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An Economic Analysis of the Timing of Childbirth*

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1. INTRODUCTION

Since Becker's seminal contributions, the new home economics approach to fertility has concentrated on completed family size.[1] Yet the existence of a two-child norm in the United States implies that the timing of births can be just as significant as completed parity for American fertility rates; and micro-economic factors are clearly of consequence in household timing decisions given the high degree of fertility control and the number of working women. The purpose of this paper is to identify theoretically those micro-economic variables which are important to decisions concerning the timing of the first birth.[2] Empirical tests are also performed, although limitations in existing data sets prevent a complete test of the hypotheses.

In Section II the basic assumptions of the model are presented.The child-timing decision is formulated as a multi-period planning problem in which life-cycle utility is a function of the time distribution of non-child consumables and child services. Since the wife is assumed to leave the labour force temporarily to raise children, the date of the first birth can affect the mean and dispersion of the household's intertemporal income distribution. It is these effects which provide an economic preference as to when to begin childbearing.

The theoretical analysis is divided into two sections. Section III serves to highlight the relationship between the timing of childbirth and the mean of the couple's life-cycle earnings. It is assumed that capital markets are perfect, so that the childbearing decision

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[1] Gary S. Becker, 'An economic analysis of fertility', in *Demographic and Economic Change in Developed Countries* (Universities–National Bureau Conference Series, No. 11, Princeton Univesity Press, 1960); 'A theory of the allocation of time', *Economic Journal*, **75** (1965), pp. 493–517. Reviews or summaries of Becker's approach to completed family size include H. Leibenstein, 'An interpretation of the economic theory of fertility', *Journal of Economic Literature*, **12** (1974), pp. 457–479; Susan Cochrane, 'Children as by-products, investment goods, and consumer goods: a review of some microeconomic models of fertility', *Population Studies*, **29** (1975), pp. 373–390; B. Turchi, *The Demand for Children: The Economics of Fertility in the United States* (Cambridge, Massachusetts, Ballinger, 1975); and M. Fulop, 'A survey of the literature on the economic theory of fertility behaviour', *American Economist*, **21** (1977), pp. 12–22.

[2] Most work on household timing patterns consists of empirical descriptions with sociological underpinnings. Recent papers in which a micro-economic modelling of timing decisions is provided include J. Heckman and R. Willis, 'Estimation of a stochastic model of reproduction: an econometric approach', in N. Terleckyj (ed.), *Household Production and Consumption* (New York, Columbia University Press, 1975), pp. 99–138; A. Razin, 'Number, birth spacing and quality of children: a micro-economic viewpoint', *Research in Population Economics*, **2** (1980), pp. 279–293; and L. Edlefsen, 'The opportunity cost of time and the numbers, timing and spacing of births', Paper presented at the Annual Meeting of the Econometric Society, Denver, 1980. The theoretical propositions advanced in these papers are derived from life-cycle models in which the capital-market opportunities available to a household are assumed perfect. A greater emphasis is placed here on those micro-economic variables which are important when capital markets are imperfect.

can be separated from the consumption–saving decision. The household relies on financial markets to 'smooth' or minimize the dispersion of its consumption profile. The optimal date of birth is the one which maximizes the wife's lifetime earnings.

When capital markets are imperfect, the household must consider the effect of its timing decision on the dispersion of its life-cycle earnings profile. Section IV focuses upon this aspect of the problem. There it is assumed that no capital market exists. Consumption smoothing is then achieved by synchronizing the full costs of child care with a time interval in which the income of the primary earner is relatively high.

In Section V data from the National Longitudinal Surveys are used to test our hypotheses. The empirical findings are consistent with the theory, and they suggest that household economic variables contribute significantly to an explanation of variations in the timing of first births. In Section VI we conclude by considering some of the implications of our analysis for future timing patterns in the U.S.

II. THEORETICAL FRAMEWORK

Couples are assumed to exercise perfect fertility control and to be free of physical impairments such as sub-fecundity and involuntary sterility, and not to experience miscarriages or stillbirths. Our concern is with the length of the first birth interval. It is assumed that this decision is made at the date of marriage, and all time-related variables are measured from this point. The choice variable T, the date of the first birth, varies continuously over the interval $[0, R]$, where R is a reproductive constraint determined by the age of the wife at marriage and by the number of children which the couple intend to have. The desired quantity of children and the spacing of births after the first are treated exogenously.

The preferences of the household are represented by a life-cycle utility function W, which is equal to the sum of periodic utilities pertaining to all consumables other than children, $U(c)$, plus a function V whose argument is the household's effective number of children N. We assume no subjective time preference for either c or N, so that W can be written as:

$$W = \int_0^L U\{c(t)\}\,dt + V(N), \tag{1}$$

where L is the household's planning horizon. The utility function U is assumed to exhibit positive and diminishing marginal utility.

The 'effective' number of children is a combination of the quantity and quality of offspring. The time path of child quality expenses, $\{e(0), e(\mu)\}$, which begins with the first birth and extends for μ periods, is assumed to be predetermined and not affected by the choice of T. Support for this assumption is found in the socio-economic literature on fertility,[3] which suggests that child quality expenditures are shaped largely by societal pressures and economic status and thus are not subject to a great deal of choice once childbearing has begun. Since e is independent of T and there is no pure time preference associated with N, $V(N)$ can be dropped from Equation (1) without altering the timing solution.

Children are viewed as consumption items with no pecuniary return. Thus household income is related solely to the work effect of the husband and wife. The husband is assumed to be employed throughout the planning period. His earnings at time t, denoted

[3] For example, see B. Okun, 'Comment', and J. Duesenberry, 'Comment', in Becker, (ed.) *op. cit.*, in footnote 1; R. Easterlin, 'Towards a socio-economic theory of fertility: a survey of recent research on economic factors in American fertility', in S. Behrman, L. Corsa and R. Freedman (eds.), *Fertility and Family Planning: A World View* (University of Michigan Press, 1969); and Leibenstein, *loc. cit.* in footnote 1.

$x(t)$, are known with certainty and are assumed to increase monotonically with t. The wife is assumed to be employed for all but τ consecutive periods ($\tau < \mu$) during which she cares for her children. Her earnings during each period of employment are determined as follows.

Let ω denote the work experience accumulated by the wife before marriage. This may be broadly interpreted to include any period during which specific job skills are acquired. Let $y(z)$ denote the income received by a woman in the same occupation, but with z periods of uninterrupted work experience. Then the earnings of the wife can be expressed as

$$y(t+\omega) \quad \text{for} \quad 0 < t < T, \quad \text{and} \quad y\{t+\omega-\tau-\min(\gamma\tau, T+\omega)\} \quad \text{for} \quad T+\tau < t < L$$

The parameter γ measures the rate of depreciation or obsolescence of job skills. For each time period spent out of the labour force, γ periods of work experience are lost.[4] If $\gamma = 0$, there is no skill loss. The wife's earnings upon re-entering the labour force equal $y(T+\omega)$, identical to her earnings at time T. If γ is positive and $T+\omega > \gamma\tau$, then the wife retains some of her human capital while caring for her children and earns $y(T+\omega-\gamma\tau)$ upon re-entry. But if $T+\omega \leqq \gamma\tau$, then all her seniority accumulated before childbirth is lost. The wife re-enters her occupation at the starting salary $y(0)$. These three possibilities are illustrated in Figure 1. In the analysis to follow we require only that $y(z)$ increase monotonically with z.

Optimal child timing, T^*, depends upon the rate at which the wife's job skills decay

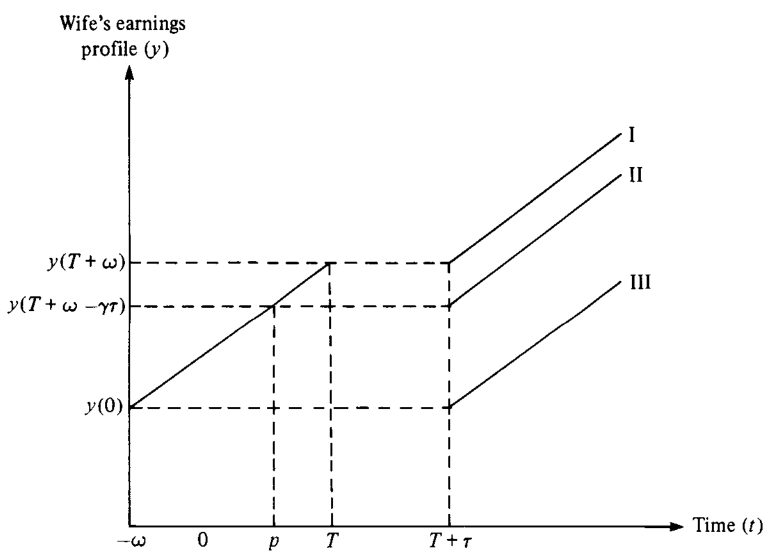

Figure 1. Time path of wife's earnings. Case I, no skill loss ($\gamma = 0$); Case II, partial skill loss ($\gamma\tau \equiv T-P < T+\omega$); Case III, total skill loss ($\gamma\tau \geqq T+\omega$).

[4] In general, lost work experience could be written as a function not only of the duration of unemployment, but also of the work experience accumulated before childbirth. Unfortunately, there is no research to date with which to structure such a relationship. We ignore the second argument and assume that lost work experience in linearly homogeneous in τ.

Note also that the depreciation of skills is phrased in time periods rather than wages. When $T+\omega > \gamma\tau$, the percentage reduction in salary resulting from τ periods of unemployment equals

$$d = \frac{y(T+\omega)-y(T+\omega-\gamma\tau)}{y(T+\omega)},$$

which varies directly with γ and τ.

during unemployment, her pre-marital work experience, the earnings profiles of both the husband and wife, child quality expenditures, and the length of the wife's unemployment. The nature of the relationship between T^* and each explanatory variable is examined in that section which illuminates the relationship most clearly. The parameters γ and ω are critical to the problem of maximizing the wife's lifetime earnings, so they are analysed in Section III. The remaining variables assume particular importance when capital markets are imperfect. Their relation to the optimal date of birth is discussed in Section IV.

III. CHILD TIMING AND LIFETIME EARNINGS

If loans and financial securities are available at equal rates of interest, the decision problem of the household is to maximize its life-cycle utility subject to the constraint that the present value of its child and non-child expenditures equal the present value of its income stream. This problem can be solved in two steps. First, the household maximizes the discounted sum of the wife's earnings by an appropriate choice of T. Secondly, the household maximizes W by selecting a life-cycle consumption path which satisfies the budget equation just derived.

Since our concern is with the timing of childbirth, we need only consider the first step in the problem. For ease of presentation, we assume a zero interest rate. The child-timing decision can then be formally represented by the following problem of mathematical optimization:

$$\max\ Y(T) = \int_0^T y\{t+\omega\}\,dt + \int_{T+\tau}^{L} y\{t+\omega-\tau-\min(\gamma\tau,\ T+\omega)\}\,dt, \tag{2}$$

subject to the constraint that $0 < T < R$. The objective function, $Y(T)$, is a simple sum of the wife's earnings after marriage. Y will be independent of T if the depreciation parameter $\gamma = 0$, as it might be for women in unskilled occupations of whose skills can be maintained during unemployment. When $\gamma > 0$, however, there is an economic preference as to the timing of childbirth. We assume this to be the case throughout the remainder of this section.

Given this description of the child-timing decision, T^* will occur at one of the boundaries of the constraint set. In other words, couples will begin childbearing either very early or very late in their marriages. When T is so small that all job skills are lost during unemployment, Y typically falls with increases in T. Immediate birth is then preferred to any other T which satisfies the inequality $T+\omega \leqq \gamma\tau$. On the other hand, when T is so large that only a fraction of the wife's job skills are lost during unemployment, Y necessarily rises with increases in T. It then follows that $T = R$ is preferred to any other T which satisfies the inequality $T+\omega \leqq \gamma\tau$. Collecting results, one of the boundaries of the constraint set must be preferred to any T which lies in its interior.

A numerical illustration is provided in Table 1. We consider a woman who works for two years before she marries and then eight more years after marriage. The total of her pre-marital earnings is \$21,000. Her total earnings after marriage depend upon when she leaves the labour force and the extent of her career regression. In our calculations we assume that $\gamma\tau = 4$, meaning that four years of work experience are lost during the τ years of unemployment. Thus, if the woman has her first birth in the third year of her marriage, i.e. $T = 3$, she earns \$14,000 in the year preceding her unemployment. When she returns to work, the salary earned is \$11,000 rather than \$15,000. The second and third columns in Table 1 depict the relationship between T and her lifetime earnings. As previously suggested, lifetime earnings fall with T when all job skills are lost during unemployment, but rise with T when the skill loss is incomplete.

Table 1. *Child timing and lifetime earnings*

Income profile ($)	Date of birth	Lifetime earnings ($)
10,000		
11,000	$T=0$	129,000
12,000	$T=1$	124,000
13,000	$T=2$	121,000
14,000	$T=3$	125,000
15,000	$T=4$	129,000
16,000	$T=5$	133,000
17,000		

Which of the two boundary points, $T=0$ or $T=R$, is in fact optimal depends upon the parameters γ and ω. Consider first the depreciation parameter γ. If $0<\gamma \leqslant \omega/\tau$, $T^*=R$. The wife suffers only a partial loss of skills even if she gives birth immediately. Postponement of childbirth then necessarily raises her life-cycle earnings. On the other hand, suppose that γ is large enough to exceed ω/τ, meaning that a complete loss of job skills would be associated with immediate childbirth. In this case, T^* may equal either 0 or R. But $Y(0)$ is independent of γ, while $Y(R)$ falls with γ.[5] Therefore, we can conclude that early timing patterns will become more attractive the more rapid the rate of skill decay.

Now consider the effect of ω on T^*. We wish to compare the optimal timing patterns of women who enter the same occupation at the same age, but who marry at different ages and thus acquire different quantities of pre-marital work experience. Such comparisons are most easily made if the variables T, R and L are defined as distances from a common age at entry into an occupation rather than as distances from age at marriage. By doing so, the child-timing problem can be rewritten as

$$\max \tilde{Y}(\tilde{T}) = \int_0^{\tilde{T}} y\{t\}\,dt + \int_{\tilde{T}-\tau}^{\tilde{L}} y\{t-\tau-\min(\gamma\tau, \tilde{T})\}\,dt, \tag{3}$$

subject to the constraint that $\omega < \tilde{T} \leqslant \tilde{R}$. The new time-related variables are denoted $\tilde{T}$, $\tilde{R}$ and $\tilde{L}$; and the objective function now measures lifetime earnings rather than total earnings after marriage. While mathematically equivalent to (2), the formulation in (3) is more convenient for determining the effect of ω on T^* because ω appears only as a lower bound in the constraint and not in the objective function.

The relationship between $\tilde{Y}$ and $\tilde{T}$ is presented in Figure 2. It is drawn to be consistent with earlier statements that $\tilde{Y}$ will first fall and then rise with $\tilde{T}$. Note also that lifetime earnings are highest for $\tilde{T}=0$. This must be the case because if childbearing is completed before entry into an occupation, the woman can avoid a regression in her career path. When $\tilde{T}>0$, that portion of the earnings profile which extends from $\{\tilde{T}-\min(\gamma\tau, \tilde{T})\}$ to $\tilde{T}$ will be completed twice.

For women who have no pre-marital work experience, the optimal date of first birth is $\tilde{T}=0$. On the other hand, women who enter their occupations before marriage are constrained in their section of $\tilde{T}$ by the interval $[\omega, \tilde{R}]$. This effectively eliminates from

[5] The wife's life-cycle earnings at the two boundary points are

$$Y(0) = \int_0^{L-\tau} y\{t\}\,dt,$$

and

$$Y(R) = \int_0^{R} y\{t+\omega\}\,dt + \int_{R+\tau}^{L} y\{t+\omega-\tau-\min(\gamma\tau, R+\omega)\}\,dt.$$

Provided that $R+\omega > \gamma\tau$, an increase in γ reduces $Y(R)$, but fails to influence $Y(0)$.

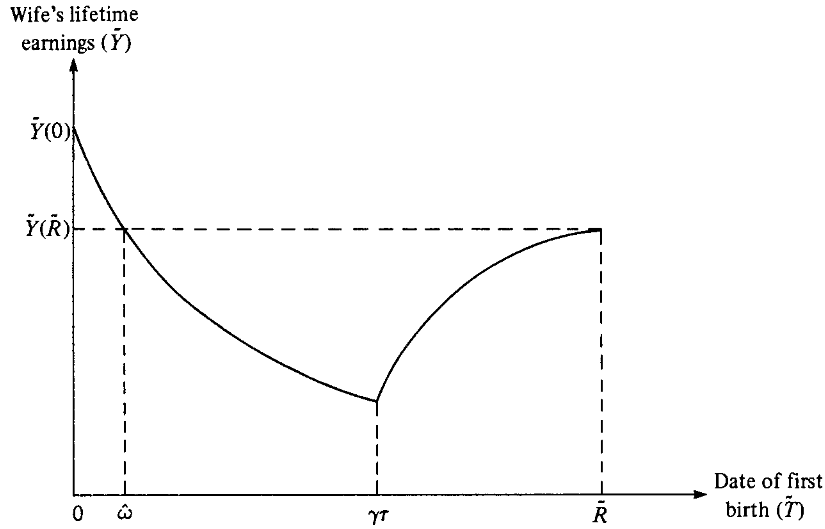

Figure 2. Child timing and the wife's lifetime earnings.

consideration that portion of Figure 2 which lies to the left of ω. If ω is gradually raised, then it remains optimal for the wife to begin childbearing immediately after marriage so long as ω is less than $\hat{\omega}$. However, once $\omega > \hat{\omega}$, the optimal timing pattern is given by $\tilde{T} = \tilde{R}$. In conclusion, the probability of a delayed first birth will increase with the amount of work experience accumulated by the wife before marriage.

IV. CHILD TIMING AND CONSUMPTION SMOOTHING

When capital markets are perfect, the size of the costs of child care influences the number of desired births, but not necessarily their timing. By borrowing on its future income, a couple can begin childbearing quite early and still enjoy a standard of living which approximates its life-cycle norm. However, even in countries with well-developed financial markets, borrowing is typically associated with a penalty rate and is available only up to a fraction of tangible assets. Faced with such a situation, couples wishing to smooth their life-cycle distribution of non-child consumption have an incentive to synchronize the costs of child care with a period in which the man's earnings are relatively high.

The consumption-smoothing motive in child-timing decisions is best illustrated by assuming a complete absence of capital markets. Consumption in each period then equals household income less any child expenses. To abstract from the points covered in Section III, we also assume that the wife's income is independent of time. This implies that the couple's mean lifetime consumption will be independent of T, and it allows us to focus upon the relationship between T and the dispersion of the consumption profile. Under these assumptions, the timing problem can be written as

$$\max W(T) = \int_0^T U\{x(t)+y\}\,dt + \int_T^{T+\tau} U\{x(t)-e(t-T)\}\,dt + \int_{T+\tau}^{T+\mu} U\{x(t)+y-e(t-T)\}\,dt + \int_{T+\mu}^{L} U\{x(t)+y\}\,dt, \quad (4)$$

subject to the constraint that $0 \leqslant T \leqslant R$. The life-cycle is divided into four time intervals. From marriage until the date of the first birth, the couple's non-child consumption equals the earnings of both the husband and wife. Once childbearing begins, household consumption is reduced by γ for τ periods, during which the wife is absent from the labour force, and by e for μ periods, owing to the pecuniary costs associated with child care. The remainder of the life-cycle is characterized by an absence of child costs and by employment of both the husband and wife.

Since mean lifetime consumption is independent of T, life-cycle utility is maximized when births are delayed to the biological limit.[6] The household smooths its consumption profile, and therefore raises its economic welfare, by delaying the τ periods of the woman's unemployment and the μ periods of child expenses to a time when the man's earnings are relatively high. Of course, we are not suggesting that the presence of capital market imperfections guarantees that births will be postponed to the biological limit; we have intentionally controlled for other factors which bear upon the timing decision, many of which encourage early timing patterns.[7] But such imperfections do generate an incentive to delay childbirth.

Those factors which determine the stength of the consumption-smoothing motive are conveniently identified with the following special case. Assume that the utility function U is quadratic, that e is time-independent, and that the male's earnings rise at a constant rate over the interval $[0, R+\mu]$. Then the rate of change in W with respect to T can be derived from Equation (4) as

$$\frac{dW}{dT} = -U'' \frac{dx}{dt}[y\tau + e\mu]. \tag{5}$$

Equation (5) offers a clear account of the factors which make for a consumption-smoothing motive in child-timing decisions. First, households prefer more to less stable life-cycle consumption streams. This statement of preference follows from the law of diminishing marginal utility and is conveyed by the negativity of U''. Secondly, if the husband's earnings are expected to rise over his working life, the time variability in household consumption can be reduced by delaying childbirth. Finally, the size of child costs influences the size of dW/dT. These costs include not only the pecuniary expenses, $e\mu$, but also the foregone wages of the wife, $y\tau$. The larger are any of the terms in Equation (5), the stronger will be the incentive to delay birth.

One particular proposition suggested by Equation (5) is that the optimal date of first birth will vary directly with the length of the wife's job absence, τ. This is a useful result, since we are then able to make statements concerning the impact on T^* of variables which bear upon the choice of τ. Consider, for example, a reduction in the costs of external child care. A greater availability of day care centres will reduce time spent out of the labour force and, therefore, will encourage earlier births. Consider also the relationship between T^* and the desired number of children. If a couple originally decided to delay birth for as long as was biologically reasonable, but then revised upward the number of desired births, the first child would have to be born earlier than initially planned. However, for women who are effectively free of the reproductive constraint, an increase in the number of children will, by raising τ, create an economic incentive to delay the first birth. This result runs counter to the conventional empirical hypothesis that the timing of the first birth will vary inversely with the desired number of births.

Finally, notice from Equation (5) that the level of the husband's earnings profile does

[6] See Appendix A for a formal demonstration of this point.

[7] A model admitting the possibility of early births might recognize some of the following: (i) women with little pre-marital work experience who expect to pursue a career where interruptions in work effort carry significant penalties in career development due to obsolecence or depreciation of job skills (see Section III); (ii) employment risks for the wife, so that childbirth may become attractive during periods of economic recession; (iii) children as income-producing assets; and (iv) a subjective time preference for early births.

not seem to influence the strength of the consumption-smoothing motive. Unlike the other variables which appear in the equation, the effect on T^* of a change in the husband's mean life-cycle earnings depends upon properties of the utility function which are not as widely accepted as the law of diminishing marginal utility. Specifically, it can be shown that an increase in the mean of x will hasten, delay, or not alter the timing of the first birth depending upon whether the third derivative U''' is positive, negative, or zero.[8] Arrow argues that U''' must be positive in order to explain observed responses in the composition of financial portfolios to changes in wealth.[9] There may then be a presumption that households with husbands employed in higher-paying occupations will begin childbearing earlier in their marriages. However, this should be considered somewhat of an empirical issue.

V. EMPIRICAL ANALYSIS

Empirical tests of our hypotheses were performed with data collected in the National Longitudinal Surveys.[10] The final sample was drawn from the cohort of women aged 14 to 24 in 1968 who were surveyed each year from 1968 to 1972. We included only married women whose spouses were present and fully employed and whose first births occurred within the survey period. This left us with a test sample of 210 households.

A potential difficulty in our sample selection process involves households which had not begun childbearing by the end of the survey period. We excluded from consideration any women who would have had their first births after age 28. This causes biased parameter estimates if the error term in our child-timing equation is correlated with the error term in a relationship describing the probability of a first birth being observed. To avoid this selection bias, we followed the two-step procedure developed by Heckman.[11]

Suppose that the child-timing model is represented by

$$T^* = X\beta + \epsilon, \tag{6}$$

where X is a matrix of explanatory variables, β is a vector of parameters and ϵ is a vector of random disturbances following classical assumptions. Suppose further that we restrict our attention to households which either experienced a first birth within the survey period or which desired children, but had failed to begin childbearing by the end of the survey period.[12] Then the probability of observing a first birth is given by

$$Pr\{\epsilon \leqq Z\theta\}, \tag{7}$$

where $Z(\theta) \equiv$ (wife's age in 1972) $-$ (wife's age at marriage) $- X\beta$. Heckman's procedure first calls for a probit estimation of (7). These estimates are used to construct a hazard ratio of the form

$$\lambda = f(Z\hat{\theta})/F(Z\hat{\theta}), \tag{8}$$

where f and F are the normal density and cumulative normal density functions. The hazard ratio is then included as an independent variable in the child-timing model. Thus the final equation to be estimated can be written as

$$T^* = X\beta + \lambda\delta + \epsilon, \tag{9}$$

[8] See Appendix B for a proof of this proposition.

[9] K. J. Arrow, *Essays in the Theory of Risk-Bearing*, Ch. 3 (Chicago, Markham, 1971).

[10] The data set is described in H. S. Parnes, 'The National Longitudinal Surveys: new vistas for labor market research', *American Economic Review*, **65** (1975), pp. 244–249.

[11] J. Heckman, 'The common structure of statistical models of truncation, sample selection and limited dependent variables, and a simple estimation for such models', *Annals of Economic and Social Measurement*, 5(4) (1976), pp. 475–492.

[12] There were 432 such households in our sample.

where γ is a parameter for the hazard ratio. As shown by Heckman, an application of OLS techniques to Equation (9) will yield consistent estimates of the parameter vector β.

The dependent variable in our regressions, the timing of the first birth, is defined as the difference between the age of the wife at first birth and her age at marriage. A list of the explanatory variables suggested by our theoretical analysis would include a rate of skill depreciation for the wife's occupation, her pre-marital work experience, the mean of her lifetime earnings profile, the period of unemployment associated with childbearing, child expenditures, and the mean and dispersion of the husband's earnings profile. Unfortunately, three of these variables – the rate of skill decay, length of unemployment, and child expenses – have no directly observable measure in either the NLS or any other existing data set. However, many of the variables can be proxied using data provided in the NLS, and others can be estimated from independent sources. The explanatory variables included in our regressions are described below.

1. *Wife's age at marriage.* This variable appears in the regression for several reasons. First, it controls for the biological constraints which bear upon child-timing decisions. Women who marry late may begin childbearing early in their marriages to reduce the risk of infertility or medical complications. Secondly, if women either marry or begin to acquire career-related skills at roughly the same age, then the age of the wife at marriage may correlate highly with the theoretical parameter ω, the wife's pre-marital work experience. Based upon this argument, women who marry at an older age should tend to delay childbirth within their marital life-cycles (see Section III). Finally, if the wife's age at marriage is included, the regression results provide statements concerning the relationships between the age of the wife at first birth and all other explanatory variables. This is useful because the mean age at first birth, rather than the mean distance from marriage, is most critical in determining population turnover.

2. *Wife's occupational class.* The wife's job characteristics were accounted for by introducing occupational dummy variables. Because the sample size was limited, we were forced to aggregate to five classes: high-skill white collar (HSW), containing professionals, technical administrators and managers; low-skill white collar (LSW), containing sales and clerical workers; high-skill blue collar (HSB), containing craftsmen and operatives; low-skill blue collar (LSB), containing labourers and service workers; and housewives (HW), containing women not classified as part of the labour force in 1968. The wife's occupational assignment was based on her type of employment before the first birth.[13]

A priori prediction of the signs and magnitudes of these regression coefficients is difficult. Suppose that, in spite of the level of aggregation, γ is highest for HSW and HSB. In Section III we argued that women who face rapid skill decay tend to have their children early. Thus we might expected smaller regression coefficients for the high-skill than for the low-skill occupations. On the other hand, the mean lifetime earnings of the wife will be positively correlated with the skill level of her occupation; and in Section IV we showed that women with a high opportunity cost of time spent in the household will have an incentive to delay childbearing. Larger coefficients for HSW and HSB are then also plausible.

3. *Parameters of the husband's earnings profile.* The man's income profile was constructed for the U.S. Bureau of the Census 1/1000 Public Use Samples for 1970.[14] We divided men's occupations into ten categories: professional and technical, managerial

[13] Because of the high level of aggregation, there were few instances of switching between occupations between 1968 and 1972.

[14] U.S. Bureau of the Census, *Public Use Samples of Basic Records from the 1970 Census: Description and Technical Documentation* (Washington, U.S. Government Printing Office, 1972).

and administrative, sales, clerical, craftsmen, operatives, non-farm labour, farm labour, non-household service, and private household service. We then estimated for each class a cubic equation relating the man's current labour income to his current age.[15] The expected income profile for a man in the NLS sample was taken to be the profile predicted for an average member of his occupational class.

In Section IV we showed that the incentive to delay birth for purposes of consumption-smoothing related directly to the rate at which the husband's earnings were expected to increase over the interval $[0, R+\mu]$. Since each estimated profile was non-linear, we used the standard deviation, computed from the husband's age at marriage to age 45, to measure the rate of increases in his earnings parametrically. In accordance with the theory, the regression coefficient should be positive and its significance will support the notion of a consumption-smoothing motive in child-timing decisions.

It was also suggested that, other things being equal, the optimal date of first birth may relate inversely to the husband's mean lifetime earnings (see Section IV). Thus we included the mean of the man's profile, computed from his age at marriage to age 65. Our expectations concerning the sign of this coefficient are less firm, however. Child quality expenditures, which do not appear in the regressions, are positively correlated with the household's permanent income and, in themselves, promote delayed first births.

4. *Husband's age at marriage*. This variable accounts for any timing preferences which are age-related, but which are not associated with the economic variables already included. A positive (negative) coefficient would indicate that, among men who marry women of the same age, the older ones are more (less) patient about beginning their families.

5. *Number of desired births*. The NLS data sample did not cover households with completed families, but couples were asked how many children they considered ideal. In contrast to the conventional demographic reasoning, we do not have strong expectations of a negative coefficient for this variable. If childbirth has been postponed to the biological limit, then an upward revision in family size must lead to an earlier first birth. However, if the couple expect to complete their family before the biological constraint, then an additional child will, as suggested in Section IV, delay the date of the first birth.

6. *Race*. Race is included to test whether differences in timing patterns across racial groups can be ascribed solely to contemporaneous differences in economic variables.

Table 2 contains the results of our multiple regression analysis for two forms of the model: with and without the wife's age at marriage as an independent variable. In those cases where *a priori* predictions were possible, the signs of the coefficients are consistent with our theoretical expectations. Furthermore, in each regression the value of R^2 is relatively high for a cross-sectional study and F is significantly different from zero.

The wife's age at marriage serves as a proxy for both her pre-marital work experience and the proximity to R, the conclusion of fertility. Its coefficient is negative and significant, implying that women who marry late begin childbearing early in their marriages. Thus the nearness to R appears to dominate the effect of pre-marital work experience, possibly because the wife's age at marriage only imperfectly measures it.

The wife's earnings characteristics are captured with occupational dummy variables, where 'housewives' is the excluded job class. The results indicate that women in high-skill occupations (HSW and HSB) tend to have their first child later than women in low-skill

[15] Age can be used in place of accumulated work experience assuming there are no significant interruptions in work effort and that, within a given occupational class, males begin to acquire specific job skills at the same age. Because the first assumption is so patently inappropriate for childbearing women, we were unable to use the Census data to estimate female earnings profiles.

Table 2. *Estimation results for the length of the first birth interval*†

Intercept	2.420*	−2.386*
	(2.19)	(−2.46)
Wife's age at marriage	−0.321	
	(−7.04)	
Wife's occupation		
HSW	11.425*	12.971*
	(14.80)	(14.73)
LSW	5.682*	6.378*
	(13.71)	(14.11)
HSB	7.776*	9.011*
	(13.21)	(13.83)
LSB	−1.082*	−0.962*
	(−3.94)	(−3.46)
Husband's earnings profile		
Mean‡	−0.240*	−0.454*
	(−1.96)	(−3.86)
Standard deviation§	1.001*	1.447*
	(2.73)	(4.02)
Husband's age at marriage	0.472*	0.494*
	(7.27)	(7.45)
Number of desired births	0.113	0.111
	(1.23)	(1.19)
Race	1.115*	1.269*
	(3.99)	(4.42)
Lambda	−11.688*	−13.447*
	(−14.5)	(−14.94)
R^2	0.59	0.57
F	25.44	25.91*

† t values reported in parentheses.
‡ Coefficients multiplied by 10^3.
§ Significant at the 95% level of confidence.

occupations (LSW, LSB and HW), and each of the included classes is statistically significant. The relatively large coefficients for HSW and HSB are theoretically acceptable, since the mean of the wife's lifetime earnings is positively correlated with the level of her job skills.

The variables which pertain to the husband's income profile also performed well. The mean of the profile is statistically significant, and its negative coefficient is consistent with the theory, assuming a low income elasticity of demand for child quality. The standard deviation should and does exert a positive influence on the timing of the first birth. Its significance attests to the importance of a consumption-smoothing motive in timing decisions.

Several of the socio-demographic variables also add to the explanatory power of the equation. The coefficient for husband's age at marriage is positive and significant, implying that men who marry at an older age take longer to begin their families. The coefficient for race is also significant and positive. Since blacks were given the value 1 and whites 0, we find that, *ceteris paribus*, black couples begin childbearing later in their marriages than do white couples. This is a somewhat novel result, but may be due to the fact that our test sample covered only legitimate births, while a significant portion of black childbearing takes place out of wedlock.[16] The coefficient for desired family size is also positive, but not statistically significant.

Finally, the coefficient of the hazard ratio λ is highly significant. This implies that a

[16] Birth statistics for the 1968–1972 period can be found in U.S. Bureau of the Census, 'Fertility of American women: June 1978', *Current Population Reports*, Series P-20, No. 341 (1979).

failure to account for couples who had not begun childbearing by the end of the survey period would result in substantial bias in the parameter estimates.

VI. CONCLUSION

The timing of childbirth can be viewed as a problem of economic choice in view of its impact on both the wife's lifetime earnings and, when capital markets are imperfect, the life-cycle distribution of the household's consumption stream. Economic variables which merit particular emphasis include: the rate of the wife's job skill depreciation during unemployment, her pre-marital work experience, the wife's opportunity cost of completing a family, and the mean and dispersion of the husband's earnings profile. Theoretically, the length of the first birth interval will be inversely related to the depreciation rate of job skills and, if the income elasticity of demand for child quality is relatively low, to the husband's mean lifetime earnings. All other variables exert a positive influence on the timing of the first birth. Our empirical results are consistent with the theory and, in terms of statistical significance, indicate that economic variables do provide significant explanatory power even when more traditional socio-demographic variables are included in the regression equation.

If U.S. households continue to abide by a two-child norm, the future age composition of the population will be shaped ever more strongly by timing decisions. The results in this paper offer some insights into emergent timing patterns. One of the most dramatic changes in labour market conditions of the post-war era has been the surge in women's labour force participation. If this trend persists and women acquire higher-paying jobs, our work indicates there will be a greater economic incentive for couples to postpone childbirth. Delays in timing patterns will also be encouraged if educational and training periods are extended and a greater proportion of primary workers concentrated in occupations with substantial life-cycle earnings variability.

In contrast, improved access to day care centres promotes earlier births by reducing the time which childbearing women must spend out of the labour force. It is difficult to predict which of these factors will prove most influential. However, it is our feeling that the recent increase in the availability of day care centres represents a normal market response to an increase in the demand for external child care, an increase which stems largely from this rising opportunity cost of time spent in the household. On balance, we then anticipate continued pressure for delays in childbearing, particularly for women with substantial earnings potential.

APPENDIX

A. Given the problem in (4), postponements of childbirth necessarily raise the economic welfare of the household. This can be formally demonstrated by deriving the rate of change in W with respect to T. First, replace the limits in the second and third integrals of W with $[0, \tau]$ and $[\tau, \mu]$, respectively. We can write

$$dW/dT = U\{x(T)+y\} - U\{x(T+\mu)+y\} + \int_0^\tau U' \frac{dx}{dt} dt + \int_\tau^\mu U' \frac{dx}{dt} dt, \tag{A 1}$$

where the arguments of the marginal utilities are $\{x(t+T)-e(t)\}$ and $\{x(t+T)+y-e(t)\}$. Now drop the child expenditures and integrate to obtain

$$dW/dT > U\{x(T)+y\} - U\{x(T)\} - U\{x(T+\tau)+y\} + U\{x(T+\tau)\}. \tag{A 2}$$

Given the law of diminishing marginal utility and our assumption that the husband's income increases with work experience, the r.h.s. of (A 2) must be positive. T would then be delayed to the biological limit.

B. To determine the effect on T^* of a change in the mean of the husband's earnings profile, re-write $x(t)$ as $\{x(t)+\alpha\}$. The term α is a shift parameter which can be assumed to equal zero initially. By making this substitution into (A 1), we can obtain

$$\partial^2 W/\partial T\partial\alpha = U'\{x(T)+y\} - U'\{x(T+\mu)+y\} + \int_0^T U''\frac{dx}{dt}dt + \int_T^\mu U''\frac{dx}{dt}dt. \tag{B 1}$$

Equation (B 1) can be expressed as

$$\partial^2 W/\partial T\partial\alpha = \int_0^T [U''\{x(t+T)-e(t)\} - U''\{x(t+T)+y\}]\frac{dx}{dt}dt$$

$$\int_T^\mu \left[U''\{x(t+T)+y-e(t)\} - U''\{x(t+T)+y\}\right]\frac{dx}{dt}dt. \tag{B 2}$$

Thus, if the utility function is quadratic, as assumed in the derivation of Equation (5), $\partial^2 W/\partial T\partial\alpha = 0$. In general, however, $\partial^2 W/\partial T\partial\alpha \gtrless 0$ as $U''' \gtrless 0$.