnings alone. Further, it can be observed that the improvement is substantially larger in periods 1B and 3 than in the second stage.

Table 5 reports the coefficients of variation, the standard deviations of the log of income and the Ginicoefficients for our two variables. These results confirm the conclusions indicated above.

In order to ascertain whether the improvements in the distribution are significant, we follow the work of Kakwani and Podder (1973), and Reynolds and Smolensky (1977). The former authors suggest the following functional form:

$$\eta = \pi e^{-\beta(1-\pi)},$$

where η is the cumulative proportion of income, and π is the cumulative proportion of families. Taking logs on both sides, this equation can be estimated by ordinary least squares. The first columns of Table 6 shows our results.

As Kakwani and Podder indicate, the Gini coefficient can then be computed in the following way:

$$\text{Gini Coefficient} = 1 - \frac{2(\beta-1)}{\beta^2} - \frac{2e^{-\beta}}{\beta^2}$$

The results of these calculations are shown on the last column of Table 6. In every case, these OLS Ginis are larger than the trapezoidal Ginis on Table 5.

TABLE 4

Distribution of Income by Ordinal Groups

Family Quintiles	Husband's Income: Share of Income	Husband's Income: Cumulative share of income	Husband's Income plus Wife's Income: Share of income	Husband's Income plus Wife's Income: Cumulative share of income
PERIOD 1B				
0-19%	4.75	4.75	5.87	5.87
20-39%	12.54	17.29	12.69	18.56
40-59%	18.19	35.48	18.41	36.97
60-79%	23.67	59.15	24.46	61.43
80-100%	40.85	100.00	38.57	100.00
PERIOD 2				
0-19%	5.54	5.54	6.26	6.26
20-39%	12.89	18.43	13.13	19.39
40-59%	17.92	36.35	17.71	37.10
60-79%	23.25	59.60	23.07	60.17
80-100%	40.40	100.00	39.83	100.00
PERIOD 3				
0-19%	5.49	5.49	6.86	6.86
20-39%	13.07	18.56	13.36	20.22
40-59%	17.48	36.04	17.53	37.75
60-79%	23.16	59.20	23.01	60.76
80-100%	40.80	100.00	39.24	100.00

TABLE 5

Inequality Measures: Coefficient of Variation,

Standard Deviation of the Log of Income and Gini Coefficient

	Coefficient of Variation	Standard deviation of the log of income	Gini Coefficient
PERIOD 1B			
Husband's income	.726	1.00	0.353
Husband's income plus wife's income	.635	0.780	0.326
PERIOD 2			
Husband's income	.704	0.973	0.344
Husband's income plus wife's income	.661	0.880	0.330
PERIOD 3			
Husband's income	.686	1.05	0.347
Husband's income plus wife's income	.620	0.837	0.319

Sample sizes:

Period 1B: 885
Period 2: 2,995
Period 3: 1,739

TABLE 6

Inequality Measure: OLS Gini

	$\hat{\beta}$	Standard Error	R^2	OLS Gini
PERIOD 1B				
Husband's income	1.80	.147	.944	.404
Husband's income plus wife's income	1.50	.0809	.974	.357
PERIOD 2				
Husband's income	1.64	.130	.947	.381
Husband's income plus wife's income	1.48	.0971	.963	.354
PERIOD 3				
Husband's income	1.67	.140	.940	.384
Husband' income plus wife's income	1.37	.0785	.971	.334

Sample size: 10 (for each period)

Our qualitative conclusions remain unchanged, however.

Reynolds and Smolensky suggest that in order to ascertain whether two Gini coefficients are significantly different, one can equivalently test the null hypothesis that the corresponding $\hat{\beta}$ coefficients are the same. The latter can easily be done by an F - test. Our results are reported below.

TABLE 7

F - Tests for Differences in $\hat{\beta}$ Coefficients

	F ratio
Period 1 B	3.29
Period 2	1.03
Period 3	3.52

The differences in periods 1B and 3 are significant at the 10% level; the difference observed in the second stage is insignificant at conventional levels.

D. 3. Interpretation of Findings

In order to explain the variability of family earnings, we have computed, for each period, the terms in equation (5), Section D. 1. The results are presented on Table 8. The last column of this table presents the simple correlation coefficient between husband's and wife's earnings.

Examination of Table 8 reveals two major facts. First, the covariance between husband's and wife's earnings is greatest in period 1B. The correlation coefficient is .3321, and significantly different from zero. The covariance is substantially smaller in magnitude in periods 2 and 3. The correlation coefficients in these cases are close to zero: 0.0397 and 0.0536, respectively. These results are consistent with what we would expect on the basis of our findings in Section C. As stated above, the correlation between husband's and wife's earnings is a function of the association between husband's

TABLE 8

Decomposition of the Squared Coefficient of Variation of Family Earnings

	$Var\left(\frac{Y_T}{\bar{Y}_T}\right)$	α^2	$Var\left(\frac{Y_M}{\bar{Y}_M}\right)$	β^2	$Var\left(\frac{Y_F}{\bar{Y}_F}\right)$	$\frac{2}{\bar{Y}_T^2}$	$(cov\ Y_M, Y_F)$	r
Period 1B	.403	.477	.527	.0955	.689	1.11 E-8	7.75E6	.332
		.252		.0658		.0860		
Period 2	.437	.763	.495	.0160	3.08	1.43 E-8	7.55E5	.0397
		.378		.0493		.0108		
Period 3	.385	.676	.470	.0315	1.68	8.35 E-9	1.67E6	.0536
		.318		.0530		.0139		

earnings and wife's wage on the one hand, and the association between husband's earnings and wife's labor supply on the other. Since the former essentially reflects the relationship between the spouses' productivity traits, we would not expect this to vary substantially over the life cycle. According to Table 2, however, the latter does vary significantly across the stages. While the coefficient of husband's earnings is insignificant in the female labor supply equation for period 1B, it is strongly negative in the equations for the subsequent stages. Thus, in the child-rearing and post child-rearing periods, the negative association between husband's income and wife's labor supply counteracts the positive relationship between their market productivities. The only effect in the pre-first birth interval, on the other hand, is the latter positive relationship.

The second important fact uncovered by Table 8 is that the inequality of wives' earnings varies greatly among the stages. It is lowest in period 1B, where the female participation rate is at its peak, and highest in period 2, where relatively few women work in the market. This is as we would expect. The greater the percentage of wives who participate in the labor force, the fewer observations we have with $Y_F = 0$, and hence, the less the inequality of female earnings.

The marked variation in married women's labor force participation rates over the life cycle, coupled with the increase in their husbands' earning power as they accumulate more experience, implies that α and β change substantially across the stages. This is shown on Table 9.

TABLE 9

The Life-Cycle Variation of Mean Incomes, α and β

	$\bar{Y}_T$	$\bar{Y}_M$	$\bar{Y}_F$	α	β
Period 1B	13,461	9,300	4,161	0.69	0.31
Period 2	11,817	10,320	1,496	0.87	0.13
Period 3	15,480	12,731	2,748	0.82	0.18

With the aid of Tables 8 and 9, we can explain why it is that while family earnings are substantially more equally distributed than husband's earnings in periods 1 and 3, there is only a small difference in period 2. An important reason is that the low level of the female labor force participation rate in the latter stage results in a high coefficient of variation of wife's earnings. Further, this low participation rate implies a large α. As can be seen from Table 8, these two forces contribute to the large magnitude of the coefficient of variation of family earnings. At the other extreme, in period 1B, the female participation rate is highest; this leads to a substantially lower inequality of female earnings, and a significantly smaller α. The resulting effects are strong enough to outweigh the impact of the positive covariance between husband's and wife's earnings.

The above ideas lead us to conclude that if female labor force participation rates continue their long-term upward trend, family earnings will become more equally distributed. As more women participate, (a) var $(Y_F/\bar{Y}_F)$ will fall; the inequality of married women's earnings will approach that of male earnings, and (b) the weights, α^2 and β^2 will tend to equality. It is true that as more women engage in market activity, the covariance between husband's and wife's earnings will increase (simply because there will be fewer women with zero earnings). But Table 8 suggests that this factor is likely to be less important than the previous ones. The relative weights of these opposing influences may be reversed, however, if the recent trend, according to which the greatest increases in female participation rates are occurring among women married to high-income husbands, accelerates in the future.

D.4. Concluding Remarks

A number of years ago, Lydall (1968, p.239) wrote: "wherever over the past half-century there have been significant long-term changes, the movement has been toward greater equality of earnings." Danziger's study and our own provide some evidence suggesting that the long-run upward trend in female labor force participation has not been, up to the present time, an exception to the rule.

The work presented here should be regarded as only a beginning. We have focused attention on only one measure, observed income at the time of the survey, and our results have shown that the contribution of wives tends to improve the distribution of this variable. But it is not obvious that the same would be true if we considered instead a broader measure of welfare. Kuznets' (1976) remarks are relevant:

> ...it is likely that in the poorer families (i.e., those in which the income of the husband does not meet the family's requirements) the greater the engagement of the wife in money or other types of income-earning activity limits the intrafamily services of making a home and providing training and guidance to the children, limits them more than in the case of the more affluent families. Thus, while the engagement of the wife in money-earning activities outside the family may narrow the differentials in family income shown in the conventional size distribution of income, the inclusion of the intrafamily activities of the wife in a wider income concept would tend to widen the differentials in the size distribution of this wider income total.

E. Summary

This paper indicates that the influence of exogenous variables on female labor supply varies among the life cycle stages. While the husband's income has no impact on the wife's market work in the pre-first birth interval, it has a significantly negative effect in the subsequent stages. With the exception of the pre-marriage period, in which investment in human capital and market work are competing activities, the wife's education is a potent force affecting labor supply. Out estimates suggest that this variable has the strongest positive influence prior to the birth of the first child, and the weakest in the second stage, when children are small. With some qualifications, our work suggests that the wife's education is a more important determinant of both market activity and fertility than the husband's income. Another implication of the analysis is that the relationship between fertility and female labor supply may change in sign across the stages.

Our inequality study suggests that family earnings are more equally distributed than husband's earnings. Thus, we may expect that, unless the correlation between husband's and wife's income increases dramatically, as the upward trend in female labor force participation rates continues to unfold in the coming years, the inequality of the income distribution across families will decrease, albeit by a small amount.

Appendix

Section A

We present below the Lagrangian function and first - order conditions associated with our model.

The Lagrangian function is the following:

$$\Phi = U(x_1, \ell_1) + U(x_2, \ell_2, f(x_2^c, K^\alpha t_2^c) + U(x_3, \ell_3, g(x_3^c, K^\alpha t_3^c)) + \lambda_1(1 - \ell_1 - k - L_1) + \lambda_2(1 - \ell_2 - t_2^c - L_2) + \lambda_3(1 - \ell_3 - t_c^3 - L_3) + \lambda_4[(1 + r)^2 L_1 w_1 + (1 + r) L_2 w_2 + L_3 w_3 + (1 + r)^2 H_1 + (1 + r) H_2 + H_3 - (1 + r)^2 px_1 - (1 + r)p(x_2 + x_c) - p(x_3 + x_c)] + \lambda_5 L_1 + \lambda_6 L_2 + \lambda_7 L_3$$

The first-order conditions are:

$$(1) \quad \Phi_{x_1} = U_{x_1} - \lambda_4(1 + r)^2 p = 0$$

$$(2) \quad \Phi_{\ell_1} = U_{\ell_1} - \lambda_1 = 0$$

$$(3) \quad \Phi_k = \frac{\partial U}{\partial f}\frac{\partial f}{\partial K^\alpha t_2^c} \alpha K^{\alpha-1} \frac{\partial h}{\partial k} t_2^c + \frac{\partial U}{\partial g}\frac{\partial g}{\partial K^\alpha t_3^c} \alpha K^{\alpha-1} \frac{\partial h}{\partial k} t_3^c - \lambda_1 + \lambda_4[(1 + r)^2 L_1 \frac{\partial w_1}{\partial K}\frac{\partial K}{\partial k} + (1 + r)L_2 \frac{\partial w_2}{\partial K}\frac{\partial K}{\partial k} + L_3 \frac{\partial w_3}{\partial K}\frac{\partial K}{\partial k}] = 0$$

$$(4) \quad \Phi_{L_1} = -\lambda_1 + \lambda_4 [(1 + r)^2 w_1 + (1 + r)L_2 \frac{\partial w_2}{\partial L_1} + L_3 \frac{\partial w_3}{\partial L_1}] + \lambda_5 = 0$$

$$(5) \quad \Phi_{x_2} = U_{x_2} - \lambda_4(1 + r)p = 0$$

$$(6) \quad \Phi_{x_2^c} = \frac{\partial U}{\partial f}\frac{\partial f}{\partial x_2^c} - \lambda_4(1 + r)p = 0$$

$$(7) \quad \Phi_{t_2^c} = \frac{\partial U}{\partial f}\frac{\partial f}{\partial K^\alpha t_2^c} K^\alpha - \lambda_2 = 0$$

(8) $\Phi_{\ell_2} = U_{\ell_2} - \lambda_2 = 0$

(9) $\Phi_{L_2} = -\lambda_2 + \lambda_4[(1 + r)w_2 + L_3 \dfrac{\partial w_3}{\partial L_2}] + \lambda_6 = 0$

(10) $\Phi_{x_3} = U_{x_3} - \lambda_4 p = 0$

(11) $\Phi_{x_3^c} = \dfrac{\partial U}{\partial g} \dfrac{\partial g}{\partial x_3^c} - \lambda_4 p = 0$

(12) $\Phi_{t_3^c} = \dfrac{\partial U}{\partial g} \dfrac{\partial g}{\partial K^{\alpha} t_3^c} K^{\alpha} - \lambda_3 = 0$

(13) $\Phi_{\ell_3} = U_{\ell_3} - \lambda_3 = 0$

(14) $\Phi_{L_3} = -\lambda_3 + \lambda_4 w_3 + \lambda_7 = 0$

(15) $L_1 \cdot \lambda_5 = 0$

(16) $L_2 \cdot \lambda_6 = 0$

(17) $L_3 \cdot \lambda_7 = 0$

Section B

In this section we prove that, for given paths of the other endogenous variables, the optimal level of k will be longer if α is zero.

With the help of equations (7) and (12) we can rewrite (3) as follows:

$$\frac{\lambda_2}{K}\alpha\frac{\partial h}{\partial k}t_2^c + \frac{\lambda_3}{K}\alpha\frac{\partial h}{\partial k}t_3^c + \lambda_4[(1+r)^2 L_1\frac{\partial w_1}{\partial K}\frac{\partial K}{\partial k} + (1+r)L_2\frac{\partial w_2}{\partial K}\frac{\partial K}{\partial k} + L_3\frac{\partial w_3}{\partial K}\frac{\partial K}{\partial k}] = \lambda_1$$

If α is zero, then we must have:

$$\lambda_4[(1+r)^2 L_1\frac{\partial w_1}{\partial K}\frac{\partial K}{\partial k} + (1+r)L_2\frac{\partial w_2}{\partial K}\frac{\partial K}{\partial k} + L_3\frac{\partial w_3}{\partial K}\frac{\partial K}{\partial k}] = \lambda_1$$

For given paths of the other choice variables, the k which satisfies the second equation must be smaller, since the $(\frac{\partial w}{\partial K})$'s and/or the $(\frac{\partial K}{\partial k})$'s must be larger in this case, and the second partial derivatives are negative.

Section C

We show here that, assuming an interior solution for the levels of labor supply in the second and third periods, L_2 will be smaller than L_3 in equilibrium.

Equations (7), (9), (12) and (14) imply the following equality:

$$\frac{\frac{\partial U}{\partial f}\,\frac{\partial f}{\partial K^{\alpha}\, t_2^c}\, K^{\alpha}}{(1+r)w_2 + L_3 \frac{\partial w_3}{\partial L_2}} = \frac{\frac{\partial U}{\partial g}\,\frac{\partial g}{\partial K^{\alpha}\, t_3^c}\, K^{\alpha}}{w_3}$$

Since, by assumption, $(1+r)w_2 + L_3 \frac{\partial w_3}{\partial L_2} < w_3$

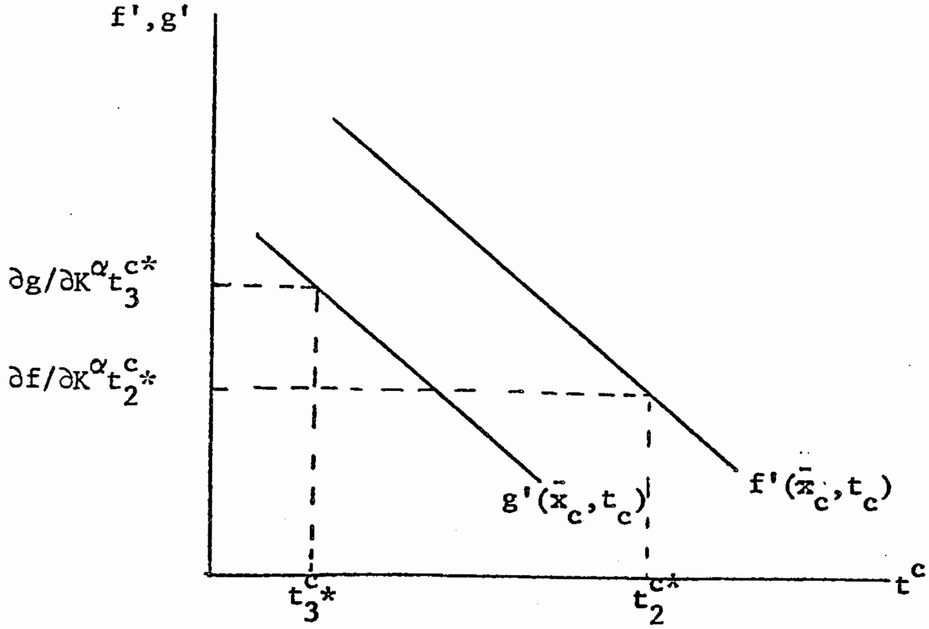
it follows that

$$\frac{\partial U}{\partial f}\,\frac{\partial f}{\partial K^{\alpha} t_2^c}\, K^{\alpha} < \frac{\partial U}{\partial g}\,\frac{\partial g}{\partial K^{\alpha}\, t_3^c}\, K^{\alpha}$$

If we restrict the form of the utility function in such a way that $\frac{\partial U}{\partial f} = \frac{\partial U}{\partial g}$, it must be the case that at the optimal t_2^c and t_3^c (denoted by $t_2^c{*}$, $t_3^c{*}$ the following holds:

$$\frac{\partial f}{\partial K^{\alpha} t_2^c{*}} < \frac{\partial g}{\partial K^{\alpha} t_3^c{*}}$$

But we have assumed that the marginal productivity of the wife's time in the second period is larger than in the third stage when applied to child services. This implies, as shown in the diagram below, that $t_2^c{*} > t_3^c{*}$.



A similar argument shows that $l_2^* > l_3^*$. Hence, it follows that $L_2^* < L_3^*$, that is, the wife supplies a smaller fraction of her time to the market in the child-rearing stage than in the final period.

Footnotes

1. For a study which specifically addresses the issues of the timing and spacing of children, see Nerlove - Razin (1979).
2. H_1 may be thought of as a weighted average of the husband's income in the period between marriage and first birth and some measure of the income of the wife's family in the period prior to marriage.
3. K_o includes variables such as the wife's native intelligence and ability, as well as the human capital she acquires at home in the pre-school years.
4. It would perhaps be more rigorous to use some average of L_1 and L_2, but this would complicate matters without altering the nature of the results.
5. A simple functional form which captures the idea and which could be used for empirical work is $\ln w(K,L) = aK+bL$ where $b = cK$, i.e., $\ln w(K,L) = aK + cKL$. This says that one element of the wage consists of a rental on the woman's capital stock, and the other part is a rental on her experience. But the latter is high or low depending on whether the capital stock is large or small.
6. For simplicity of notation we denote the three utility functions by U, although it is understood that this does not imply they are all the same.
7. Since the oldest woman in the survey was only 45 years of age, none of our respondents had completed the third period according to our definition. Thus, we use the post child-rearing stage to date.
8. The Pareto fit was found to be appropriate to our data, according to the criterion indicated in Miller (1963). This procedure led us to use $37,610 as the average income in the open end interval.
9. We do not compare elasticities <u>among</u> periods, because these are influenced by the fact that the average level of labor supply is smaller in periods 1B and 2 than in the first and last stages.

10. This may be due to the fact that CONTR, our proxy for contraceptive efficiency, captures two effects. First, women who use more modern contraceptive techniques have fewer children, ceteris paribus, because they have a smaller numer of unplanned pregnancies. But, second, it may also happen that those couples who have already had many children may seek better methods to avoid increasing their family size further. The insignificant result we obtained may be a result of the netting out of these two influences.

11. The husband's income variable is obtained as indicated in Section C.2. The variable representing the wife's income is computed in a similar manner. Extrapolation yielded $36,016 for the open-end interval.

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