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CHILD SPACING AND NUMBERS: AN EMPIRICAL ANALYSIS */

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1. Introduction

The impetus for our work on the timing and spacing of children has come from two surveys done by the University of Montreal in 1971 (Henripin and Lapierre-Adamcyk, 1974 and 1975). These surveys are unusual in that they contain questions on work experience before marriage, after marriage but before the birth of the first child, at the time of the interview, and the number of years worked after marriage. The questions enable one to reconstruct the proportion of a woman's time spent working during the child-rearing period. The usual questions are asked concerning socio-economic background and pregnancy history. Because the time of the mother spent with her children is thought to be an important determinant of child "quality" -- begging the question of just what that is -- and because female labor force participation is known to be greatly inhibited by the presence of young children, (Sweet, 1973) it was clear to us that we had an almost unique opportunity to explore the joint relationship among the timing and the spacing of children and female labor force participation.[1] In addition, the surveys contained an impressive set of questions related to the couple's preferences for children. These questions included not only the usual inquiry concerning the ideal number of children and the number of children wanted by the couple, but also more abstract questions concerning couples in general, and questions related to preferences about the timing and spacing of children. These questions enable us, additionally, to test an hypothesis advanced by Nerlove (1974) about the relative educational levels of husband and wife and the couple's underlying preference for children vis-a-vis wife's market activity.

In what follows, we develop and estimate a model which relates the timing and spacing of children to their number and a measure of the couple's preferences for children as well as other socio-economic variables. Despite the fact that the timing and spacing of children is an inherently dynamic phenomenon, we, nonetheless, work entirely within a static theoretical framework assuming utility maximization under perfect certainty, although at various points we consider what effects uncertain fecundity, uncertain contraception, and infant and child mortality might have. The point is that, while these phenomena are clearly of great importance in reality, they are not central to our development, which concentrates on a few of the more manageable relationships. A key feature of our analysis is the identification of average spacing between successive children as an indicator of child quality, greater spacing being associated with higher quality, ceteris paribus. This has already been noted informally by Ross (1973), who assumed that, at least up to a maximum of six years, longer intervals between births enhance child survival, health, intelligence and verbal ability. It is also consistent with Zajonc's (1976) explanation of the relationship between family configuration and intelligence, particularly of why earlier-born children have, on the average, higher intelligence than their later-born siblings, holding family size and socio-economic group constant. The identification of child-spacing with child-quality permits us to verify, among other things, some of the results of Becker and Tomes (1976) concerning the interaction between the qualtity and quality of children.

Our theory predicts the following principal propositions: (1) The higher the level of a mother's education, holding both the number of children and the average space between them constant, the greater the age of the mother at the first birth. (2) The proportion of a mother's time spent in market activity during the child rearing period is negatively related to the average interval between births. (3) Under mild restrictions, the proportion of a woman's time spent in market activity during the child-rearing period is negatively related to the household's permanent income. (4) Finally, if the income elasticity of child quality is,plausibly, positive, the average interval between births increases as household income increases, but the number of children may increase or decrease depending upon the elasticity of substitution between other goods on the one hand, and the number and quality of children on the other. When preferences are homothetic and the non-time (direct) costs of children are small in comparison with the cost in terms of mother's time, numbers decrease with an increase in household income.[2]

There is naturally a considerable gap between the variables and constructs of theory and what can be, let alone what is, measured in practice. Generally, it is only possible to interpret the father's educational attainment as a measure of the permanent income of the household, the mother's attainment as indicative of the opportunity costs of her time, and the location of the household, e.g., rural vs. urban, as reflecting differences in the direct costs of children. Unfortunately, even these rather standard interpretations are further complicated by the existence and possible effects of differences among couple's preferences for children. Given, however, the limitations of any empirical analysis, we, nonetheless find a substantial degree of confirmation for the theory in the Quebec surveys already mentioned, and in the 1965 and 1970 National Fertility Surveys for the United States: The average interval between births is negatively related to a mother's market activity during the child-rearing period. Numbers and average interval are also negatively related, although this might have been predicted on purely biological grounds. The father's education is negatively related to numbers, although often not strongly so, and positively associated with average interval (except for the older Québécoises). It is markedly and negatively associated with the wife's market activity during the child-rearing years. Our measure of the couple's preference for children, in general, vis-a-vis market activity and, therefore, other goods, is positively associated with numbers of children, holding both average interval and age at first birth constant.

The plan of the paper is as follows: First, following Razin (1979), we outline a theory of the timing and spacing of children and female labor force participation. A revision of Razin's earlier model is presented in Appendix A. Next, we give the details of four sets of empirical analyses based on the theoretical model: These are, respectively, for women in the Québec survey born before 1936 and for women born after 1936, and for the 1965 and 1970 U. S. National Fertility Surveys. For the Québec women, we have estimated equations for numbers of children (born alive and/or expected), average birth interval, age at first birth, and fraction of time the mother worked during the child-rearing period. Analyses for the NFS data are similar except that it was not possible to estimate the fraction of time mothers worked during the child-rearing period. The data available and the construction of the variables used is described in some detail. We also include a discussion of why the residual from the regression of a wife's formal schooling on that of her husband may partially measure the couple's preferences for children. Some tests of this theory using additional questions from the Québec survey are presented in Appendix B. Finally, we draw some conclusions with respect to directions for further research and the general implications of our analysis.

2. A Theory of the Timing and Spacing of Children and of Female Labor-Force Participation

In a recent paper, Razin (1979) has extended the work of Becker and

Lewis (1973) and of Becker and Tomes (1976) to model the interrelations of fertility and the timing and spacing of births with the labor-force participation of mothers. Although it is natural to consider this problem within the context of a model of dynamic optimization which would consider explicitly the sequential nature of decisions regarding contraceptive practice and the uncertainty of contraception and fecundity, such a general approach has not as yet proved to yield sufficiently unambiguous results to serve as a guide for empirical research. In this section we sketch these results, referring to Appendix A for mathematical details.

As is usual in investigations of this sort, we assume a single household utility function is maximized. Utility depends on the parents' consumption of goods and services other than children, Y, the number of children they have during their lifetime, N, and the average "quality" per child, Q. We do not allow for differences in quality among children, although one could easily modify the analysis along the lines of Becker and Tomes (1976, section 3) to allow for the effects of differences in child endowments.

In our basic formulation, "quality" per child is assumed to be proportional to the amount of time spent by the mother during the child-rearing period. Moreover, we assume that only time between the birth of a child and his next younger sibling counts in quality production, so that there are no economies of scale as there would obviously be if mother's time at home could produce quality in more than one child at a time.[3] If we denote the average interval between births by S and the proportion of time during the child-rearing period spent at home by ρ, then the production function for child quality is simply

$$(1) \qquad Q = \rho S.$$

We assume that S cannot be less than some minimal level σ, which may be in part biologically determined. ρ, of course, must lie between zero and one. Indeed, if quality is essential in the utility function, it is clear from (1) that $\rho = 0$ can never be optimal.

The analysis may be modified to permit a more general production function.

$$QN = F(\rho SN, KN),$$

where K represents inputs in the production of child quality other than mother's time, without any great modification in the implications of the model. In the present formulation, other inputs in the production of child quality are represented by an exogenously determined level per child, C, which represents a deduction from parents' consumption. We suppose that parents cannot affect this level per child nor the contribution of these inputs to child quality.

We divide the work career of the mother into three periods:

(1) The period after entry into the labor force, age A, but before the first birth, age T_F. This period may include education which enhances market productivity; the important thing is that work or other experience in this period enhances the wage of the mother in the post-child-rearing period.

(2) The child-rearing period, which extends from the age at first birth, T_F, until the age at last birth, T_L, plus the average interval between births. It is assumed that whatever interval between births is chosen is applied equally to all children including the last; however, the mother may work during all or part of the child-rearing period.

(3) The post-child-rearing period, in which the mother is assumed to return to market work until the age of retirement, R. Thus, this period extends from $T_L + S$ until R.

During the pre-first-birth period, A to T_F, we assume the mother can earn a market wage, W_F. This is assumed to depend on her education prior to A and other endowments, so that we treat it exogenously to the problem of optimal timing and spacing of children and market work. During the period of child-rearing, we assume the mother can command a market wage of W_M, which, for simplicity, we take to be entirely determined exogenously by the same factors which determine W_F. The wage in the post-child-rearing period is, however, assumed to vary endogenously with the amount of prior work experience a woman has had. Let $\theta = 1 - \rho$ be the proportion of time during the child-rearing period in which a mother engages in market work, then the total work experience to the end of the child-rearing period is

$$T_F - A + \theta NS ,$$

since T_F, T_L, N and S satisfy the identity

$$T_L = T_F + (N - 1)S \tag{2}$$

and the post-child-rearing period commences at $T_L + S$. Thus, we assume

$$W_L = \varphi(T_F - A + \theta NS), \ \varphi' > 0. \tag{3}$$

The wage rates W_F, W_M, and W_L should be thought of as the average values of the discounted wages per unit of time for the periods in question. We should also allow anticipated economic growth to affect these wages, which may then affect some of the effects of discounting. Otherwise, W_L will almost certainly be much lower than W_F.

Earnings of the father and other sources of income, I, are treated as exogenous.

Finally, we assume that no family will choose to have a child after the latest age, τ, at which a healthy child can be borne.

If the family's utility depends upon the number, N, and average quality per child, Q, and on the family's other consumption, Y, the family's problem is to choose Y, N, Q, ρ, S and either T_F or T_L so as to maximize U(Y, N, Q) subject to the budget constraint

$$(4) \qquad Y + CN = I + (T_L-(N-1)S-A)W_F + (1-\rho)NSW_M + (R-T_L-S)\varphi(T_L-(N-1)S-A + (1-\rho)NS),$$

for where substitutions have been made for Q from (1), T_F from (2), and for W_L from (3), and the inequality constraints

$$(5) \qquad \begin{cases} 0 < \rho \leq 1 \\ S \geq \sigma \\ A \leq T_F \leq T_L \leq \tau . \end{cases}$$

If "quality" is essential in U, it is clear that ρ cannot equal zero.

As shown in Appendix A, the first-order condition for the determination of T_L or T_F can be expressed as

$$(6) \qquad W_F + (R - T_L - S)\,\varphi' - W_L \geqq 0 ,$$

according as $T_L = \tau$ or $T_L < \tau$, or as

$$(6') \qquad W_F + (R - T_F - NS)\,\varphi' - W_L \leqq 0$$

according as $T_F = A$ or $A < T_F$. Because $T_L = T_F + (N-1)S$, (6) and 6') can be written as a single condition, but this does not mean that the choice of whether to treat T_L or T_F as endogenous is irrelevant. It will be irrelevant only as long as a strictly interior solution $A < T_F \leq T_L < \tau$ is obtained, but if not, then the fixing of T_F determines the position of the child-rearing period and somewhat different conclusions are obtained depending on whether T_F or T_L is at a boundary.

The meaning of the first order condition (6) or (6') is as follows: If the child-rearing period is determined as an interior solution, the gain to be realized by moving it forward one period, holding S and N constant, is W_F. This gain must be compared with the loss of one period's wages, W_L, in the post-child-rearing period net of the increase in the wage throughout the remaining post-child-rearing period, $(R - T_L - S)\varphi'$. As long as the solution is an interior one, the two must be equal; if, however, $T_L = \tau$, there is no possibility of a forward shift so W_F must exceed $W_L - (R - T_L - S)\varphi'$; if, on the other hand, $T_F = A$, there is no possibility to shift the child-rearing period to an earlier date, so $W_L - (R - T_L - S)\varphi'$ must exceed W_F.

If no economic growth were expected, it is clear that W_F would in general exceed W_L so that the child-rearing period would, in this model, be postponed to the last possible moment. On the other hand, if very substantial economic growth is expected, W_L may exceed W_F by more than $(R - T_L - S)\varphi'$, in which case the first birth will be timed as early as possible. Neither type of behavior is realistic in terms of our casual observation of what couples actually do. There are a number of reasons why the child-rearing period will not usually be pushed to either extreme and why, despite discounting of future earnings, the period will generally occur fairly early: First, fecundity is uncertain; couples do not know whether they will be able to have children, especially whether they will be able to have them near the end of the possible period. Moreover, child rearing may be more difficult and less enjoyable at an advanced age. In addition, if contraception is uncertain, couples may use a less-than-perfect method more-or-less continuously thus stretching out the entire child-rearing period and, on the average, having a first birth earlier than with perfect control. Finally, our assumption that the post-child-rearing period wage is simply a function of earlier experience omits the depreciation of skills and knowledge which may occur simply through the passage of time. If this is important, women with such skills may trade off experience early against a greater depreciation and bear children early in order to re-enter the labor force soon.

In any case, the implication which we wish to draw from the model is not that the child-rearing period will be pushed to one extreme or another, but rather that an exogenous increase in W_F, because for example the woman is more highly educated, should, in the absence of an important element of depreciation, lead to an increase in the age at first birth, ceteris paribus. An extremely important implication of the analysis, but one which cannot be tested with presently available data, is that the timing of births, and therefore other variables of the model, is likely to be very sensitive to expectations of future economic growth. It has long been argued that fertility depends on growth expectations, but to the best of our knowledge, the finding that timing and spacing may be even more sensitive is novel.

As we show in Appendix A, however, the fact that a strictly interior solution is implausible within the context of the model as stated, has importance for the further results obtained since these differ for the variables S and N depending upon whether T_F = A and T_L is variable (as a function of S and N once T_F is fixed) or whether $T_L = \tau$ and T_F is variable (of course, only as a function of N and S).

When T_F is fixed, the first-order condition for N derived in Appendix A is

(7) $$MRS_{NY} = U_N/_{U_Y} = S\ \{W_F - (1-\rho)W_M + (R - T_L - S)\rho\varphi'\} + C.$$

On the other hand, when T_L is fixed, the condition is

(7*) $$MRS_{NY} = S\{W_L - (1-\rho)W_M - (R - T_F - NS)\varphi'(1-\rho) + W_L\} + C.$$

Both are equalities on the assumption $N > 0$, a condition we have imposed in our empirical analyses below by considering only couples having at least one child. After some manipulation (7) and (7*) may be reduced to

(8) $$MRS_{NY} = S\{W_F + X\} + C, \ T_F \text{ fixed;}$$

and

(8*) $$MRS_{NY} = S\{W_L - (R - T_F - NS)\varphi' + X\} + C, \ T_L \text{ fixed,}$$

where $X = -(1-\rho)W_M + (R - T_F - NS)\varphi'\rho$.

The difference between the two is only in the substitution of $W_L - (R - T_F - NS)\varphi'$ for W_F in passing from (8) to (8*). (These two are equal if there is a strictly interior solution.) If T_F is fixed,it must be fixed by being at the boundary $T_F = A$. In this case, we know from (6') that

(9) $$W_F < W_L - (R - T_L - S)\varphi' .$$

On the other hand if T_L is fixed it must be at the boundary $T_L = \tau$ so that

(9*) $$W_F > W_L - (R - T_F - NS)\varphi' .$$

If T_F is fixed the decision as to how many children to have in relation to other consumption is governed by the level of human capital embodied in the woman by previous investment as indicated by W_F and the way it will depreciate over the child-rearing period as well as the exogenously given costs per child. On the other hand, if T_L is fixed the number of children in relation to other consumption is governed primarily by the wages the woman can expect to get in the last period and the exogenously given costs. As indicated, the former is more likely if expectations of growth in the general level of wages over time outweigh discounting.

The first-order conditions for S are, for T_F fixed,

$$(10) \qquad \rho MRS_{QY} = \frac{U_Q}{U_Y} = \{(N-1)W_F-(1-\rho)NW_M + W_L-(R-T_L-S)(1-\rho N)\varphi'\} \leqq 0,$$

according as $S = \sigma$ or $S > \sigma$, and, for T_L fixed,

$$(10^*) \qquad \rho MRS_{QY} = \rho\frac{U_Q}{Y_Y} \leqq \{W_L N-(1-\rho N)W_M-(R-T_F-NS)\varphi' N(1-\rho)\}$$

according as $S = \sigma$ or $S > \sigma$. After some manipulation we can reduce (10) and (10*) to

$$(11) \qquad \rho MRS_{QY} \leq NW_F + \{-W_F+W_L-(R-T_F-NS)\varphi'\} + X^*, \; T_F \text{ fixed},$$

and

$$(11^*) \qquad \rho MRS_{QY} \leq NW_F + N\{-W_F+W_L-(R-T_F-NS)\varphi'\} + X^*, \; T_L \text{ fixed},$$

where $X^* = -(1-\rho)NW_M + (R-T_F-NS)\rho N\varphi'$.

The conditions (11) and (11*) must be examined in relation to the first-order conditions for ρ: These are from Appendix A, the same for T_F fixed, or T_L fixed:

$$(12) \qquad MRS_{QY} \geqq (W_M + (R-T_F-NS)\varphi')N,$$

according as $\rho = 1$ or $0 < \rho < 1$.

The economic interpretation of (12) is as follows: A one-unit increase in ρ increases average child quality by S, if S is fixed, and this, in turn, increases utility in terms of other consumption by MRS_{QY}. The costs per child are wages per unit time during the child-rearing period plus the loss in wages per unit time in the post-child-rearing period due to the diminution in experience. The gain must be equal to the costs as long as it is possible to change ρ, but if the mother is already full time at home, $\rho = 1$, no further increase is possible and the strict inequality applies.

The economic interpretation of (11) or (11*) is a little more difficult: If T_F is fixed at A, then with N fixed, an increment of one unit in S increases the length of the child-rearing period, $T_L + S - T_F$, by N units. Since T_F is fixed this means T_L must increase by N units, reducing the post child-rearing period by N units and wages earned during that period by $W_L N$. On the other hand, $\theta = 1-\rho$ of the time during the longer child-rearing period is spent in market work, so this offsets the wage loss by $(1-\rho)NW_M$. If T_F is fixed no income change occurs in the pre-first birth interval, but the wife gains $(1-\rho)N$ units of experience in the child-rearing period, so her wage in the post child-rearing period is increased by $(R-T_F-NS)\varphi' N(1-\rho)$.

If T_L is fixed at τ a similar analysis can be made using (11*). The only difference between (11) and (11*) is that the factor N appears in front of the second expression in curly brackets, reflecting the fact that a one unit increase in S, holding N fixed, now <u>reduces</u> the age at first birth, T_F, by N units, a fact which is then reflected <u>throughout</u> the child-rearing period and so multiplying the wage effect $\{W_L - W_F - (R-T_F-NS)\varphi'\}$.

In Appendix A to this paper we demonstrate that an inverse relationship between S and ρ is plausible if not probable, irrespective of whether there are expectations of growth sufficient to offset discounting or not. Moreover, the presence of increasing returns to scale in the production of children does not greatly alter our conclusions, although the introduction of commodities other than mother's time in the production of child-quality may have quite complicated effects. If the expected growth in wages is high, the child-rearing period will be pushed to the earliest point. As we show in Appendix A if W_L is sufficiently greater than W_M the family will alter ρ and S in an inverse manner until either $\rho = 1$ with $S > \sigma$ or $S = \sigma$ with $\rho < 1$. Moreover, since the conditions under which mothers may be able to work during the child-rearing period are likely to be adverse, there are other reasons than wage growth to expect W_M to be substantially less than W_L. On the other hand, when discounting predominates, the child-rearing period will be pushed to the end of the period; in this case we show in Appendix A that the existence of an inverse relation between S and ρ depends upon how much W_F exceeds W_M in relation to how much W_F exceeds W_L and on the number of children. Again, if institutional factors make W_M low relative to both W_F and W_L, the plausibility of a negative association between S and ρ is enhanced. Even if not, however, simple numerical examples suffice to show that the result remains plausible. In general then, our theory predicts that there will be a tendency for much work during the child-rearing interval to be associated with short intervals between births, and vice versa.

One reason why women may work part-or full-time during child-rearing and nonetheless space births out with relatively long intervals between births is that experience accumulated during this period has a more pronounced effect on wages in the post-child-rearing period than experience in the more distant pre-child-rearing period.

The argument so far suggests that, in investigating the comparative statics of our model, we may concentrate on two distinct situations: (1) wage growth over time is anticipated to be substantial and more than offsets the effects of discounting; and (2) wage growth does not offset the effects of discounting. In the first case, the child-rearing period will be as early as possible and birth intervals will be greater for women who do not work at all than for women who work:

Case I: $T_F = A$ and $N > 0$;

$S = \sigma$ and $\rho < 1$ or $S > \sigma$ and $\rho = 1$.

In the second case, the child-rearing period will be as late as possible, but the same conditions with respect to S and ρ apply:

Case II: $T_L = \tau$ and $N > 0$;

$S = \sigma$ and $\rho < 1$ or $S > \sigma$ and $\rho = 1$.

When the mother is completely specialized at home during the child-rearing period, the problem is identical to the problem considered by Becker and Lewis (1973) and extended by Becker and Tomes (1976). Quality is measured by average birth interval since $\rho = 1$. To paraphrase their results: If the "true" income elasticity of S, holding constant the "shadow" prices of S and N, is positive and larger than the true income elasticity of N, then the observed income elasticity of S, holding market prices of S and N constant will also be positive if the elasticity of substitution between the other consumption and the number of children is greater than or equal to the elasticity of substitution between other consumption and the quality of children. Under these circumstances birth intervals will increase with income at the same time that the number of children increases proportionately less or declines.

When the birth interval is minimal, the mother may or may not work outside the home, but, in any case, quality is determined by ρ since $Q = \rho\sigma$. Again, the Becker-Lewis analysis applies with quality interpreted as the fraction of time the mother spends at home. If the elasticity of substitution of child numbers for other consumption is greater than or equal to the elasticity of substitution between child quality and other consumption, and if the true income elasticity of child quality is larger than that of child numbers, then ρ will increase with income while N will either increase less than proportionately or decrease.[4]

The effects of changes in C, the autonomous direct cost per child, is relatively easy to analyze since C enters only the budget constraint and the first-order conditions (8) and (8*), which refer to MRS_{NY}. From the latter we conclude that, if the MRS_{NY} is diminishing, a compensated increase in C must cause N to fall. Moreover, this effect will not be altered if N is a normal good and/or if C is a relatively small part of the costs of a child, i.e., if the time costs bulk relatively large.

What can be said about changes in the timing and spacing of births as a result of exogenous changes in the mother's wage? As usual, changes in wage rates have both an income and substitution effect, so we must consider compensated changes. We should also restrict ourselves to changes which leave the relation among W_F, W_M, and W_L unchanged, since, for example, an increase in W_F unaccompanied by corresponding increases in the levels of W_M and W_L might have the abrupt, discontinuous effects of shifting the whole child-rearing period from the beginning of the life cycle to its end. A compensated change in the level of a mother's wage increases the cost of her time both within the child-rearing period and at either end. In Case II, this should lead to a reduction in the number of children and either an increase in the amount worked outside the child-rearing period or a decrease in the interval between children, depending on whether $S = \sigma$ and $\rho < 1$ or $S > \sigma$ and $\rho = 1$. This is because an increase in mother's wage is equivalent to a fall in the price of other consumption and if both child numbers and child quality are equally good substitutes for other consumption, one would expect a substitution away from both. However, one must be careful because a change in numbers and a change in interval between births or proportion worked during the child-rearing period have different associated costs. In Case II, a reduction in numbers, ceteris paribus, augments income by SW_F, has no effect on income if the woman doesn't work during the child-rearing period, and augments income by $(R - T_L - S)S\varphi'$ during the post-child-rearing period. On the other hand, a reduction in interval, ceteris paribus, augments income by $(N-1)(R-T_L-S)\varphi'$ in the final period. In addition, there is a saving of C due to a reduction in numbers of children. A careful analysis would require differentiation of the appropriate first-order constraints and would show the final result to be ambiguous.

3. Empirical Results

In this section, we report the results of fitting relationships suggested by the foregoing model to data from the 1971 Étude de la Famille au Québec conducted by the University of Montreal and the 1965 and 1970 National Fertility Surveys for the United States. For the Québec survey we have reasonably detailed information on work history so it is possible to investigate whether or not the interval between births is negatively associated with both child numbers and the proportion of time the mother worked outside the home during the child-rearing period. Although numbers and spacing are strongly negatively associated for both the Québec and NFS surveys, unfortunately the expected negative association between birth interval and labor force participation during the child-rearing period emerges only for the subsample of Québec women born before 1936. The husband's education, which is the best indicator we have of the household's permanent income other than the mother's earnings, I, is negatively related to numbers of children in all samples, but sometimes positively related to birth interval and/or female labor force participation contrary to theoretical expectations. The mother's level of formal schooling is negatively related to birth interval and positively related to labor force participation, as theory predicts. A detailed examination of the results follows.

The Québec Survey

Two surveys were conducted in 1971 by the University of Montreal. One was addressed to married women born before 1936, the other to married women born after that date.

The information common to both of these surveys is as follows:*

(1) Background variables: the number of children in the wife's family, her father's level of schooling and occupation; husband's and wife's religion; national origin and birth dates; the area where the wife lived most of the time before marriage; wife's age on the date of marriage; income of the household other than husband's and wife's salaries.

(2) Other information about the husband: level of schooling; degree, if any; occupation at marriage and on the date of the survey; employment status on interview date; annual income at the time of the survey.

(3) Female education and labor-force participation: years of schooling; degree, if any; occupation, if any; whether she worked before marriage, between marriage and first birth, after the birth of her first child and at the time of the interview; total number of years she worked after marriage; annual salary at the time of the interview, if applicable.

(4) Pregnancy history: the date of birth of each child, sex, and, if applicable, the date of death of the child.

(5) Contraceptive history: the contraceptive technique used before each pregnancy, whether it was interrupted in order to conceive; the method used at the time of the survey; knowledge of the various contraceptive methods; attitudes toward the use of contraception.

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*We give a relatively detailed account of the content of these surveys since they are less well-known than the U. S. National Fertility Surveys.

(6) Subfecundity: respondents were asked whether it ever happened that they wished to have a child and they could not, or whether it took them longer than they would have wished to have a child. If they experienced temporary sterility, there is information on when it occurred, whether they sought medical advice, and whether they received treatment.

(7) Residence: the area where husband and wife lived most of the time after marriage.

(8) Preferences for children: the attitudinal questions included in the survey are the following:

   (a) The more children a couple has, the happier the couple is.
   (b) It is essential for the happiness of a couple to have children.
   (c) In most cases a couple that prefers not to have children is a selfish couple that does not have a sense of responsibility.
   (d) In general those couples having few children are the happiest ones.
   (e) Those couples who decide not to have children are generally very happy.
   (f) People have too many children, and those couples who desire not to have any, help society.

Respondents were expected to express agreement, disagreement, neutrality or uncertainty about these statements. The original questions in French are reproduced in the Appendix B.

The survey addressed to women born after 1936 includes all of the above information and also the following:

(1) Female labor-force participation: If the wife reported she was not working at the time of the interview, she was asked the reasons for this; whether she planned to work later on and at what age, and also, how much she thought she could make if she were to work full-time in the market. If the wife reported that she was working at the time of the interview, she was asked whether this was on a part-time or full-time basis. If the former, she was asked how much she thought she could command in the market if she were to work full-time. Working women were also asked the reasons for participation, the date until which they expected to work, and whether they anticipated stopping definitely or temporarily at that time. They were also asked about their child-care arrangements and the expense involved.

In addition, each woman interviewed was asked the dates of beginning and end of each job held both before and after marriage, as well as the occupation involved on each occasion.

(2) Expected fertility and spacing: number of additional children expected and, if applicable, the dates in which the wife expects to have them.

(3) Husband's background information: number of siblings in his family, his father's level of schooling and occupation.

(4) Wife's attitudes toward policy issues: whether she feels it would be particularly useful for the government to build more child-care institutions, to engage help to take care of children after school and during vacations.

(5) Wife's perception of adequacy of family income: whether she feels that the income of her family is sufficient to fulfill its needs, whether she feels it is greater or smaller than that of most of their friends.

(6) Aspirations for children's education: schooling level the wife wishes her sons and daughters to attain.

Of the total of 1,745 women interviewed we were able to obtain 404 to 464 (depending on the relation estimated) usable replies for women born in or after 1936 and 385 usable replies for women born before 1936. We call first sample Young Women, and the second sample Old Women, with apologies to our readers born before 1936. Because the information collected is different in the two samples and because the Old Women could plausibly be assumed to have completed or very nearly completed their child bearing by the date of the survey, the definitions of the endogenous variables of the empirical counterpart of the model differ somewhat. They are as follows:

NUM — Old Women: Number of children born alive. We excluded all cases in which no children were reported born alive.
Young Women: Number of children born alive to date of survey plus the additional number of children expected. We excluded all cases in which the woman had no children and did not expect to have any.

SPAC — Old Women: (Date of the last birth minus date of the first birth) / (NUM-1). If NUM = 1, we set SPAC = 45 - mother's age at first birth. Less than 6% of these women had no child or only one.

Young Women: (Date, actual or expected of the last birth, minus date, actual or expected, of the first birth) / (NUM-1). As before, if NUM = 1, we set SPAC = 45 - mother's age, actual or expected, at first birth. Since the survey only contains information on the expected dates of up to the next three births, if more than three additional children are expected we compute the average interval on the basis of children already born and the next three for whom expected dates of birth are reported.

AGEFB Old Women: Mother's age at first birth.

Young women: Mother's age at actual or expected first birth.

THETA Percentage of time in market work during the child-rearing period (CRP).

Old Women: (TOT - A - B)/CRP1, where

TOT = number of years worked after marriage,

A = interval between marriage and first birth,

B = period between the end of the CRP and the date of the survey or age 65, whichever is least,

CRP1 = date of the last birth plus 6, if NUM = 1, or plus SPAC, if NUM > 1, minus date of first birth.

A is subtracted only if the woman reports she worked between marriage and first birth.

B is not subtracted if the woman is not working at the time of the survey and is younger than 65.

Young Women: NUMER/CRP2, where

NUMER = the sum of all work segments during the CRP according to the detailed work history,

CRP2 = date of the last birth plus 6, if NUM = 1, or SPAC, if NUM > 1, minus the date of the first birth, if the date of the last birth plus 6 or SPAC is earlier than the date of the survey,

otherwise

= date of the survey minus the date of the first birth.

The exogenous or explanatory variables used in our study are defined as follows for both Old Women and Young Women:

HEDUC Husband's education measured as number of years of formal schooling.

WEDUC Wife's education measured as number of years of formal schooling.

RESID Residuals of regression of the wife's education on the husband's.*

WEXPPD Dummy variable which equals 1 if the wife had some work experience before marriage and is 0 otherwise.

WEXPAD Dummy variable which is 1 if the wife had some work experience between marriage and the birth of the first child and is 0 otherwise.

SUBFD Dummy variable which is 0 if the wife answered "no" to the question: "Has it ever happened to you that you wished to have a child and you could not, or that it took you longer than you would have wished to become pregnant?", and is 1 otherwise (i.e., if she answered "yes," "don't know," or if there was no response).

ACOND Dummy variable for attitudes toward contraception, based on the question: "Many couples try to avoid a pregnancy so as to have the number of children they wish, and have their children when they wish. Do you approve or disapprove of these couples?" ACOND is 1 if the answer is "Approve absolutely," and 0 otherwise.

ARAF Dummy variable which is 1 if the couple lived in a rural area most of the time after marriage, and 0 otherwise.

Our statistical results are summarized in a series of tables. All regressions have been run using ordinary least squares (OLS) despite the fact that our model is a simultaneous one involving four endogenous variables: NUM, SPAC, AGEFB, and THETA. Two-stage least-squares estimates were obtained but are wildly implausible, and we do not report them here for the Québec survey data. We do, however, report two-stage least-squares estimates in the next section describing the results obtained using data

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*See Appendix B for an explanation of this variable.

Table 1: OLS Regressions for NUM, Québec, 1971.
Figures in parentheses are standard errors. N = Sample size.

OLS Regression	Constant	SPAC	AGEFB	RESID	HEDUC	SUBFD	ARAF	ACOND	R^2
1. Old Women N = 385	9.8269 (0.5738)	- .2127 (0.02137)	- .1594 (0.01988)	- .1051 (0.04059)	- .07108 (0.02776)	- .5990 (0.2792)	1.0295 (0.2286)	- .8001 (0.2050)	0.455
Elasticity at mean.	- - -	- .2497	-1.0532	- - -	- .1621	- - -	- - -		
2. Young Women N - 464	3.9382 (0.3668)	- .1240 (0.01382)	0.01018 (0.1474)	- .1005 (0.02548)	- .03996 (0.01876)	- .04126 (0.1576)	0.5023 (0.1264)	- .4708 (0.1288)	0.259
Elasticity at mean.	- - -	- .1301	0.0730	- - -	- .1234	- - -	- - -	- - -	

from the 1965 and 1970 National Fertility Surveys. In this section we also report the result of fitting a TOBIT equation for THETA (Tobin, 1958). THETA can take on only values between 0 and 1; moreover; many women in the sample do not engage in market work during the child-rearing period at all. Consequently, the results of an OLS regression in which THETA is treated as dependent will, in general, be biased toward zero, apart from simultaneity considerations.

Table 1 reports results for OLS regressions explaining NUM for each of our two subsamples: Old Women and Young Women. SPAC is strongly negatively related to NUM for both groups, but the effect is about double for older women than for younger. This could very well reflect greater errors of measurement in this variable for the younger women, since SPAC had to be constructed for this group in part from expectations as to future births. AGEFB is strongly negatively related to NUM for the older women but hardly related at all to NUM for the younger women. As explained in Appendix B, RESID, the residual from the regression of a wife's level of formal schooling on that of her husband, should be at least partially an indicator of the couple's preference for the wife to engage in market work as against bearing and rearing children. RESID has the expected negative sign and is highly significant for both groups of women; moreover, it is of almost the same magnitude for both groups.[5] HEDUC, which is the best indicator of the household's permanent income available, has a negative and significant effect. While the coefficients are rather different for older and younger women, the elasticities are similar. SUBFD has the expected negative effect but it is significant only for the older women, perhaps because the younger perceive the problem less well or are more optimistic with respect to their future success in having children. ARAF, living in a rural area is positively related to NUM for both groups, as anticipated, but twice the magnitude for the older women as for the younger. ACOND, positive attitudes towards using contraceptives, is negatively related and significant. The magnitude of the coefficient is also about twice as high for the older women as compared to the younger.

Table 2 reports results for the OLS regression for SPAC. NUM is strongly negatively related to SPAC for both groups, but the magnitude of the effect is considerably greater for younger women. This suggests that the effect is neither largely biological nor due to contraceptive practice, since younger women presumably have and have had access to better contraceptive technology than their elders. THETA is negatively related to SPAC for the older women but not for younger women; in both cases the standard error of the coefficient is large. This is, indeed, a disappointing result for one of the strongest implications of our theoretical model is that labor force participation in the child-rearing period should be inversely correlated with the birth interval. It is possible, however, that these poor results are due to measurement errors in both THETA and SPAC, especially for the younger women. In the case of the young women, SPAC is estimated on the basis not only of actual births but expected ones and SPAC is also used to estimate the denominator of THETA, the child-rearing period for both older and younger women. For the younger women only the child-rearing period to the date of the survey or the date of the last birth plus SPAC and work during it is counted. HEDUC is negatively related to SPAC for Old Women and positively related for Young Women, but neither coefficient is larger than its standard error. WEDUC is negatively related to SPAC for both groups, as expected, but the standard errors are large

Table 2: OLS Regressions for SPAC, Québec, 1971.
Figures in parentheses are standard errors. N = Sample size.

OLS Regression	Constant	NUM	THETA	HEDUC	WEDUC	SUBFD	R^2
1. Old Women N = 385	8.8532 (0.8979)	- .8448 (0.09157)	-1.1205 (0.7970)	- .05357 (0.07078)	- .07035 (0.08970)	1.5362 (0.6095)	0,225
Elasticity at mean	- - -	- .7196	- .0300	- .1041	- .1319	- - -	
2. Young Women N - 404	8.0707 (0.9728)	-1.2628 (0.1389)	0.6695 (0.4211)	0.03318 (0.06677)	- .09041 (0.08478)	0.04594 (0.4947)	0.191
Elasticity at mean	- - -	-1.2186	0.03830	0.09424	0.2574	- - -	

relative to the coefficients. SUBFD is positively related for both groups, but significant only for the older women.

Table 3 reports results for the OLS regressions with AGEFB as dependent variable. NUM is negatively related for both groups, but the elasticity for younger women is markedly less. This finding, which accords with intuition, contrasts with the result in the corresponding regression for younger women for NUM but is consistent with that for the older women. Husband's education, HEDUC, and wife's education, WEDUC, are both positively related to AGEFB, as we would expect. The magnitude of the effect of HEDUC is about the same for both older and younger women, but the elasticity of WEDUC is about double that of the older women for the younger. It is interesting in this connection to note that the younger women are both better educated and marry younger than the older women surveyed. Work experience prior to marriage, WEXPPD, and between marriage and the birth of the first child is of major significance in explaining AGEFB for the younger women; both are positively related, as expected. But work experience between marriage and AGEFB is completely insignificant for the older women, which suggests that this group did not have access to, or did not use, effective contraceptive technology. SUBFD is positively related for both groups, as we would anticipate, the magnitude of the effect, however, being much less for the younger women.

Finally, Table 4 reports results for OLS regressions and TOBIT equations explaining THETA. Since THETA is a limited dependent variable, with many zero observations, the OLS results will, in general, be biased towards zero; thus we concentrate on the TOBIT equations. For the group of older women,

Table 3: OLS Regressions for AGEFB, Québec, 1971.
Fogures in parentheses are standard errors. N = Sample size.

OLS Regression	Constant	NUM	HEDUC	WEDUC	WEXPPD	WEXPAD	SUBFD	R^2
1. Old Women N = 385	26.8613 (0.9347)	- .6994 (0.1016)	0.1124 (0.06742)	0.04537 (0.05462)	1.1715 (0.8192)	- .07560 (0.8219)	1.1849 (0.6815)	0.165
Elasticity at mean	- - -	- .1057	0.03890	0.01287	- - -	- - -	- - -	
2. Young Women N = 404	20.8883 (0.7505)	- .4000 (0.1029)	0.1058 (0.04905)	0.06538 (0.06145)	1.6804 (0.3961)	0.8739 (0.3280)	0.6742 (0.3636)	0.204
Elasticity at mean	- - -	- .05783	0.04500	0.02789	= - -	- - -	- - -	

Table 4: OLS and TOBIT Equations for THETA, Québec, 1971
Figures in parentheses are standard errors. N = Sample size.

Equation	Constant	NUM	SPAC	HEDUC	WEDUC	WEXPPD	WEXPAD	ARAF	R^2
1. Old Women OLS Regression N = 385	0.1250 (0.06356)	- .009271 (0.006281)	- .001530 (0.003127)	- .009350 (0.004410)	0.005706 (0.005517)	0.07974 (0.03079)	0.2732 (0.04261)	- .04695 (0.03138)	0.166
Elasticity at mean	- - -	- .2945	- .05706	- .6776	0.3991	- - -	- - -	- - -	
TOBIT Equation N = 385	- .6410 (0.2623)	- .05532 (0.02998)	- .009530 (0.01251)	- .03076 (0.01685)	0.02136 (0.02038)	0.5381 (0.1494)	0.6218 (0.1374)	- .2237 (0.1304)	- - -
Elasticity at mean	- - -	-1.76	- .355	-2.23	1.49	- - -	- - -	- - -	
2. Young Women OLS Regression N = 404	- .2769 (0.1204)	0.02223 (0.01661)	0.008404 (0.005364)	- .01296 (0.007319)	0.03707 (0.008953)	0.01347 (0.05852)	0.4640 (0.04806)	- .003006 (0.04503)	0.262
Elasticity at mean	- - -	0.3750	0.1521	- .6431	1.8450	- - -	- - -	- - -	
TOBIT Equation N = 404	-2.1510 (0.4207)	0.03982 (0.06104)	0.01863 (0.01606)	- .04139 (0.02254)	0.1092 (0.02764)	0.3089 (0.2383)	1.2795 (0.1396)	- .09816 (0.1493)	- - -
Elasticity at mean	- - -	0.672	0.326	-2.05	5.44	- - -	- - -	- - -	

NUM and SPAC are both negatively related to THETA, as expected, although the standard error of the coefficient for SPAC exceeds the value of the coefficient. For the younger women, however, the results are disappointing: both NUM and SPAC are positively related to THETA, although not significantly so. HEDUC is strongly negatively related to THETA, as we expected with an elasticity which is roughly the same for both groups. WEDUC is also positively and significantly related, but magnitude of the elasticity is strikingly higher for the group of younger women. Work experience prior to marriage, WEXPPD, and between marriage and first birth, WEXPAD, are positively related to THETA for both groups of women. It is interesting, however, to note that the magnitudes and significance of the coefficients differ markedly: The effects for older women of each variable is about the same magnitude and level of significance, but for younger women the effect of work experience between marriage and first birth is much larger than that for older women and more than four times the effect of their own work experience prior to marriage. This presumably reflects, in part, the fact that the younger women in our sample have married earlier. Living in a rural area, ARAF has a small negative but insignificant effect on THETA for both groups.

Although we have attempted to estimate structural equations above, it is also possible to look at the reduced form equations in order to verify the principal relationships suggested by the theory. For example, if we argue that there is a negative association between the proportion of time spent working outside the home during the child-rearing period, THETA, and the average interval between children, SPAC, we would expect to find that the coefficients of the main exogenous variables differ in sign in the two reduced-form equations and that the residuals from the two equations are negatively correlated.

Reduced-form equations for NUM, SPAC, AGEFB, and THETA are presented in Tables 5-8. In Table 9 we present the simple correlations of the residuals from the OLS estimates of the reduced-form equations and, in the case, of THETA, the TOBIT estimates.

As expected, the coefficients of husband's education, for example, have opposite signs in the equation for NUM and those for SPAC and AGEFB. Unfortunately, this is not the case except for the old women as between the coefficient in either the OLS or TOBIT equation for THETA. Nor does the other important variable in the analysis, RESID, work especially well since it has a coefficient with the same sign in the equation for THETA and in the equation for SPAC. Moreover, the residuals from the two equations are negatively correlated as expected only for the old women. For the most part, however, these results are not significant and the conclusions obtained from the structural equations are supported.

Table 5.: Reduced Form OLS Regressions for NUM, Québec, 1971
Figures in parentheses are standard errors. N = Sample size.

OLS Regression	Constant	HEDUC	RESID	WEXPPD	WEXPAD	ACOND	SUBFD	ARAF	R^2
1. Old Women	5.6400	-0.09796	-0.1503	-0.2955	-0.7532	-0.7625	-1.3320	1.2651	0.2386
N = 333	(0.3955)	(0.03439)	(0.04974)	(0.2852)	(0.3824)	(0.2548)	(0.3624)	(0.2733)	
Elasticity at mean	- - -	-0.1993	- - -	- - -	- - -	- - -	- - -	- - -	
2. Young Women	4.0987	-0.03734	-0.1191	-0.07053	-0.2934	-0.4572	-0.1618	0.4388	0.1649
N = 385	(0.2810)	(0.02000)	(0.02866)	(0.1860)	(0.1559)	(0.1413)	(0.1725)	(0.1431)	
Elasticity at mean	- - -	-0.1055	- - -	- - -	- - -	- - -	- - -	- - -	

Table 6: Reduced Form OLS Regressions for SPAC, Québec, 1971.
Figures in parenthese are standard errors. N = Sample size.

OLS Regression	Constant	HEDUC	RESID	WEXPPD	WEXPAD	ACOND	SUBFD	ARAF	R^2
1. Old Women	2.6878	0.02234	0.003880	0.3796	0.1322	0.01421	0.1608	-0.2706	0.02814
N = 333	(0.3036)	(0.02640)	(0.03819)	(0.2189)	(0.2936)	(0.1956)	(0.2782)	(0.2098)	
Elasticity at mean	- - -	0.06299	- - -	- - -	- - -	- - -	- - -	- - -	
2. Young women	2.2072	0.01216	0.02246	0.2853	0.07917	0.005532	0.04778	-0.04065	0.01566
	(0.2848)	(0.02028)	(0.02905)	(0.1885)	(0.1580)	(0.1432)	(0.1748)	(0.1450)	
N = 385									
Elasticity at mean	- - -	0.04582	- - -	- - -	- - -	- - -	- - -	- - -	

TABLE 7: Reduced Form OLS Regressions for AGEFB, Québec, 1971.
Figures in parentheses are standard errors. N = Sample size.

OLS Regression	Constant	HEDUC	RESID	WEXPPD	WEXPAD	ACOND	SUBFD	ARAF	R^2
1. Old Women	23.3003	0.1592	0.2179	1.1991	-0.6108	-0.7519	1.9989	-0.4518	0.07716
	(0.8152)	(0.07089)	(0.1025)	(0.5878)	(0.7882)	(0.5252)	(0.7470)	(0.5634)	
N = 333									
Elasticity at mean	- - -	0.05543	- - -	- - -	- - -	- - -	- - -	- - -	
2. Young Women	19.4161	0.1749	0.1351	1.8464	1.03867	-0.3125	0.7851	0.2666	0.1764
	(0.6229)	(0.04435)	(0.06355)	(0.4124)	(0.3456)	(0.3133)	(0.3824)	(0.3172)	
N = 385									
Elasticity at mean	- - -	0.07411	- - -	- - -	- - -	- - -	- - -	- - -	

Table 8: Reduced Form OLS and TOBIT Equations for THETA, Québec, 1971. Figures in parentheses are standard errors. N = Sample size.

Equation	Constant	HEDUC	RESID	WEXPPD	WEXPAD	ACOND	SUBFD	ARAF	R^2
1. Old Women OLS Regression N = 333	0.08864 (0.04472)	-0.006664 (0.003889)	0.004391 (0.005625)	0.06422 (0.03225)	0.3045 (0.04324)	0.01949 (0.02882)	0.06284 (0.04098)	-0.04515 (0.03091)	0.1810
Elasticity at mean	- - -	-0.4969	- - -	- - -	- - -	- - -	- - -	- - -	
TOBIT equation N = 333	-0.8510 (0.1918)	-0.02012 (0.01478)	0.01916 (0.02091)	0.4178 (0.1522)	0.7241 (0.1413)	0.1641 (0.1144)	0.2887 (0.1490)	-0.2273 (0.1292)	- - -
Elasticity at mean	- - -	-1.50	- - -	- - -	- - -	- - -	- - -	- - -	
2. Young women OLS Regression N = 385	-0.004474 (0.08976)	0.003930 (0.006391)	0.03218 (0.009158)	0.02407 (0.05943)	0.4412 (0.04981)	0.02888 (0.04515)	0.005364 (0.05510)	0.006830 (0.04572)	0.2381
Elasticity at mean	- - -	0.2031	- - -	- - -	- - -	- - -	- - -	- - -	
TOBIT equation N = 385	-1.4635 (0.3198)	0.01098 (0.02030)	0.1001 (0.02886)	0.3358 (0.2433)	1.2540 (0.1439)	0.03725 (0.1496)	0.08065 (0.1652)	-0.09282 (0.1535)	- - -
Elasticity at mean	- - -	0.567	- - -	- - -	- - -	- - -	- - -	- - -	

Table 9: Correlation Matrix, Residuals from the OLS or TOBIT Reduced-Form Equations, Québec 1971
Figures in parentheses are p-values.

1. Old Women, N=333	NUM	SPAC	AGEFB	THETA (OLS)	THETA (TOBIT)
NUM	1.0000	-0.3249 (0.001)	-0.2921 (0.001)	-0.0467 (0.396)	0.0305 (0.579)
SPAC		1.0000	-0.1408 (0.010)	-0.0979 (0.074)	-0.0640 (0.244)
AGEFB			1.0000	-0.0007 (0.990)	-0.0005 (0.993)
THETA (OLS)				1.0000	- - -
THETA (TOBIT				- - -	1.0000

2. Young Women, N=385.

	NUM	SPAC	AGEFB	THETA (OLS)	THETA (TOBIT)
NUM	1.0000	-0.3131 (0.001)	-0.2253 (0.001)	0.0514 (0.315)	0.0331 (0.518)
SPAC		1.0000	0.0537 (0.293)	0.0638 (0.211)	0.0411 (0.421)
AGEFB			1.0000	-0.0032 (0.950)	-0.0021 (0.968)
THETA OLS)				1.0000	- - -
THETA (TOBIT)				- - -	1.0000

The 1965 and 1970 National Fertility Surveys

The 1965 and 1970 National Fertility Surveys are rather fully described in Ryder and Westoff (1971) and Westoff and Ryder (1977), respectively, both with respect to the sample design and characteristics and the questions asked. We refer the reader to these books for details. Suffice it to say here, however, that, although the sample sizes are much larger than for the

Québec surveys, we are lacking data on work history and also attitudes on preferences for children as measured by "other directed" questions. For three of the endogenous variables of our model, number of children, average interval between births, and age at first birth, we have been able to construct measures comparable to those for the Québec analysis. We have, as well, a considerably richer set of exogenous variables, reflecting in part the greater heterogeneity of conditions and the population in the United States as compared with the Province of Québec.

The endogenous variables are defined as follows:

NUM — For the NFS 1965, this variable is equal to the number of children born alive plus 1 if the wife was pregnant at the time of the survey. For the NFS 1970, we add to this the number of children the respondent expects to have in the future.

SPAC — This is calculated as follows:

If NUM $\geq$ 2, SPAC = $\dfrac{\text{date of last birth - date of first birth}}{\text{NUM - 1}}$.

If NUM = 1 and the wife expects to have no additional children, then SPAC = 45 - mother's age at first birth.

If N = 0 the case is excluded from the sample.

AGEFB — Mother's age at first birth.

The exogenous variables are defined as follows:

HEDUC — Husband's education (years of schooling).

WEDUC — Wife's education (years of schooling).

RESID — Residuals from regression of wife's education on husband's education.* (For the NFS 1970, the square of the husband's education is also included.)

WEXPPD — A dummy variable which equals 1 if the wife had a full-time job before marriage and is 0 otherwise.

WEXPAD — A dummy variable which equals 1 if the wife had a job between marriage and first birth, zero otherwise.

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*See Appendix B for an explanation of this variable.

WORK	A dummy variable which equals 1 if the wife never worked in the market, and is 0 otherwise.
WKNOW	A dummy variable which takes the value 1 if the wife is participating in the labor market at the time of the survey and is 0 otherwise.

FMPR	A dummy variable which equals 1 if the wife went at any time to a family planning clinic and is 0 otherwise.
FECND1, FECND2	Dummy variables to indicate the couples fedundity. FECND1 is 1 if they are sterile and 0 otherwise. FECND2 is 1 if they are subfecund and 0 otherwise.
ACON	A dummy variable which takes the value 1 if the wife's attitudes toward contraception are liberal , and the value 0 otherwise.
RACE	A dummy variable which equals 1 if the respondent is black and is 0 otherwise.
NRACE	A dummy variable which equals 1 if the respondent lives in a black neighborhood and is 0 otherwise.
CATH	A dummy variable which equals 1 if the wife is Catholic and is 0 otherwise.
COMSIZ	A dummy variable which equals 1 if the couple lives in one of the 14 largest cities of the U. S. and is 0 otherwise.

The variables are not directly comparable with those considered for the Québec surveys and this gives rise to some apparently anomalous results and different interpretations.

Table 10 summarizes both OLS and 2SLS regressions with NUM as dependent. Considering the very large numbers of observations involved the OLS fits are extraordinarily good. SPAC has the expected sign in all equations. Its effect in the 2SLS equation except old women, 1970, is much larger, however, than either of the OLS regressions in which SPAC has a coefficient much more comparable in magnitude to the corresponding coefficients for Québec women. AGEFB is negatively related to NUM as it is for older Québec women. RESID has the expected negative sign for both the 1965 and 1970 Surveys and is of similar magnitude to the coefficient obtained for both older and younger women in Québec. HEDUC is negatively related to NUM with a coefficient comparable in magnitude to that found for both groups of Québécoises.[6] Perhaps the most unexpected results are the postive coefficient for FECND1 and FECND2. These variables refer to sterility from all causes including an operation of menopause and subfecundity due to age as well as other problems encountered in bearing children. 1433 respondents were reported as sterile and

Table 10: OLS and 2SLS Regressions for NUM, 1965 and 1970 National Fertility Surveys. Figures in parentheses are standard errors. N - sample size.

Regression	Constant	SPAC	AGEFB	RESID	HEDUC	FECND1	FECND2	ACOH	FMPR	CATH	RACE	NRACE	COMSIZ	R^2
1. 1965 NFS														
Old women N = 2293														
OLS	10.5581 (0.2050)	- .1774 (0.0060)	- .1322 (0.0078)	- .1239 (0.0158)	- .0852 (0.0089)	- .2267 (0.0861)	0.0096 (0.1038)	- .2737 (0.0903)	- - -	0.2784 (0.0926)	- - -	0.6150 (0.1342)	- .2385 (0.1293)	0.390
Elasticity	- - -	- .1799	- .5586	- - -	- .1644	- - -	- - -	- - -		- - -		- - -	- - -	
2SLS	11.7856 (4.2446)	- .7169 (0.1940)	- .0740 (0.2087)	- .1470 (0.1077)	- .0807 (0.0597)	0.4702 (0.3276)	0.8972 (0.4028)	- .4669 (0.2146)	- - -	- .2380 (0.3449)	- - -	0.9079 (0.3109)	0.2780 (0.4084)	- - -
Elasticity	- - -	- .7272	- .3127	- - -	- .1556	- - -	- - -	- - -		- - -		- - -	- - -	
Young women N = 2142														
OLS	8.6089 (0.2309)	- .1454 (0.0078)	- .0858 (0.0112)	- .0736 (0.0191)	- .0816 (0.0115)	0.2684 (0.0961)	0.0107 (0.1093)	- .1894 (0.0741)	- - -	0.6187 (0.0782)	- - -	0.5821 (0.1073)	- .1059 (0.1014)	0.249
Elasticity	- - -	- .0845	- .3131	- - -	- .1634	- - -	- - -	- - -		- - -		- - -	- - -	
2SLS	11.1226 (4.9393)	- .5585 (0.2674)	- .1686 (0.2572)	- .0261 (0.1366)	- .0420 (0.0970)	0.5451 (0.2011)	0.9789 (0.6822)	- .3691 (0.2300)	- - -	0.4009 (0.1719)	- - -	0.3094 (0.3908)	- .2239 (0.1940)	- - -
Elasticity	- - -	- .5665	- .7125	- - -	- .0810	- - -	- - -	- - -		- - -		- - -	- - -	
2. 1970 NFS														
Old women N = 699														
OLS	7.7500 (0.4463)	- .2732 (0.0291)	- .1296 (0.0187)	- .0669 (0.0352)	- .0297 (0.0230)	- - -	- - -	- - -	0.9168 (0.3564)	0.0934 (0.0325)	1.2456 (0.1992)	- - -	0.0209 (0.1459)	0.262
Elasticity	- - -	- .2565	- .7573	- - -	- .0883				- - -	- - -	- - -		- - -	
2SLS	6.2324 (2.6676)	- .0149 (0.4764)	- .1017 (0.0639)	- .0606 (0.0468)	- .0347 (0.0315)	- - -	- - -	- - -	0.9423 (0.3789)	0.1044 (0.0428)	1.4184 (0.3784)	- - -	- .0253 (0.1747)	- - -
Elasticity	- - -	- .0140	- .5943	- - -	- .1026				- - -	- - -	- - -		- - -	
Young women N = 3098														
OLS	6.5385 (0.2052)	- .2126 (0.0161)	- .0688 (0.0096)	- .0593 (0.0164)	- .0990 (0.0106)	- - -	- - -	- - -	0.0982 (0.0985)	0.0704 (0.0122)	0.7018 (0.0768)	- - -	- .1205 (0.0585)	0.186
Elasticity	- - -	- .1669	- .4066	- - -	- .3260				- - -	- - -	- - -		- - -	
2SLS	7.0492 (1.4205)	- .7656 (0.7622)	- .0024 (0.0671)	- .1130 (0.9598)	- .1254 (0.0291)	- - -	- - -	- - -	- .0379 (0.2421)	0.0321 (0.0514)	0.6356 (0.1526)	- - -	- .1109 (0.0762)	- - -
Elasticity	- - -	- .7187	- .0140	- - -	- .3724				- - -	- - -	- - -		- - -	

981 as subfecund in 1965 out of a total of 4609 respondents. Clearly, these variables bear little relation to SUBFD used in our analyses of the Québec data. There the question is specifically designed to uncover trouble in conceiving wanted children, whereas, in the NFS, sterility and/or subfecundity may be simply related to age or the desire not to bear more children. ACON, reflecting positive attitudes toward contraception, is negatively related to NUM in the 1965 NFS, but FMPR, which refers to visits to a family planning clinic, is positively related in the 1970 NFS, presumably reflecting a desire not to bear more children on the part of women for whom NUM is already high. CATH is much more strongly related to NUM in 1965 than in 1970, but is significant in both cases. RACE or NRACE is also strongly positively associated with NUM. The occupational dummies in the analysis of the 1965 NFS surprisingly suggest that, holding educational level fixed, those professional and managerial classifications have more children.

Table 11 summarizes the results for OLS and 2SLS regressions with SPAC as dependent. As before, FECND1 and FECND2 are not comparable to SUBFD in the analysis of the Québec data, but they do have similar large and significant positive effects. NUM, HEDUC, and WEDUC are all negatively related to SPAC, except for Old Women in 1970. This accords both with our expectations and the results obtained for both the older and younger Québécoises. On the whole the results are similar to those for the Québec survey and generally supportive of our theory.

Table 12 summarizes the results of OLS and 2SLS regressions with AGEFB as dependent. As expected and consistent with the results for the Québec survey, NUM is negatively related to AGEFB, and, except for the 1965 2SLS estimate, the

Table 11: OLS and 2SLS Regressions for SPAC, 1965 and 1970 National Fertility Surveys. Figures in parentheses are standard errors. N = sample size.

Regression	Constant	NUM	HEDUC	WEDUC	FECND1	FECND2	CATH	R^2
1. 1965 NFS								
Old Women								
N = 2293								
OLS	16.105	-1.3733	- .0264	- .2836	0.6888	1.2310	- .4828	0.242
	(0.6681)	(0.0526)	(0.0276)	(0.0472)	(0.2629)	(0.3156)	(0.2744)	
Elasticity	- - -	-1.3538	- .0501	- .5458	- - -	- - -	- - -	
2SLS	11.1824	- .8587	- .0068	- .1788	0.8895	1.4193	- .5860	- - -
	(2.4284)	(0.2853)	(0.0300)	(0.0747)	(0.2897)	(0.3381)	(0.2856)	
Elasticity	- - -	- .8465	- .0129	- .3441	- - -	- - -	- - -	
Young Women								
N = 2142								
OLS	9.9334	- .9448	- .0427	- .1061	0.9664	2.0143	- .0081	0.167
	(0.5965)	(0.0508)	(0.0336)	(0.0474)	(0.2470)	(0.2791)	(0.1988)	
Elasticity	- - -	-1.6248	- .1471	- .3643	- - -	- - -	- - -	
2SLS	8.9445	- .8161	- .0338	- .0899	0.9442	2.0586	- .0871	- - -
	(2.4784)	(0.3171)	(0.0400)	(0.0616)	(0.2532)	(0.2995)	(0.2768)	
Elasticity	- - -	- .8045	- .0643	-.1730	- - -	- - -	- - -	
2. 1970 NFS								
Old Women								
N = 699								
OLS	6.2140	- .3694	0.0047	- .1066	- - -	- - -	- .0268	0.104
	(0.4687)	(0.0421)	(0.0342)	(0.0431)			(0.0390)	
Elasticity	- - -	- .3935	0.0148	- .3421			- - -	
2SLS	6.0262	- .3375	0.0066	- .1027	- - -	- - -	- .0287	- - -
	(0.9484)	(0.1463)	(0.0352)	(0.0465)			(0.0399)	
Elasticity	- - -	- .3595	0.0209	- .0310			- - -	
Young Women								
N = 3098								
OLS	4.2707	- .2498	- .0056	- .0440	- - -	- - -	- .0368	0.060
	(0.1959)	(0.0186)	(0.0131)	(0.0167)			(0.0130)	
Elasticity	- - -	- .3181	- .0234	- .1829			- - -	
2SLS	5.2222	- .4091	- .0216	- .0624	- - -	- - -	- .0273	- - -
	(0.5703)	(0.0915)	(0.0160)	(0.0198)			(0.0142)	
Elasticity	- - -	- .4358	- .0683	- .2002			- - -	

Table 12: OLS and 2SLS Regressions for AGEFB 1965 and 1970 National Fertility Surveys. Figures in parentheses are standard errors. N = sample size.

Regression	Constant	NUM	HEDUC	WEDUC	WEXPPD	WEXPAD	WKNOW	WORK	FEDND1	FECND2	R^2
1. 1965 NFS Old Women N = 2293											
OLS	22.6980	- .5556	0.0089	0.3843	- - -	- - -	- .8633	0.1170	- .7829	0.2399	0.157
	(0.5907)	(0.0455)	(0.0237)	(0.0408)			(0.2270)	(0.2581)	(0.2248)	(0.2710)	
Elasticity	- - -	- .1315	0.0041	0.1775			- - -	- - -	- - -	- - -	
2SLS	22.2474	- .5298	0.0099	0.3840	- - -	- - -	- .8616	0.1344	- .7725	0.2497	- - -
	(3.0451)	(0.3473)	(0.0268)	(0.0754)			(0.2281)	(0.3482)	(0.2648)	(0.3008)	
Elasticity	- - -	- .1254	0.0045	0.1797			- - -	- - -	- - -	- - -	
Young Women N = 2142											
OLS	15.6234	- .2610	0.0922	0.4688	- - -	- - -	- .7734	0.4183	- .3909	0.2950	0.213
	(0.4471)	(0.0374)	(0.0250)	(0.0356)			(0.1569)	(0.1541)	(0.1848)	(0.2078)	
Elasticity	- - -	- .0716	0.0506	0.2568			- - -	- - -	- - -	- - -	
2SLS	10.8937	0.3436	0.1288	0.5428	- - -	- - -	- .6620	0.4778	- .4922	0.4685	- - -
	(1.4879)	(0.1846)	(0.0287)	(0.0437)			(0.1695)	(0.1642)	(0.1981)	(0.2261)	
Elasticity	- - -	0.0813	0.0588	1.0597			- - -	- - -	- - -	- - -	
2. 1970 NFS Old Women N = 699											
OLS	16.8210	- .2913	0.2034	0.2087	1.3020	1.8328	- - -	- - -	- - -	- - -	0.289
	(0.1238)	(0.0641)	(0.0517)	(0.0662)	(0.2880)	(0.2527)					
Elasticity	- - -	- .0498	0.1034	0.1076	- - -	- - -					
2SLS	13.0495	0.3324	0.2377	0.2802	1.4422	1.9568	- - -	- - -	- - -	- - -	- - -
	(1.6023)	(0.2421)	(0.0566)	(0.0754)	(0.3114)	(0.2733)					
Elasticity	- - -	0.0569	0.1208	0.1444	- - -	- - -					
Young Women N = 3098											
OLS	13.5012	- .2069	0.0671	0.5238	1.7232	0.3396	- - -	- - -	- - -	- - -	0.340
	(0.3201)	(0.0303)	(0.0214)	(0.0277)	(0.1038)	(0.0772)					
Elasticity	- - -	- .0350	0.0374	0.2894	- - -	- - -					
2SLS	15.5202	- .4889	0.0399	0.4929	1.6908	0.3207	- - -	- - -	- - -	- - -	- - -
	(0.8974)	(0.1421)	(0.0255)	(0.0319)	(0.1065)	(0.0788)					
Elasticity	- - -	- .0837	0.0203	0.2540	- - -						

the magnitudes of the coefficients and elasticities are comparable. HEDUC and WEDUC are both positively associated with AGEFB, but, whereas for the Québec survey husband's education was significant and wife's not, the situation is reversed for Old Women in the 1965 NFS. Work experience both before marriage and between marriage and first birth is significantly associated with a later age at marriage in the 1970 NFS, as it is in the Québec survey. In 1965, however, working at the time of the survey is associated with an earlier age at first birth. Curiously, if the wife never worked she is more likely to marry later, and sterility or subfecundity is associated with later marriage.

Tables 13-15 present the results for the reduced form equations. As before, we note that, for example, a negative association between NUM and SPAC is reflected in the fact that the coefficients of the exogenous variables generally have opposite signs in the respective equations. Table 16 shows the correlations between the residuals from each pair of regressions. The residuals, with few exceptions, show significant negative associations, tending to support the negative relation expected between NUM and SPAC. On the other hand, there is no such consistency in the results for NUM and AGEFB or for SPAC and AGEFB.

Table 13: Reduced Form OLS Regressions for NUM 1965 and 1970 National Fertility Surveys. Figures in parentheses are standard errors. N = Sample size.

Regression	Constant	HEDUC	RESID	WEXPPD	WEXPAD	WKNOW	WORK	FECND1	FECND2	ACON	FMPR	CATH	RACE	NRACE	COMSIZ	R^2
1. 1965 NFS																
Old women N = 2293	7.4709	-0.1162	-0.1689			-0.0744	-0.6822	-0.3784	-0.3822	-0.1400		0.2904		0.6289	-0.5536	0.1233
Coefficient	(0.1590)	(0.0106)	(0.0186)			(0.1040)	(0.1172)	(0.1028)	(0.1237)	(0.1083)		(0.1107)		(0.1613)	(0.1544)	
Elasticity	- - -	-0.2242	0.0044			- - -	- - -	- - -	- - -	- - -		- - -		- - -	- - -	
Young women N = 2142	6.8428	-0.1138	-0.1120			-0.2260	-0.1072	0.2402	-0.3225	-0.1010		0.6574		0.7659	-0.0422	0.1082
Coefficient	(0.1494)	(0.0120)	(0.0200)			(0.0890)	(0.0871)	(0.1050)	(0.1177)	(0.0806)		(0.0847)		(0.1168)	(0.1106)	
Elasticity	- - -	0.2279	-0.0003			- - -	- - -	- - -	- - -	- - -		- - -		- - -	- - -	
2. 1970 NFS																
Old women N = 699	1.0479	-0.3689	0.6242	-0.1270	-0.2523						0.9543	0.1016	1.4244		-0.0738	0.1318
Coefficient	(2.0122)	(0.1740)	(0.3564)	(0.1665)	(0.1430)						(0.3865)	(0.0349)	(0.2162)		(0.1587)	
Elasticity	- - -	-1.0955	1.8027	- - -	- - -						- - -	- - -			- - -	
Young women N = 3098	-1.1052	-0.6393	1.0743	-0.0782	-0.1025						0.2495	0.0833	0.7783		-0.1646	0.1362
Coefficient	(0.8004)	(0.0710)	(0.1440)	(0.0609)	(0.0444)						(0.1010)	(0.0125)	(0.0793)		(0.0604)	
Elasticity	- - -	-2.1047	3.3944	- - -	- - -						- - -	- - -	- - -		- - -	

Table 14: Reduced Form OLS Regressions for SPAC 1965 and 1970 National Fertility Surveys. Figures in parentheses are standard errors. N = Sample size.

Regression	Constant	HEDUC	RESID	WEXPPD	WEXPAD	WKNOW	WORK	FECND1	FECND2	ACON	FMPR	CATH	RACE	NRACE	COMSIZ	R^2
1. 1965 NFS																
Old women N = 2293	3.9352	0.0220	-0.0184			-0.0625	1.0012	1.2369	1.7409	-0.4272		-0.8539		0.4285	1.0409	0.0238
Coefficient	(0.4611)	(0.0308)	(0.0538)			(0.3016)	(0.3398)	(0.2981)	(0.3587)	(0.3139)		(0.3211)		(0.4676)	(0.4478)	
Elasticity	- - -	0.0419	0.0005			- - -	- - -	- - -	- - -	- - -		- - -			- - -	
Young women N = 2142	2.8236	0.0272	0.0033			0.5451	0.0339	0.6904	2.2592	-0.3334		-0.6644		-0.5328	-0.2519	0.0378
Coefficient	(0.3819)	(0.0307)	(0.0512)			(0.2273)	(0.2227)	(0.2685)	(0.3008)	(0.2060)		(0.2165)		(0.2985)	(0.2826)	
Elasticity	- - -	0.0935	- - -			- - -	- - -	- - -	- - -	- - -		- - -		- - -		
2. 1970 NFS																
Old women N = 699	12.5322	0.6963	-1.4865	-0.4677	0.0693						-0.0378	-0.0564	-0.6779		0.1144	0.0335
Coefficient	(2.4170)	(0.2089)	(0.4281)	(0.2000)	(0.1718)						(0.4642)	(0.0419)	(0.2597)		(0.1906)	
Elasticity	- - -	2.2025	-4.5729								- - -	- - -	- - -		- - -	
Young women N = 3098	12.5322	0.2012	-0.4198	0.0553	0.0821						-0.3180	-0.0591	-0.1738		0.0489	0.0155
Coefficient	(2.4170)	(0.0770)	(0.1562)	(0.0661)	(0.0482)						(0.1096)	(0.0136)	(0.0861)		(0.0655)	
Elasticity		0.8435	-1.6889	- - -	- - -						- - -	- - -	- - -		- - -	

Table 15: Reduced Form OLS Regressions for AGEFB 1965 and 1970 National Fertility Surveys. Figures in parentheses are standard errors. N = Sample size.

Regression	Constant	HEDUC	RESID	WEXPPD	WEXPAD	WKNOW	WORK	FECND1	FECND2	ACON	FMPR	CATH	RACE	NRACE	COMSIZ	R^2
1. 1965 NFS																
Old women N = 2293	20.3329	0.2725	0.4942			-0.7400	0.4550	-0.4618	0.4373	-0.3177		0.9527		-0.1888	1.1492	0.1154
Coefficient	(0.3572)	(0.0238)	(0.0417)			(0.2336)	(0.2632)	(0.2309)	(0.2779)	(0.2432)		(0.2488)		(0.3622)	(0.3469)	
Elasticity	- - -	0.1244	-0.0030			- - -	- - -			- - -		- - -		- - -	- - -	
Young women N = 2142	16.7260	0.3370	0.5048			-0.6664	0.4427	-0.4435	0.2524	-0.4873		0.6814		-0.9144	-0.2356	0.2182
Coefficient	(0.2637)	(0.0212)	(0.0353)			(0.1569)	(0.1538)	(0.1854)	(0.2077)	(0.1422)		(0.1495)		(0.2061)	(0.1951)	
Elasticity	- - -	0.1851	0;0004			- - -	- - -	- - -	- - -	- - -		- - -		- - -		
2. 1970 NFS																
Old women N = 699	5.1435	-1.0052.	2.7652	1.4411	1.9623						-0.1039	0.1465	0.0720		0.5039	0.2849
Coefficient	(0.8688)	(0.3003)	(0.6276)	(0.2933)	(0.2519)						(0.6807)	(0.0614)	(0.3807)		(0.2795)	
Elasticity		-0.5108	1.3665	- - -	- - -						- - -	- - -	- - -		- - -	
Young women N = 3098	-1.9167	-1.2991	3.2697	1.8215	0.5305						-0.7636	0.0407	-0.7606		0.3012	0.2967
Coefficient	(1.4302)	(0.1268)	(0.2572)	(0.1089)	(0.0793)						(0.1805)	(0.0224)	(0.1418)		(0.1078)	
Elasticity	- - -	-0.7233	1.7470	- - -	- - -						- - -	- - -	- - -		- - -	

Table 16: Correlation Matrix, Residuals, Reduced Form Equations, 1965 and 1970 NFS. Figures in parentheses are p-values.

1. 1965 NFS Old Women, N=2293	NUM	SPAC	AGEFB
NUM	1.0000	-0.4787 (0.001)	-0.2493 (0.001)
SPAC		1.0000	-0.0959 (0.001)
AGEFB			1.0000
Young Women, N=2142			
NUM	1.0000	-0.3717 (0.001)	-0.1634 (0.001)
SPAC		1.0000	0.0226 (0.148)
AGEFB			1.0000
2. 1970 NFS Old Women, N=699			
NUM	1.0000	-0.2957 (0.001)	-0.2204 (0.001)
SPAC		1.0000	-0.0961 (0.006)
AGEFB			1.0000
Young Women, N=3098			
NUM	1.0000	-0.2156 (0.001)	-0.1739 (0.001)
SPAC		1.0000	-0.0475 (0.004)
AGEFB			1.0000

4. Conclusions and Directions for Further Research

In this paper we have developed a model relating the timing and spacing of births, numbers of children and female labor-force participation. Our model is a static one which permits us to interpret the quality dimension of children in terms of the spacing between children and/or the proportion of time the mother spends at home. Our model does not allow for increasing returns to scale in the production of child quality or the use of variable inputs other than mother's time. Generalization of the model in this direction and exploration of the empirical implications of increasing returns and particularly the use of the variable inputs in the production of child quality are of the first order of priority in further research.

variable inputs are of the first order of priority in further research.

Despite the unrealistic nature of our model several conclusions are well-supported by the data from the 1971 Québec survey and the 1965 and 1970 National Fertility Surveys. We find numbers and average birth intervals to be negatively related. The husband's educational level is negatively associated with the wife's market activity during the child-rearing period, when we are able to observe a measure of such activity. We do not, unfortunately, observe the strong inverse relation between birth intervals and female labor force participation we expected to find. In part, this may be due to difficulties of measurement. Some effort might well be devoted, therefore, to obtaining better retrospective labor-force participation histories from older women with completed families.

One rather remarkable theoretical finding is that the timing and spacing of children depends in an important way on people's expectations with respect to economic growth and the level of future wage rates in relation to present ones. Surely, the implications of this result for the interaction among demographic change, family decision-making, and economic growth deserve a great deal of further attention.

FOOTNOTES

1. Lapierre-Adamcyk (1977) has also addressed herself to this question. She shows that female labor force activity, although associated with reduced fertility, cannot be considered a "direct" cause of the reduction in the number of children. Moreoever, the duration of employment both before and after marriage is not associated with fertility aspirations. Labor force activity, especially after marriage, is, however, associated with reduced fertility. In her analysis, Lapierre-Adamcyk relies almost entirely on bivariate cross-tabulations. Our multivariate simultaneous-euqations model is intended to complement her research, and we have obtained rather different findings with respect to the relation between female labor force activity and fertility.

2. As Becker and Tomes (1976) show, however, the existence of sizeable innate quality endowments may result in a positive income elasticity of numbers at higher levels of income even though the elasticity is negative at lower levels.

3. Hill and Stafford (1971) have dealt with the question of how the amount of time spent on children by their parents varies with the age, spacing and number of children using data from the Michigan Survey Research Center, described in Morgan, et al. (1966). Their study suggests that the time spent on child care by parents increases with wider spacing. Lindert (1978 , Appendix C) summarizes existing studies of this problem and reports results using data from a Cornell University survey of 1296 Syracuse families in 1967-68. Lindert's results suggest that ". . .parental attention is a joint good shared by more than one sibling." The impact of an infant on total time spent on child care is greater than for an older child, and the impact of a child of a given age tends to be lower the more children there are. His results imply that parents' time is not a perfect "public good" but that there may be substantial increasing returns to scale.

4. Razin (1979) shows that if preferences are homothetic, numbers of children will unambiguously decrease with an increase in household income.

5. Since the residuals from the regression of a wife's education on that of her husband are simply linear combinations of the two education variables, a regression of a measure of fertility on the two education variables does not provide, of course, an independent test of the hypothesis, but rather a reinterpretation of the coefficients. It is only by comparing the residuals

with alternative indicators of underlying preferences, as we do in the Appendix, that an appropriate test may be obtained. The Québec data appear to be almost unique in supplying several different alternative indicators of preferences for children.

The relation between the two forms of equation is as follows: Let

$$NUM = a + b\ HEDUC + c\ WEDUC$$

be the regression of NUM on HEDUC and WEDUC separately. Let

$$RESID = WEDUC - \alpha - \beta\ HEDUC$$

be the residuals from the regression of the wife's education on that of her husband. Then

$$NUM = d + e\ HEDUC + f\ RESID$$

where $d = a + c\ \alpha$

$e = b + c\ \beta$

$f = c.$

Thus the negative coefficient of RESID may simply indicate the usual strong negative relation between a woman's level of formal schooling and the number of children she has.

6. In another OLS analysis, we found

$$NUM = \underset{(0.177)}{6.44} - \underset{(0.004)}{.132}\ SPAC - \underset{(0.007)}{.075}\ AGEFB$$

$$- \underset{(0.014)}{.069}\ RESID - \underset{(0.009)}{.087}\ HEDUC$$

$$- \underset{(0.076)}{.046}\ WFS1 - \underset{(0.066)}{.065}\ WFS2$$

$$- \underset{(0.086)}{.162}\ HFS1 - \underset{(0.073)}{.015}\ HFS2$$

$$+ \underset{(0.065)}{0.780}\ RACE + \underset{(0.048)}{0.197}\ AREA$$

$$- \underset{(0.052)}{.103}\ COMSIZ$$

$R^2 = 0.30$ 1970 NFS

$N = 4,274$

which differs from the reported mainly in the inclusion of variables for present and future schooling plans and AREA.

APPENDIX A: Details of the Model

Introduction

The variables of the basic model described in section 2 are as follows:

θ = the proportion of the mother's time spent working outside the home during the child-rearing period.

We will sometimes substitute

ρ = $1 - \theta$ = proportion of time at home during the child-rearing period for convenience in the mathematical derivations.

S = the average interval between births.

N = the number of children.

Y = parent's consumption of goods other than child numbers or quality.

T_F = the mother's age at first birth.

T_L = the mother's age at last birth.

= $T_F + (N-1)\,S$.

W_L = the mother's wage in the post-child-rearing period which we assume to be an increasing function of her experience up to T_L:

(1) $W_L = \varphi(T_F - A + \theta NS), \quad \varphi' > 0$,

where

A = the mother's age when she entered the labor force in the pre-child-rearing period.

A may include a period of education, as well as work. We take it as given in the theoretical analysis, although, to the extent it includes formal education and even work experience, it may reflect in part the woman's preferences for children, (and, therefore, her husband's as well, assuming assortative mating with respect to preferences). We assume she can earn this wage until retirement age, which we take as given.

R = age of retirement.

We take as given, as well, the following variables:

C = the non-time or direct costs per child, including expenditures on goods and services during the child-rearing period, which may also contribute to quality.

W_F = the mother's wage rate in the pre-first birth period.

To the extent that formal education influences W_F and to the extent that the formal education a woman seeks is influenced by her preferences for children, this variable may be jointly determined with child numbers, birth spacing, and labor force participation.

W_M = the mother's wage rate or potential wage rate during the child-rearing period.

One might also make this a function of experience in the period prior to the first birth, but the analysis is simplified without losing anything essential if we take it to be exogenous.

I = other income, including the father's wage income.

τ = the last age at which a healthy child can be born.

We assume there is a minimum interval between children.:

σ = the minimal average interval between children.

Utility is assumed to depend on the consumption of "other" goods, the number of children, N, and their total "quality." We measure average quality, say Q, by the simple relation

(2) $Q = \rho S$,

so that average quality per child only depends on how much time the mother spends at home during the child-rearing period. We assume that mother's time benefits the child only until his next sibling is born and that all children are treated equally including the last child. Relaxation of the strict conditions on the production function for quality of children, implicit in (2), to permit economies of scale and purchased inputs is discussed below. We do not, at this point, however, allow purchased inputs, or inputs other than mother's time, to enter the production process. Utility is thus

$$U(Y, N, \rho S),$$

which is to be maximized subject to the budget constraint

$$(3)\quad I + (T_L - (N-1)S - A)W_F + \theta SNW_M + (R-T_L-S)\varphi(T_L-(N-1)S-A+\theta NS) = Y + CN.$$

Note that the identity $T_L = T_F + (N-1)S$ has been used to substitute for T_F. This, in effect, makes T_L the choice variable. As we shall see, however, there is a slight asymmetry between making T_L or T_F the choice variable. The reasons for this as well as results obtained when T_F is endogenous are given below. The term

$$T_L - (N-1)S - A$$

represents the mother's time between entry into the labor force and age at first birth, the term

$$\theta SN$$

represents the amount of time the mother spends in the labor force during the child-rearing period. Finally,

$$R - T_L - S$$

is the amount of time spent in the labor force at the end of the child-rearing period if we assume that this period extends only to $T_L + S$. While unrealistic, this is clearly innocuous, since any fixed interval could be added without affecting the results. But note, the existence of such a period might well be cause for economies of scale, which we consider in the last section of this appendix. The function φ for the mother's wage post child-rearing is evaluated as the time worked before the first birth plus the amount of time worked during the child-rearing period.

The wage rates W_F, W_M and

$$W_L = \varphi(T_L - (N-1)\,S - A + \theta NS)$$

may be thought of as average values of the discounted wages per unit time for the periods in question. We should also allow anticipated economic growth to affect these wages as well, and thus offset some of the effects of discounting.

<u>The first-order conditions for T_L endogenous</u>

Form the Lagrangian expression

$$(4)\quad \mathcal{L} = U(Y, N, \rho S) + \lambda\{I + (T_L-(N-1)S-A)W_F + (1-\rho)SN\,W_M+(R-T_L-S)\ \varphi\ (T_L+S-\rho NS-A)-Y-CN\}.$$

Differentiating with respect to T_L, Y, N, ρ, S, and λ we obtain:

$$(5)\qquad \lambda.\{W_F + (R-T_L-S)\,\varphi'-W_L\} \geq 0,$$

according as $T_L = \tau$ or $T_L < \tau$.* Since, differentiating with respect to Y yields

$$(6)\qquad U_y - \lambda = 0,$$

λ, is the marginal utility of other consumption and must be positive. Therefore, the interpretation of (5) depends on whether a boundary condition is

*Note, we must also have $A + (N-1)S \leq T_L$ since $T_F \geq A$.

attained for the age at last birth: When the age at last birth is less than the latest age at which a healthy child can be born, the gain to be made by moving the child-rearing period forward by one unit, W_F, is just equal to the net loss in the post child-rearing period, which consists of one period's wages W_L less the amount gained over the whole post-child-rearing period by virtue of the additional experience prior to the first birth, $(R-T_L-S)\varphi'$. Clearly, when T_L is already at the maximum possible the gain must exceed the net loss (otherwise the family would have the incentive to shift the child-rearing period back).

Differentiating with respect to N:

$$(7) \quad U_N - \lambda\{SW_F - (1-\rho)SW_M + (R-T_L-S)\ \rho S\varphi' + C\} = 0,$$

if $N > 0$.* We do not consider the boundary solution $N = 0$. Since λ is the marginal utility of other consumption, condition (7) states that the marginal rate of substitution between children and other goods

$$MRS_{NY} = U_N / U_Y$$

equals the "price" of an additional child in terms of other goods as a numeraire. Holding the interval between children constant, this "price" consists of two parts: first, the direct, non-time costs of an additional child, C; second, the lost wage in the first pre-child-rearing period, SW_F, plus the reduction in wage in the post-child-rearing period due to reduced experience, $(R-T_L-S)\ \rho\ S\varphi'$, net of the additional wage earned during the longer child-rearing period, $(1-\rho)SW_M$. Note that with S fixed, a larger N implies a longer child-rearing period.

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*We must also have $N \leq \frac{T_L - A}{S} + 1$, which will normally hold for plausible values.

Differentiating with respect to ρ:

$$SU_Q - \lambda\{SNW_M + SN(R-T_L-S)\ \varphi'\} \gtreqless 0$$

according as $\rho = 1$, $0 < \rho < 1$, or $\rho = 0$, where U_Q is the marginal utility of "quality." This condition may be more readily interpreted by dividing through S and substituting $U_Y = \lambda$. Then

(8) $MRS_{QY} = U_{Q/U_Y} \geqq (W_M + (R - T_L - S)\ \varphi')N,$

according as $\rho = 1$, or $0 < \rho < 1$. That is, with an interior solution, an increase in the amount of time, holding the interval between children and the number of children fixed, amounts to an increase in child quality. This increase occurs at the expense of time which might be spent working in the child-rearing interval, NW_M, and at the expense of a higher wage in the post-child-rearing interval, $N(R - T_L - S)\varphi'$ due to lost experience. When the mother is full time at home, $\rho = 1$, quality cannot be increased, so that the marginal rate of substitution between quality of children and other goods must be greater than the cost of achieving such an increase through variation in ρ. On the other hand, when the mother works full time outside the home, the marginal rate of substitution between quality of children and other goods must be less than the opportunity cost. The boundary condition $\rho = 0$ is implausible if the couple has any children and quality is essential in the utility function.

Finally, differentiating with respect to S we obtain

$$\rho U_Q - \lambda\{(N-1)W_F - (1-\rho)NW_M + W_L - (R-T_L-S)(1-\rho N)\varphi'\} \leqq 0,$$

according as $S = \sigma$ or $S > \sigma$.*

(9) $MRS_{QY} = U_{Q/U_Y} \leqq \frac{1}{\rho}\{(N-1)W_F - (1-\rho)NW_M + W_L - (R-T_L-S)(1-\rho N)\varphi'\}$,

according as $S = \sigma$ or $S > \sigma$.*

The condition (9) may be interpreted as follows: Raising S when S is above the minimal interval σ will increase quality per child by ρ, since ρ is the fraction of that extra unit of time that will go into quality production. The extra quality, in turn, increases utility by ρMRS_{QY} in terms of other goods.

*We must also have $S \leq \frac{T_L - A}{N - 1}$.

The benefits of an increase in S must be compared with the costs. With N fixed, an increment of 1 unit in S increases the length of the child-rearing period $T_L + S - T_F$ by N units; when T_L is fixed this means T_F must fall by N-1 units, reducing the pre-first-birth interval by N-1 units and wages earned during that period by $(N-1)\ W_F$. On the other hand, $1 - S = \theta$ fraction of the time during the child-rearing period is spent in market work, so this offsets the wage loss by $(1-\rho)N\ W_M$. If T_L is fixed and the woman leaves the child-rearing period at $T_L + S$, an increase in S reduces wages in the post-child-rearing period by W_L. Prior to this time, she loses $1-\rho N$ units of experience so her wage in the post-child-rearing period is reduced by $(1 - \rho N)\ (R - T_L - S)\varphi'$. Clearly, when $S = \sigma$ is minimal, the costs of increasing S must exceed the gains.

Differentiating with respect to λ yields the constraint (3).

The first-order conditions for T_F endogenous

The Lagrangian expression is

$$(4^*)\quad \mathcal{L} = U(Y, N, \rho S) + \lambda\{I + (T_F - A)W_F + (1-\rho)SNW_M + (R - T_F - NS)\varphi(T_F + NS(1-\rho)-A) - Y - CN\} .$$

Differentiating with respect to T_F yields

$$(5^*)\qquad W_F + (R - T_F - NS)\varphi' - W_L \gtreqless 0$$

according as $T_L = \tau$, $A < T_F < \tau$, or $T_F = A$, since, as before, differentiating with respect to Y yields $U_Y = \lambda$, which must be positive. If we substitute T_L for T_F from the identity connecting them and N and S, exactly (5) is obtained from (5*).

Differentiating with respect to ρ and substituting $U_Y = \lambda$, we obtain

$$(8^*)\qquad MRS_{QY} = \frac{U_Q}{U_Y} \geqq (W_M + (R - T_F - NS)\varphi')N,$$

according as $\rho = 1$ or $0 < \rho < 1$. Equation (8*) is identical to (8) if we substitute T_L for T_F from $T_F = T_L - (N-1)S$.

Differentiating with respect to S, and substituting $\lambda = U_Y$, we obtain

$$(9^*)\qquad \rho MRS_{QY} = \rho\frac{U_Q}{U_Y} \leqq \{W_L N - (1-\rho N)W_M - (R-T_F-NS)\varphi' N(1-\rho)\}$$

according as $S = \sigma$ or $S > \sigma$. Even if we substitute for T_F, equation (9*) is not identical to (9). The two results are identical, however, if we have a strictly interior solution with respect to T_F and T_L, i.e., $A < T_F \leq T_L < \tau$, because then

$$W_F + (R - T_F - NS)\varphi' - W_L = 0 ,$$

and

$$W_F + (R - T_L - S)\varphi' - W_L = 0 .$$

When we have a strictly interior solution with respect to T_F and T_L, this determines a relation between W_F and W_L which then enables one to demonstrate the equivalence of (9) and (9*) for a strictly interior solution. When the solution is not a strictly interior one, however, the difference between the two first-order conditions arises because, once the couple decide to have one child, the decision as to whether or not to have another is governed by the magnitude of $W_L S$ rather than $W_F S$.

Differentiating with respect to N and substituting $\lambda = U_Y$ we obtain

$$(7^*) \qquad MRS_{NY} = \frac{U_N}{U_Y} = S\{-(1-\rho)W_M - (R - T_F - NS)\varphi'(1-\rho) + W_L\} + C,$$

for $N > 0$. (7*) differs from (7) by the appearance of W_F in (7) in place of $W_L - (R - T_F - NS)\varphi' = W_L - (R - T_L - S)\varphi'$. But, as can be seen from the first-order condition for T_L the two are equal for a strictly interior solution $A < T_F \leq T_L < \tau$. Again, we see the importance of the fact that as soon as the couple has their first child, T_F and hence, the positioning of the child-rearing period is fully determined.

Conditions for an inverse relationship between S and ρ.

One of the important conclusions we seek to establish in the body of our paper is an inverse relationship between S and ρ. That one of the two must be at a boundary provides us with a unique measure of child quality. We can then invoke the Becker-Lewis-Tomes analysis to deduce the remaining properties of the model. Unfortunately, the inverse relation of S and ρ can only be demonstrated to be plausible and does not unambiguously follow from the assumptions of our model.

Suppose that $S > \sigma$ and $\rho < 1$; then it is possible to decrease S and increase ρ so as to keep $Q = \rho S$ constant. Decreasing S by one period and increasing ρ by a compensating amount without changing the number of children must either raise the age at first birth or lower the age at last birth, or both, if we have a strictly interior solution: With N fixed, a decrease of one unit in S decreases the length of the child-rearing period, $T_L + S - T_F$, by N units and income earned during that period by NW_M. So, if $T_F = A$ is fixed, T_L decreases by N units increasing the post child-rearing period by N units and wages earned during that period by $W_L N$. The net effect of reducing the length of the child-rearing period by N units and decreasing the amount of time spent working is to reduce experience prior to the post child-rearing period and to offset the added income by $(R - T_F - NS)\varphi'N$. Clearly, there is no income in the pre child-rearing period and no change in this as long as $T_F = A$. On the other hand, when $T_L = \tau$ is fixed, T_F increases by N-1 units, so that income in the pre child-rearing period is increased by $(N-1)W_F$. Clearly, the income lost during the child-rearing period is the same, NW_M, as when $T_F = A$. Now, however, the net effect of the increase in the post child-rearing period by one unit and the experience lost during the child-rearing period and gained during the pre child-rearing perid is to increase income in the post child-rearing period by $W_L-(R-T_L-S)\varphi'$. To summarize: Decreasing S by one unit with a compensated increase in ρ (holding $Q = \rho S$ constant) leads to the following change in lifetime income:

$$(10)\quad \begin{cases} -NW_M + NW_L - (R-T_F-NS)\varphi'N, \text{ when } T_F = A, \\ (N-1)W_F - NW_M + W_L - (R-T_L-S)\varphi', \text{ when } T_L = \tau . \end{cases}$$

When $A < T_F < T_L < \tau$, these two changes can be shown to be identical.

Clearly, if the family starts from a position in which it is possible to decrease S and increase ρ, holding Q constant, and if, at the same time, income is thereby increased, the situation cannot be optimal, so it will clearly pay the family to continue changing ρ and S until either $\rho = 1$ with $S > \sigma$ or $S = \sigma$ with $\rho < 1$. Now, if the expected growth in wages is very high, the child-rearing period will be pushed to the earliest possible point so that $T_F = A$; then income increases if

$$(11)\quad W_L - W_M > (R-T_F-NS)\varphi' > 0.$$

Provided prior experience does not effect W_L too greatly, this will surely be true in a situation in which wages are expected to grow a great deal over time. Moreover, since it is likely to be necessary to work part time or to accept certain kinds of employment consistent with child-rearing, there are other reasons to expect W_M to be substantially less than W_L. Conversely, suppose that no, or little, growth in wages is expected over time; in this case discounting of future wages leads the family to push the child-rearing period to the latest possible point, $T_L = \tau$. In this case, income increases with a decrease in S and compensating increase in $\rho(Q = \rho S = \text{constant})$ if

$$(12) \qquad N(W_F - W_M) > W_F - W_L + (R - T_L - S)\varphi'.$$

When discounting predominates, W_F will be considerably larger than W_L; moreover, the term $(R-T_1-S)\varphi'$ is positive; hence, whether or not income will increase with a decrease in S and compensating increase in ρ becomes a question of how much W_F exceeds W_M. For example, if, considering discounted values, W_F is twice W_M and the family has three children, then, neglecting the term $(R-T_L-S)\varphi'$, W_F can be as much as six times W_L. A wage difference of this magnitude caused by discounting alone (i.e., assuming equal undiscounted wages) implies a discount of approximately 13% if the child-rearing period is 15 years. Since the likely rate of discount is less, we conclude that, irrespective of whether $T_F = A$ or $T_L = \tau$, if $S > \sigma$ and $\rho < 1$, decreasing S and increasing ρ so as to hold Q constant will increase income. This is especially true if institutional factors make W_M low relative to both W_F and W_L. When $A < T_F < T_L < \tau$, the condition becomes simply

$$(13) \qquad W_F - W_M > 0.$$

We conclude that it is plausible, in terms of our model, that S and ρ are inversely related.

Economies of Scale

To consider economies of scale in child-rearing, we introduce in place of the simple quality-generating function (2), the function

$$(14) \qquad QN = F(\rho SN, KN),$$

where K are purchased inputs per child and F is a function homogeneous of degree $\alpha \geq 1$. C now represents directs costs per child which are neither time costs nor purchased inputs into child quality production; they may be thought of as part of the parents' consumption which goes to each child simply by virtue of its being born. That F is homogeneous of degree α implies

$$(15) \qquad Q = N^{\alpha-1} f(\rho S, K).$$

Let

p = the price of purchased inputs to child-quality production relative to parents'. consumption goods.

Then the family's problem is to maximize U(Y,N,Q) subject to the budget constraint

$$(16) \quad Y + CN + pKN = I + (T_L-(N-1)S-A)W_F + (1-\rho)SNW_M + (R-T_L-S)\ \varphi\ (T_L+S-\rho NS-A),$$

the production function (15) and the inequality constraints

$$S \geq \sigma,$$

$$0 \leq \rho \leq 1,$$

and $$A \leq T_F \leq T_L \leq F.$$

At this point we could substitute for Q from (15) and from the standard Lagrangian and proceed to derive standard first-order conditions. Were we to do so these would show that the introduction of increasing returns to scale in child quality production ($\alpha > 1$) and the possibility of substituting other inputs for mother's time modifies the left-hand sides of the first-order conditions for child numbers and child quality. (When $\alpha = 1$ and $f(\rho S,K) = \rho S$, these additional terms vanish leaving the same conditions as before, provided we also set $pK = 0$.)

In general, if the degree of increasing returns is large and/or the marginal rate of substitution of child quality for other consumption is high relative to the costs of inputs into child quality other than mother's time, the conditions show that more children will be desired. The effects on child quality, holding numbers constant is, however, ambiguous since it is not clear that $N^{\alpha-1}f_1 > 1$. Certainly, if the degree of increasing returns to child numbers is great enough, these factors will be large and will increase the likelihood that the mother does not work and that the birth-space interval is larger than the minimal level σ.

It is easy to see, however, that the plausibility of an inverse relation between S and ρ is unaffected by increasing returns to scale, provided we hold K fixed. Holding child-quality constant implies

(17) $$dQ = N^{\alpha-1} f_1 \rho dS + N^{\alpha-1} f_1 S d\rho = 0,$$

so that

(18) $$d\rho = - \frac{\rho}{S} dS.$$

Since the production of Q does not enter the income constraint and since $d\rho$ has the same value in relation to dS as before, exactly the conditions (11) and (12) derived above determine whether or not it will be optimal to drive either ρ or S to its boundary. The problem, of course, is that K cannot be held fixed; the opening of an alternate route for the production of quality will most surely affect our results; however, it is clear that it is this rather than economies of scale which cause the essential change.

APPENDIX B: EMPIRICAL MEASURES OF PREFERENCES FOR CHILDREN

In most advanced countries, a negative relationship between number of children and women's labor supply has been observed (See references in Weller (1968).) Although this can be interpreted in economic terms as being the result of substitution effects outweighing income effects on average, to some extent this negative relationship may simply be due to variation in tastes, as Hall (1973) has pointed out. That is, if all families faced identical prices, wages and resources, we would still observe an inverse relationship between fertility and female labor supply if some families value highly large numbers of children and domestic chores whereas others place a higher value on market activities.

That tastes vary across families is admitted by almost everyone. However, after acknowledging this, most studies do not hold preferences constant in the empirical analysis, arguing that they really cannot be observed. Some attempts have been made to deal with this problem. Easterlin (1973) develops a theory of taste formation over the life cycle. He theorizes that couples in the childbearing ages will tend to have more children if they are enjoying a better standard of living than they did in their childhood; i.e., the number of children is a function of what he terms "relative economic status." This, in turn, depends crucially on the comparative labor market situations experienced by the young adults and their parents. This model, however, has failed to explain cross-section variation in fertility (MacDonald and Rindfuss (1976)). Leibenstein (1974) presents an alternative theory of tastes, arguing that populations are divided into social status groups characterized by different preferences for children. However, it is hard to see how this could be tested empirically, given the high correlation between social status groups and income groups. Finally, Edlefsen and Lieberman (1974) have approached the problem in an empirical study of fertility in Iran by assuming that tastes for children vary systematically across geographical regions which differ in their cultural, environmental and economic influences. Although their results are encouraging, their approach is not of general applicability to regions lacking cultural diversity or ready measures of such variables.

A new way of attacking the problem of variation of tastes is offered in this Appendix. In an earlier article, Nerlove (1974) argued that the difference in educational attainment of husband and wife partly reflects the couple's preferences for children. It is well-known that in the marriage market there is positive assortative mating by education, so that men with very high education tend to marry women who also have high levels of schooling. We would not expect differences in tastes to be reflected in the educational attainment of males; however, it is very plausible that women with low preferences for market activities and high preferences for children will tend to seek and receive small 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, we would expect men with a given educational attainment with high preferences for children 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 the income effect, while his wife's education is associated mostly with the substitution effect, it can be seen 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.

The recognition that the relationship between husband's and wife's education reflects assortative mating in two dimensions leads to an empirical measure for the elusive taste variable. This consists of the residuals of the regression of the wife's education on the husband's. A large value of the residual indicates a low preference for children and conversely. Of course, the substitution effect of the opportunity cost reflected in the wife's education is confounded with this variable when husband's education is also included in the analysis. A more appropriate specification would be to derive a continuous latent variable, "preference for children," from the answers to several attitudinal questions of the sort found in the Québec survey.

In the two surveys conducted in 1971 by the University of Montreal described in the text, respondents were asked to express agreement, disagreement, neutrality, or uncertainty about the following statements

a. Plus un couple a d'enfants, plus il est heureux.

b. Il est essentiel pour le bonheur d'un couple d'avoir des enfants.

c. Dans la plupart des cas un couple qui préfère ne pas avoir d'enfants est un couple égoiste qui n'a pas le sens de ses responsabilités.

d. En général les couples qui ont peu d'enfants sont les plus heureux.

e. Les couples qui décident de ne pas avoir d'enfant sont généralement très heureux.

f. Les gens ont trop d'enfants et les couples qui ne souhaitent pas en avoir rendent service à toute la société.

These questions have one characteristic in common: they are other-directed, i.e., they direct the respondent's attention away from herself. Thus we expect the answers to these questions to be less contaminated by the subject's actual family size than would be the answer to a question such as "What is your ideal family size?" (See Festinger (1957) and Zajonc (1968) on cognitive dissonance.) The availability of these questions is very valuable for the purpose of testing the proposed empirical measure for preferences for children.

We propose to test the validity of the hypothesis advanced above by ascertaining whether the probability that these questions are answered in a way reflecting high preferences for children increases as the residuals decrease, and vice versa. In addition, of course, if this hypothesis is valid, the residuals should have a negative coefficient in the fertility equation and a positive one in the female labor supply equation. (See footnote 5 to the text.) The preliminary results reported below are encouraging and suggestive of the usefulness of this approach.

For exploratory purposes, we first selected three of the above questions, (a), (b), and (c). If the hypothesis is correct, we would expect that as the residuals increase, the probability of agreeing with these statements should decrease.

To test this hypothesis we estimated three one-way log-linear models. The responses to each of the above attitudinal questions give rise to a trichotomous variable, according to whether the subjects agree, disagree or express neutrality. These trichotomous variables are the dependent variables in our models, and the residual is the exogenous variable which is assumed to enter the main effects.

Let Y_1, Y_2, and Y_3 denote the trichotomous random variables associated with questions 1, 2 and 3 above. Let categories 1, 2 and 3 represent disagreement, agreement and neutrality respectively. Finally, let x denote the residual. Then the probability of Y_i taking on a specified categorical value given the vector of observations x is:

$$P = [Y_i = k|x] = \frac{e^{a_k + b_k x}}{\sum_{j=1}^{3} e^{a_j + b_j x}}, \quad i = 1, 2, 3, \; k = 1, 2, 3 .$$

Thus, for example,

$$P[Y_i = 1|x] = \frac{e^{a_1 + b_1 x}}{\sum_{j=1}^{3} e^{a_j + b_j x}}$$

$$= \frac{1}{1 + e^{a_2 - a_1 + (b_2 - b_1)x} + e^{a_3 - a_1 + (b_3 - b_1)x}}$$

It can easily be seen that the probability that Y_1 takes on the value 1 given x increases unambiguously as x rises if $(b_2-b_1) < 0$ and $(b_3-b_1) < 0$. On the other hand, this probability decreases unambiguously as x goes up if $(b_2-b_1) > 0$ and $(b_3-b_1) > 0$. Similarly, it can be observed that $P[Y_1=2|x]$ increases with x if $(b_1-b_2) < 0$ and $(b_3-b_2 < 0$, and it decreases with x if both of these terms are positive.

The results of the estimation, carried out by a maximum-likelihood procedure are as follows:

TABLE B1

Estimated Coefficients in Three Univariate Trichotomous Log-Linear Models
(Standard errors in parentheses)

	Question 1	Question 2	Question 3
a_1	0.3117 (0.0533)	-0.7581 (0.1074)	-0.3237 (0.06717)
a_2	-0.1248 (0.05952)	1.609 (0.07291)	0.7732 (0.05354)
a_3	-0.1869 (0.05950)	-0.8509 (0.1271)	-0.4495 (0.06933)
b_1	0.1289 (0.02386)	0.1007 (0.03939)	0.06399 (0.02690)
b_2	-0.1304 (0.02670)	-0.08924 (0.02869)	-0.08594 (0.02306)
b_3	0.0015 (0.02562)	-0.01146 (0.04251)	0.02195 (0.02797)
b_2-b_1	-0.2593 (0.04311)	-0.1899 (0.05391)	-0.1499 (0.04080)
b_3-b_1	-0.1274 (0.04800)	-0.1122 (0.08008)	-0.04204 (0.05405)
b_1-b_2	0.2593 (0.04311)	0.1899 (0.05391)	0.1499 (0.04080
b_3-b_2	0.1319 (0.05276)	0.07780 (0.06537)	0.1079 (0.04801)

Below we show an example of how the probabilities vary as x varies.

TABLE B2
Probabilities of Response to Question 3 as a Function of the Residual, x, of the Regression of Wife's Education on Husband's Education

x	$P[Y_3$ = Disagree]	$P[Y_3$ = Neutral]	$P[Y_3$ = Agree]
-9.000	.072	.093	.835
-8.500	.077	.097	.826
-8.000	.082	.101	.816
-7.500	.087	.106	.807
-7.000	.093	.110	.797
-6.500	.099	.115	.786
-6.000	.105	.119	.775
-5.500	.112	.124	.764
-5.000	.119	.129	.752
-4,500	.126	.134	.740
-4.000	.133	.139	.728
-3.500	.141	.144	.715
-3.000	.149	.149	.701
-2.750	.154	.152	.694
-2.500	.158	.155	.688
-2.250	.162	.157	.681
-2.000	.167	.160	.674
-1.750	.171	.162	.666
-1.500	.176	.165	.659
-1.250	.180	.168	.652
-1.000	.185	.170	.644
- .750	.190	.173	.637
- .500	.195	.176	.629
- .250	.200	.178	.622
0	.205	.181	.614
.250	.210	.183	.606
.500	.215	.186	.599
.750	.221	.189	.591
1.000	.226	.191	.583
1.250	.231	.194	.575
1.500	.237	.196	.567
1.750	.243	.199	.559
2.000	.248	.201	.551
2.250	.254	.204	.543
2.500	.260	.206	.534
2.750	.265	.208	.526
3.000	.271	.211	.518
3.500	.283	.215	.502
4.000	.295	.220	.485
4.500	.307	.224	.469
5.000	.320	.228	.452
5.500	.332	.232	.436
6.000	.344	.236	.420
6.500	.357	.240	.403
7.000	.370	.243	.388
7.500	.382	.246	.372
8.000	.395	.249	.356
8.500	.407	.251	.341
9.000	.420	.254	.326

The above results indicate that indeed the required inequalities are satisfied and the probability of responses to attitudinal questions indicating high preferences for children increases as the residuals decrease and conversely, as predicted by the hypothesis.

We have also estimated a two-way log-linear model, taking the answers to questions (a) and (b) above as jointly dependent endogenous variables.

The conditions which must be satisfied so as to be assured of an unambiguous impact of a change in the residuals on the probability that the answers to the attitudinal questions (a) and (b) stated above both express agreement or both indicate disagreement are derived here. We then present the estimated coefficients of the two-way, trichotomous log-linear model where the responses to these questions are the endogenous variables and the residual constitutes the exogenous variable. Finally, we test whether the required conditions hold.

Let Y_1 and Y_2 denote the trichotomous random variables associated with the responses to questions 1 and 2. Let categories 1, 2 and 3 represent disagreement, agreement and neutrality, respectively. Let x denote the residual. Then we can write the following:

$$P[Y_1 = 1,\ Y_2 = 1] \ \frac{e^{\mu_1 + \alpha_1(1)x + \alpha_2(1)x}}{\text{DEN}}$$

where $\alpha_k(i_1)$, $i_1=1,2,3$, $k=1,2$ is that part of the main effect of Y_k associated with the exogenous variable x

μ_i, $i=1,9$ is a constant which includes the constants of the appropriate main effects and bivariate interaction terms. (The latter are assumed not to be functions of the exogenous variable)

$$\begin{aligned}\text{DEN} = {} & e^{\mu_1 + \alpha_1(1)x + \alpha_2(1)x} + e^{\mu_2 + \alpha_1(1)x + \alpha_2(2)x} \\ & + e^{\mu_3 + \alpha_1(1)x + \alpha_2(3)x} + e^{\mu_4 + \alpha_1(2)x + \alpha_2(1)x} \\ & + e^{\mu_5 + \alpha_1(2)x + \alpha_2(2)x} + e^{\mu_6 + \alpha_1(2)x + \alpha_2(3)x} \\ & + e^{\mu_7 + \alpha_1(3)x + \alpha_2(1)x} + e^{\mu_8 + \alpha_1(3)x + \alpha_2(2)x} \\ & + e^{\mu_9 + \alpha_1(3)x + \alpha_2(3)x}.\end{aligned}$$

After dividing numerator and demoninator by the numerator and cancelling some terms, we obtain the following:

$$P[Y_1=1,Y_2=1]= \Big[1 + e^{\gamma_1 + (\alpha_2(2) - \alpha_2(1))x}$$
$$+ e^{\gamma_2 + (\alpha_2(3) - \alpha_2(1))x}$$
$$+ e^{\gamma_3 + (\alpha_1(2) - \alpha_1(1))x}$$
$$+ e^{\gamma_4 + (\alpha_1(2) + \alpha_2(2) - \alpha_1(1) - \alpha_2(1))x}$$
$$+ e^{\gamma_5 + (\alpha_1(2) + \alpha_2(3) - \alpha_1(1) - \alpha_2(1))x}$$
$$+ e^{\gamma_6 + (\alpha_1(3) - \alpha_1(1))x}$$
$$+ e^{\gamma_7 + (\alpha_1(3) + \alpha_2(2) - \alpha_1(1) - \alpha_2(1))x}$$
$$+ e^{\gamma_8 + (\alpha_1(3) + \alpha_2(3) - \alpha_1(1) - \alpha_2(1))x}\Big]^{-1},$$

where the γ's are appropriate constants.

Thus, the probability that Y_1 and Y_2 equal 1 increases unambiguously as x increases if all the following 8 inequalities are satisfied:

$$\alpha_2(2) - \alpha_2(1) < 0$$
$$\alpha_2(3) - \alpha_2(1) < 0$$
$$\alpha_1(2) - \alpha_1(1) < 0$$
$$\alpha_1(2) + \alpha_2(2) - \alpha_1(1) - \alpha_2(1) < 0$$
$$\alpha_1(2) + \alpha_2(3) - \alpha_1(1) - \alpha_2(1) < 0$$
$$\alpha_1(3) - \alpha_1(1) < 0$$
$$\alpha_1(3) + \alpha_2(2) - \alpha_1(1) - \alpha_2(1) < 0$$
$$\alpha_1(3) + \alpha_2(3) - \alpha_1(1) - \alpha_2(1) < 0 \quad .$$

Similarly, the probability that Y_1 and Y_2 equal 2 will increase unambiguously as x falls if:

$$\alpha_1(1) + \alpha_2(1) - \alpha_1(2) - \alpha_2(2) > 0$$
$$\alpha_1(1) - \alpha_1(2) > 0$$
$$\alpha_1(1) + \alpha_2(3) - \alpha_1(2) - \alpha_2(2) > 0$$
$$\alpha_2(1) - \alpha_2(2) > 0$$
$$\alpha_2(3) - \alpha_2(2) > 0$$
$$\alpha_1(3) + \alpha_2(1) - \alpha_1(2) - \alpha_2(2) > 0$$
$$\alpha_1(3) - \alpha_1(2) > 0$$
$$\alpha_1(3) + \alpha_2(3) - \alpha_1(2) - \alpha_2(2) > 0 \quad .$$

We present below the estimated coefficients of the two-way trichotomous log-linear model where Y_1 and Y_2 are the jointly dependent variables and x is the exogenous variable, assumed to enter the main effects. Standard errors are reported in parentheses.

	$Y_1=1$	$Y_1=2$	$Y_2=1$	$Y_2=2$	$\beta^*_{12}(1,1)$	$\beta_{12}(1,2)$	$\beta_{12}(2,1)$	$\beta_{12}(2,2)$
Constant	0.9407 (0.1753)	-1.031 (0.3172)	-1.269 (0.3693)	1.992 (0.1740)	0.8951 (0.3752)	-0.7590 (0.1785)	-0.9198 (0.7154)	1.035 (0.3214)
Coefficient of x	0.1180 (0.02410)	-0.1218 (0.02716)	0.06495 (0.04074)	-0.04799 (0.03014)				

*$\beta_{ij}(i_1,i_2)$ is the bivariate interaction between variables i and j at levels i_1 and i_2, respectively.

Therefore, following the notation of Section A above, we have:

$\alpha_1(1) = 0.1180$

$\alpha_1(2) = -0.1218$

$\alpha_1(3) = 0.0038$

$\alpha_2(1) = 0.06495$

$\alpha_2(2) = -0.04799$

$\alpha_2(3) = -0.01696$

since $\alpha_1(1) + \alpha_1(2) + \alpha_1(3) = 0$, and
$\alpha_2(1) + \alpha_2(2) + \alpha_2(3) = 0$.

Thus, it can be verified that:

$\alpha_2(2) - \alpha_2(1) = -0.1129 < 0$

$\alpha_2(3) - \alpha_2(1) = -0.0819 < 0$

$\alpha_1(2) - \alpha_1(1) = -0.2398 < 0$

$\alpha_1(2) + \alpha_2(2) - \alpha_1(1) - \alpha_2(1) = -0.3527 < 0$

$\alpha_1(2) + \alpha_2(3) - \alpha_1(1) - \alpha_2(1) = -0.3218 < 0$

$\alpha_1(3) - \alpha_1(1) = -0.1142 < 0$

$\alpha_1(3) + \alpha_2(2) - \alpha_1(1) - \alpha_2(1) = -0.2271 < 0$

$\alpha_1(3) + \alpha_2(3) - \alpha_1(1) - \alpha_2(1) = -0.1961 < 0$

and

$\alpha_1(1) + \alpha_2(1) - \alpha_1(2) - \alpha_2(2) = 0.3527 > 0$

$\alpha_1(1) - \alpha_1(2) = 0.2398 > 0$

$\alpha_1(1) + \alpha_2(3) - \alpha_1(2) - \alpha_2(2) = 0.2708 > 0$

$\alpha_2(1) - \alpha_2(2) = 0.1129 > 0$

$\alpha_2(3) - \alpha_2(2) = 0.03103 > 0$

$\alpha_1(3) + \alpha_2(1) - \alpha_1(2) - \alpha_2(2) = 0.2385 > 0$

$\alpha_1(3) - \alpha_1(2) = 0.1256 > 0$

$\alpha_1(3) + \alpha_2(3) - \alpha_1(2) - \alpha_2(2) = 0.1566 > 0$

Thus, all the required inequalities are satisfied, providing additional support for the hypothesis.

We have also examined the joint variation of responses to all six questions and the residual from the regression of wife's education on her husband's by estimating six conditional trichotomous logit models, one for each question, in which the residual and specially coded variables reflecting answers to the remaining five questions. It is interesting to note in this connection that S. Kawasaki has shown that, if there were only categorical variables involved, these estimates and their standard errors would be identical to maximum-likelihood estimates of all parameters jointly. The coding for the response to a question which appears as a conditioning variable requires two variables, say w_1 and w_2, and is as follows:

	w_1	w_2
Answer expresses:		
1) Low preference	1	0
2) High Preference	0	1
3) Neutrality	-1	-1

Table A3 summarizes the parameter estimates and their standard errors. $Y_1,\ldots,Y_6$ are categorical variables reflecting, respectively, the answers to questions (a) - (f) above.

Table A3: Estimated Coefficients in Six Univariate Trichotomous Logit Models

	Y_1 Lo	Y_1 Hi	Y_2 Lo	Y_2 Hi	Y_3 Lo	Y_3 Hi	Y_4 Lo	Y_4 Hi	Y_5 Lo	Y_5 Hi	Y_6 Lo	Y_6 Hi
STANT	1.028 (0.1559)	-1.152 (0.2628)	-1.049 (0.2535)	1.537 (0.1537)	.1221 (0.1302)	.4406 (0.1302)	-.01490 (0.1195)	-.03536 (.1267)	-.7409 (0.1574)	.5879 (0.1198)	-.6004 (0.1493)	.3808 (0.1219)
ID	.1075 (0.07436)	- .1170 (0.02645)	.06192 (0.04317)	- .03558 (0.03351)	.02253 (0.03028)	-.04539 (0.02513)	-.01435 (.02691)	.02925 (.02347)	.04171 (0.04756)	-.02168 (0.02883)	.005963 (0.03893)	.03226 (0.02769)
	Bivariate Interactions						Standard Errors					
	(a)	(b)	(c)	(d)	(e)	(f)	(a)	(b)	(c)	(d)	(e)	(f)
(Lo,Lo)	.7865	.7835					.2594	.2535				
(Lo,Hi)	-.5634	-.5628					.1570	.1519				
(Hi,Lo)	-.8267	-.8203					.4656	.4512				
(Hi,Hi)	.8837	.8620					.2598	.2309				
(Lo,Lo)	.4102		.3950				.1024		.1049			
(Lo,Hi)	-.4740		-.4608				.08106		.08295			
(Hi,Lo)	-.02303		-.03171				.1344		.1365			
(Hi,Hi)	.3727		.3714				.09558		.09881			
(Lo,Lo)	.3026			.2923			.09142			.09155		
(Lo,Hi)	-.1824			-.1629			.08095			.08105		
(Hi,Lo)	-.05576			-.06594			.1023			.1032		
(Hi,Hi)	.1516			.1415			.08629			.08632		
(Lo,Lo)	.008987				.02755		.1451				.1437	
(Lo,Hi)	.04989				.03789		.09885				.09830	
(Hi,Lo)	.09948				.05281		.1672				.1638	
(Hi,Hi)	.1218				.1440		.1088				.1085	
(Lo,Lo)	.1839					.1944	.1337					.1360
(Lo,Hi)	.06854					.04998	.09409					.09499
(Hi,Lo)	-.01111					-.00006967	.1545					.1535
(Hi,Hi)	-.03533					-.03547	.1029					.1033
(Lo,Lo)		.3498	.3495					.1406	.1463			
(Lo,Hi)		-.4419	-.4399					.1721	.1751			
(Hi,Lo)		-.6819	-.6709					.1109	.1146			
(Hi,Hi)		.6412	.6228					.1150	.1194			
(Lo,Lo)		.04748		.01874				.1499		.1528		
(Lo,Hi)		.02285		.04091				.1521		.1554		
(Hi,Lo)		-.1650		-.1280				.1162		.1188		
(Hi,Hi)		.08949		.08213				.1135		.1172		
(Lo,Lo)		.07786			.1536			.1999		.1990		
(Lo,Hi)		-.08312			-.1248			.1578		.1562		
(Hi,Lo)		-.1898			-.2419			.1652		.1627		
(Hi,Hi)		.3554			.3751			.1221		.1209		
(Lo,Lo)		-.1209				.1033		.1839				.1857
(Lo,Hi)		-.1813				-.1616		.1547				.1546
(Hi,Lo)		-.2697				-.2660		.1522				.1504
(Hi,Hi,)		.3184				.3199		.1178				.1194
(Lo,Lo)			.04139	.04086					.1116	.1117		
(Lo,Hi)			.03347	.04349					.1042	.1026		
(Hi,Lo)			.08884	.09904					.09613	.09525		
(Hi,Hi)			-.04995	-.05866					.08545	.08370		
(Lo,Lo)			.1496		.1661				.1726		.1679	
(Lo,Hi)			-.09743		-.1106				.1210		.1182	
(Hi,Lo)			.1988		.1985				.1379		.1520	
(Hi,Hi)			.03777		.04416				.1046		.1007	
(Lo,Lo)			.1681			.1746			.1561			.1532
(Lo,Hi)			-.03113			-.01916			.1158			.1144
(Hi,Lo)			.1037			.1191			.1429			.1417
(Hi,Hi)			.07631			.07197			.09911			.09781
(Lo,Lo)				.2157	.2260					.1378	.1336	
(Lo,Hi)				-.1884	-.1921					.09832	.09589	
(Hi,Lo)				-.2253	-.2275					.1516	.1470	
(Hi,Hi)				.4033	.4045					.09602	.09481	
(Lo,Lo)				.2649		.2571				.1247		.1234
(Lo,Hi)				-.2316		-.2323				.09305		.09206
(Hi,Lo)				-.2582		-.2714				.1349		.1338
(Hi,Hi)				.4599		.4634				.08910		.08990
(Lo,Lo)					.5290	.5362					.1504	.1506
(Lo,Hi)					-.5088	-.5062					.1378	.1393
(Hi,Lo)					-.2868	-.2818					.1249	.1264
(Hi,Hi)					.5561	.5532					.09501	.09637

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