T. Paul Schultz
University of Minnesota
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DETERMINANTS OF FERTILITY: A MICRO ECONOMIC MODEL OF CHOICE*

I. INTRODUCTION

There are many explanations of why human fertility varies from one society to another and among different groups or individuals within the same society. Attempts to identify and measure the factors that affect fertility and hence to discriminate among competing causal hypotheses have not been notably successful. This gap in our basic stock of knowledge is both a source of embarrassment to social scientists and an obstacle to the strategic formulation and tactical evaluation of population policies throughout the world.

In this paper I discuss one framework for interpreting variation in reproductive behavior. This economic approach to the analysis of fertility holds promise of accounting for factors affecting fertility, especially those which might be influenced by public policy, and of relating these factors in a consistent manner to other important forms of household decision making, such

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as labor force participation, marriage and savings. Unlike many other areas of household nonmarket choice, the number of children a couple has is of course readily measured. Recent progress in the extension of economic analysis to the study of fertility has clarified many issues, but the field remains in a state of flux. For the economic approach to yield empirically refutable propositions it is necessary to impose upon it a number of specific assumptions. At this time, however, it is unclear which set of assumptions least impairs the model's realism. My objective is to restate the central theoretical elements of this approach to the determinants of fertility, explore briefly as yet unsolved problems with this schema, and speculate on its usefulness for the choice and evaluation of policy.

II. TASTES AND BIOLOGICAL DETERMINANTS OF FERTILITY

If variation in fertility across individuals and groups were a purely random phenomenon, a theory of fertility would have little point. But there is widespread agreement that two sources of systematic variation in fertility warrant a place in any theory of fertility determination--biological factors that constrain the reproductive process and determine fecundity or the potential supply of births, and conscious and inadvertent differences in behavioral factors that modify the extent to which the biological maximum is realized.

For the policymaker the more interesting factors affecting fertility are those that can be influenced by administratively and politically feasible policies.[1] A continuing objective of my research in this field has been to discover promising policy options to facilitate economic and demographic development, and this may explain why I emphasize factors that are plausibly linked to policy instruments. Many of these presumed links, of course, are very poorly understood, such as how public policy affects child mortality or the age at which children leave school and first enter the labor force. Any manageable and illuminating representation of the complex process determining fertility must neglect

[1] For example, more analytical attention might be given to the relationship between the educational attainment of parents and their fertility than to the relationship between desired family size and fertility. The former relation is subject to obvious policy instruments and can be projected accurately for a cohort as it ages; the latter relation is not yet reliably affected by policy options and has not, to my knowledge, been projected for a cohort with great precision.

many facets of the problem. Hopefully, these omitted factors interact neither with those factors that are analyzed nor with each other.[1] If this were true, their neglect need not distort interpretation of empirical evidence on the responsiveness of fertility to those group and individual characteristics implied by the economic framework as determining reproductive demands. Two such broad classes of factors that are neglected in most economic analyses of fertility are systematic[2] differences in reproduction associated with fecundity and "tastes". In the

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[1]In formulating a simple statistical model from a complex conceptual model, the assumption is often made that the large number of omitted and frequently unobserved factors are independent of each other and therefore their sum may be assumed to approach a normally distributed random disturbance in the form of the model to be statistically estimated. It should not be surprising therefore that it is possible to account for a larger fraction of the differences in average reproductive behavior across groups because these stochastic elements cancel out and the systematic factors appear to "explain" more of the aggregate variation in fertility. Conversely, it is more difficult to account for the reproductive behavior of individual families, for a larger share of the variation in fertility will stem from purely random factors and the systematic factors will "explain" a smaller share of the observed variation in fertility. Appropriate tests of statistical significance, therefore, are not explanatory power (i.e., R^2) but the magnitude and sign of estimated coefficients (i.e., effects) relative to their standard errors, or asymptotic standard errors where simultaneous equations or nonlinear estimation techniques are required to obtain consistent estimates.

[2]Systematic differences refers here to those that could be predicted on the basis of obtainable information and estimatable models. Certainly a substantial fraction of the variability in individual reproductive behavior is in no sense systematic or predictable, resulting from truly stochastic parameters to underlying biological processes, and perhaps equally random vagaries of individual human behavioral response to the same conditioning stimuli.

next section I consider this limitation to the specification of the demand theory of fertility.

Biological Constraints on Fecundity

In most contemporary societies the biological maximum fecundity is not a binding constraint on the desired reproductive behavior of a substantial fraction of parents over their entire life cycle. Undoubtedly there have been historical periods when a majority of parents failed to rear to maturity the number of children they wanted, perhaps because of severe child mortality. But in most low income countries these conditions no longer exist. Child mortality has been falling for three decades or more, and evidence from both anthropology and sociology suggests that a majority of parents in these countries have for some time exercised individual choice or adopted social conventions to limit their reproductive performance. There are also historical instances when the spread or control of specific diseases may have affected fecundity, such as in certain of the Pacific Islands in the 19th and 20th centuries (Pirie, 1972). But such cases are always difficult to document, and are often transparent means for denying the importance of elusive behavioral factors in the control of fertility.[1] Although the relative importance and effectiveness of individual and societal modes of reproduction

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[1]Reynolds Farley (1970) is surely open to this interpretation, where the economic depression is ignored as a possible cause for the drop in U.S. Negro fertility during the 1930's, whereas on the other hand, the spread of venereal disease is emphasized as the probable explanation (p. 215-235).

control are as yet unclear, it is well established that biological constraints on fecundity are today relatively unimportant in accounting for systematic differences in fertility, except perhaps across societies with very different standards of living or endemic disease.

Moreover, it is extraordinarily difficult to separate empirically the biological and behavioral components of the reproductive process. It is, of course, well known that fecundity or the biological capacity to give birth varies systematically with a woman's age. The proportion of women biologically incapable of childbearing appears to increase gradually from age 20 to 40, and increase sharply thereafter. By the time women reach age 50, virtually all are sterile. In studies of several cohorts of non-contracepting women of proven fecundity (i.e. they subsequently had children), intervals between births are observed to increase gradually from 24 months for women in the 20-24 age group to about 31 months for the 35-39 age group (Henry, 1966). Thus, both the probability of being incapable of bearing a child and the time required, on average, for fecund couples to have a child appear to increase with age.

The analytical problems of separating empirically the biological and behavioral components of the reproductive process arise because the onset of sterility and the spacing of births may also be influenced by diet, general health, prevalence of specific diseases, and the prior pattern of childbearing and breast feeding. It is widely believed that the time between a

birth and the reappearance of ovulation is an increasing function of the duration and intensity of the mother's suckling. Since some of these secondary biological effects on fecundity, holding age constant, can be behaviorally influenced by social custom or individual choice, observed differences in fecundity might reflect in part differences in desired fertility that could be accounted for within a behavioral framework.[1] The distinction between biological and behavioral determinants of fertility is thus a difficult one to draw, in practice, except where the conditioning factor is clearly exogenous; that is, not subject to individual or even to social choice, such as with age.

Although much work is underway characterizing the biological determinants of fecundity, there is not yet a consensus on how lactation practices, diet, or health status of the mother, for example, affect the duration of sterility she experiences after a birth, her subsequent rate of conception and fetal mortality. Moreover, the values of parameters used to describe the most interesting relationships in the reproductive process have often been based on small sample clinical studies that leave much to be desired. Only recently have such parameters, as for example,

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[1]A mother is free to vary her lactation practices depending upon her desired rate of conception. This decision may also influence the incidence of child mortality among her infants, for mortality is sometimes more frequent among those weaned before the second year of life (Wyon and Gordon, 1971). Also the incidence of pregnancy wastage is clearly affected by a woman's regime of work, diet, etc., and differential spontaneous abortion, miscarriage and stillbirth rates probably reflect more than purely stochastic variability (Freedman and Coombs, 1966; James, 1969).

those linking lactation to intervals between births, been estimated satisfactorily within the context of an explicit stochastic framework. These findings have not yet, to my knowledge, been verified for different populations.[1]

This weak empirical foundation for models of fecundity is undoubtedly related to the complexity of the pertinent biological processes, but it is also a function of the scarcity of longitudinal analyses of individual reproductive histories and the likelihood that these studies are contaminated by induced "behavioral" variation in reproductive performance.[2]

In sum, important differences in biological fecundity are associated with the aging process.[3] Within age-stratified groups

[1]Jain's (1968) dissertation develops a stochastic model of human reproduction and estimates for a sample of Taiwanese women the effect on fecundity of socioeconomic factors, holding constant (approximately) for duration of lactation. (See also Jain, et. al. 1970, Schultz and DaVanzo, 1970.) Studies of child mortality have also begun to use individual survey data and more persuasive methods of multiple regression, for example, Shah and Abbey (1971).

[2]Unfortunately, longitudinal histories that include the necessary demographic, economic and biological/nutrition/health information to estimate such a model are still uncommon (Butz, 1972; Butz and Schultz, 1972; Schultz and DaVanzo, 1970). Theoretical work in this direction is being undertaken by Robert Michael and Robert Willis at the National Bureau of Economic Research to gain a better understanding of the determinants of contraceptive behavior. Their investigation is proceeding in the tradition of Sheps and Perrin (1963), Sheps (1965), Henry (1972), and Mencken and Sheps (1973).

[3]Age in a cross section is also associated with birth cohort effects, and will tend to capture time variant determinants of fertility that are omitted or measured with systematic error in a predictive model. Willis (1973) for example includes a quadratic in age when he considers in one regression equation the number of children ever born to currently married U.S. white women in 1960 between the ages of 35 and 64. (Table 2, S50). The quadratic in age accounts for part of the cycle in cohort fertility associated with the baby boom. But what is more interesting, the inclusion of three "economic" determinants of desired fertility (measured contemporaneously) in the regression equation does not modify

in a given society, differences in women's fecundity can stem either from factors that are beyond her control, such as regional health conditions, or from factors over which she has greater control, such as prolonged lactation or induced abortion. If the former uncontrolled factors influencing fecundity are independent of the environmental variables that will later be interpreted as the determinants of the demand for children, the neglect of these determinants of fecundity should pose no statistical problem in the analysis of fertility as a demand determined process. Moreover, as fecundity becomes an ever less frequently binding constraint on women having at least the number of children they want, and birth control technology reduces the cost and inconvenience of curbing excess fecundity, the demand framework should account for an increasing share of systematic variation in completed fertility.

Demand and the Role of Tastes

Reproductive behavior is often associated with a parent's socioeconomic characteristics. These empirical regularities might be attributed to differences in preferences for offspring among these socioeconomic groups of parents. Parents derive intangible rewards and in some cases pecuniary transfers from their children, and differences in a parent's evaluation of these returns are undoubtedly responsible for a part of cross-sectional and time series variation in fertility. The importance of "tastes" in determining desired fertility is thus widely recognized (Easterlin, 1969), but the operational significance of this

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greatly the explanatory role of the quadratic in age. These results reinforce evidence from other sources that the broad aggregate time trends in fertility are not yet adequately explained by available evidence assembled in the micro economic framework.

interpretation is rarely made explicit. To the economist, tastes differ among individuals if they behave differently when confronted by the same prices and endowed with the same resources and productive technology. If tastes are thus defined as the variability in behavior unexplained by economic variables, the concept of taste acquires substantive content only when the distribution of tastes across a population is related to observable phenomena, or more generally, when a model of taste-formation is postulated with refutable empirical implications.[1]

Lacking a psychological theory that specifies relationships between observable characteristics of parents and their "tastes" for children, this line of inquiry has not yet been notably productive.[2] Given the nonpecuniary context in which parents

[1]Such a model of taste formation is verbally stated by Easterlin (1968) and Fuchs (1956). The hypothesis is essentially that individuals develop their expectation for an acceptable material standard of living on the basis of the economic status of their parents when they are teen-agers. If the economic fortunes of the children are better than they anticipated, they feel they can "afford" somewhat more children than secular trends would predict, and vice versa. Children are essentially supernumerary expenditures that absorb the excess or shortfall of actual to anticipated incomes. The cohort born and raised during the Great Depression, hence, contributed to the postwar baby boom, whereas the offspring of the baby boom are not faring as well as they expected, in part because of their cohort's relatively large size. Consequently, the cohort born in the 1950's is now contributing to the sharp decline in birth rates in the United States. Though this model may have considerable predictive power to account for cross-sectional and disaggregated time series variation in fertility in all high income countries, it has been tested only to a limited extent against U.S. aggregate time series.

[2]To propose that unexplained differences in reproductive behavior among race or religious groups reflect differences in "tastes" is, in my judgment, to mask our ignorance. An alternative approach to searching for the sources of ethnic group differences is evident in the observation that Catholic women with a college education have more children than nonCatholics with the same

obtain satisfactions from their children[1], and the highly subjective and intangible nature of certain "tastes" for parenthood, presently there is no obvious way to integrate and analyze the role of tastes within a theory of fertility.

It is common, therefore, to assume that all individuals share the same utility function embodying their basic preferences. Differences among individuals in appraising specific goods are then attributed to differences in their environment, some aspects of which are assumed to be stochastic.[2] Specifically, people

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education, but that these differences are insignificant between women with lesser education. Implicitly two working hypotheses may be entertained. Is it the Catholic college experience that contributes to "taste" formation in the United States, or do those with such family-formed tastes elect to enroll in Catholic colleges? Empirical tests can be imagined to refine further one's understanding of the ultimate source of ethnic fertility differentials. It is also obvious, that when one stops with distinguishing differences in behavior among ethnic groups, one has provided little useful knowledge to the policymaker that has no leverage on group identification.

[1]In most societies parents are encouraged to satisfy only their own demand for children. With an imperfect market for exchange, children represent a classic example of a non-market commodity that is produced only for the final consumer. Specialization in child production is uncommon, therefore, except under unusual circumstances (see S. Chueng, 1972).

[2]Alternatively, it may be assumed that parent tastes for children vary and are distributed across populations in a specific fashion. This representation of tastes is in some respects more appealing than the abstraction of a "representative individual", and in certain circumstances it implies different response estimates from the same empirical evidence. For example, when observations are obtained on only a portion of a population, the distribution of tastes may be estimated by analyzing both pieces of evidence: data on the observed population, and the proportion of the population observed with differing characteristics. Gronau (1973a, 1973b) has used this formulation to study the shadow price of a housewife's time, when market wages are observed for only the portion of the female population that is currently in the labor force.

are assumed to prefer different amounts of a particular good, even when prices and resources appear to be the same because of a combination of unobserved "taste" factors, each independently normally distributed across populations. The sum of these specific taste-effects on fertility can be represented by a properly-behaved disturbance term in a statistical model designed to analyze systematic sources of variation in reproductive behavior.[1]

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[1]It is nonetheless important to probe beneath personal values and social norms to determine how they mould individual preferences and the related roles of culture and genetics. But measurable, variable, and potentially policy-manipulatable elements of the individual and his culture are difficult to discern. How important is it to the policymaker (in contrast with the projector or planner) that Catholics want more children than Protestants? Yet, however conceptualized and quantified, the influence of these "taste" factors can be properly assessed only when the tangible pecuniary returns have also been isolated and taken into account.

III. THE DEMAND FOR CHILDREN

The family's choice of final consumption activities is limited by its market income and the time of its members, and typically, market-determined wage opportunities provide the rate of exchange between these two scarce inputs in household consumption. (Mincer, 1963; Becker, 1965.) Since the activity of childbearing and rearing absorbs a substantial fraction of the family's available time and market income, this approach to the determinants of household demand suggests that reproductive behavior impinges importantly on parent welfare. Beyond some level of fertility, specified for a couple by its economic environment, wealth, and tastes, additional births are likely to diminish the well-being of parents, and lead them, therefore, to search more diligently for ways to avert further births. From this working hypothesis, a number of questions follow. Should one expect that differences in market prices, wages, and incomes will have a significant bearing on reproductive behavior? Is the micro economic framework of choice useful in structuring empirical research into the critical relationships between fertility and the features of the parents' environment and endowments that are predetermined for the individual i.e. outside of his control, but which are ultimately subject to some social policy control? Answers to these questions are hard to come by, but a number of recent empirical studies[1] have met with some success in interpreting

[1]The bibliography cites many of these studies. For example, see Becker, 1960; Mincer, 1963; Schultz, 1969 and a collection of studies in New Economic Approaches to Fertility (ed.) T.W. Schultz, Supp. Journal of Political Economy, 81:2, pt. II, March/April, 1973. A second conference volume will appear in a March/April 1974 supplement to the Journal of Political Economy.

reproductive behavior as a response to the relative scarcity of resources available to the household and the associated costs of children. Nonetheless, important problems remain unresolved, to which I shall turn later.

The determinants of the demand for births will be explained in terms of this framework of household choice in a resource constrained environment. This is clearly a partial approach to the problem that should eventually incorporate the salient biological, technical and behavioral features of the reproductive process that determine the supply of births. But as already noted, the biological, psychological and technical factors affecting both the supply and demand of births are not yet adequately identified or conveniently formulated for inclusion in the demand model. Despite these shortcomings, the economic framework of constrained choice appears to provide a general way of accommodating the factors dictated to individuals by their environment which presumably motivate parents to want a smaller or larger number of births. Ultimately the test of the usefulness of the demand approach will be its predictive and integrative power in comparison with alternative frameworks. It would be premature to attempt such an evaluation at this time.[1] In

[1]The most obvious reason to postpone such an evaluation is the absence of any comparable alternative structure of logical hypotheses with empirical implications, against which the economic demand model might be judged. Also, the current interest of economists in this topic is hardly a decade old, and a consensus among economists would be hard to come by at this time. Moreover, most of the multivariate empirical testing of the demand model (see Tables A and B) has been prudently focused on cross-sectional differences in fertility that are partially "explained" by almost any socioeconomic variables. The more severe test of the economic approach will be to predict time-series variation in completed reproductive performance. Whether economic theory has any interesting implications for the optimal timing of family formation (birth intervals, etc.) has not yet been established.

the remainder of this paper I shall consider some of the problems in restricting this formulation of the demand model of fertility to obtain refutable predictions; I shall also indicate how difficult it is to translate the relevant concepts into empirically observed variables; and I shall discuss the theoretical and econometric problems of identifying and estimating the structure to the dynamic household behavioral system, of which fertility is an integral part. A mathematical statement of the constrained maximization approach is presented in the Appendix for the simplified case in which it is assumed that the family chooses between only two final consumption commodities, children and all other commodities.

The resources that individuals allocate over their lifetime are ultimately their own time and their initial stock of nonhuman wealth. It is assumed that time is allocated between two classes of activities: 1) those that yield money, goods or services which can be readily exchanged in a market, and 2) those that yield goods or services which cannot be exchanged in a market and are therefore valued by the producer solely for their own consumption. Since eating, sleeping and virtually all forms of final consumption require the input of one's own time, all persons engage in the "production" of some nonmarket final consumption goods. It is also assumed that all persons allocate some time to the production of goods and services exchanged in the

marketplace.[1] In this case, if the net disutility associated with each of the two classes of activity is assumed identical, the net value of time expended at the margin in market and nonmarket activities is also equal. The market wage received by an individual equals the opportunity value of his time in nonmarket activities (Becker, 1965).

Income influences the demand for children, within this framework differently according to which member of the family experiences the change in wage rates, or whether the income comes from nonearned sources. Therefore, the lack of an invariant positive relationship between income and fertility cannot be interpreted as prima facie evidence that economic scarcity and individual choice are irrelevant to the fertility decision. If children required a fixed amount of their parents' time and market resources, one would anticipate, however, that an increase in the parents' stock of nonhuman wealth would shift their demand schedule for children and other ordinary goods unambiguously to the right. However, the simplifying assumption implicit in this argument, that children can be treated as a homogeneous commodity, overlooks the important behavioral relationship between the number of children

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[1]It is conceivable that individuals whose spouse was sufficiently productive in the market or who owned sufficient nonhuman wealth might allocate none of their time to market activities. The occurrence of such a "corner solution" leaves the individual's nonmarket allocation of time and shadow price of time dependent upon the value of his marginal productivity in each nonmarket activitiy, which is ultimately dependent on his spouse's market-determined value of time, nonhuman wealth, and nonmarket production possibilities or technology. See Willis (1971, 1973) and Gronau (1973a, 1973b).

parents want and the "endowments" parents want to give each of their offspring. I shall return to this problem of "quality" investments in children in section V and methods for dealing with this complication.

On the other hand, increases in the household's stock of human wealth, as reflected by an increase in a parent's permanent (lifetime average discounted) wage rate, generate both a positive wealth effect and an offsetting price effect due to the increase in the opportunity cost of parents' time required in the care and enjoyment of their children. Since this framework is essentially based on comparative statics, these changes in the household's human and nonhuman wealth position are assumed to be exogenous to the individual decisionmaking unit.

For linear homogeneous separable household production functions (see Appendix), the elasticity of demand for children with respect to either spouse's wage rate can be decomposed into a weighted combination of the compensated price elasticity and income elasticity of demand for children; the price elasticity is weighted by the value share of the respective spouse's time in the total cost of children minus the value share of the spouse's time in the cost of producing the composite commodity; the income elasticity is weighted by the value share of the spouse's market earnings in the household's full income (see Appendix). Stronger assumptions are required to prescribe the sign of the wage elasticities, but plausible magnitudes for these weights suggest that the elasticity of fertility with respect to the wife's wage will be

algebraically smaller than that with respect to the husband's wage, given the time intensity of children and the predominant role of mothers in child rearing.

In sum, economic analyses of fertility as a demand determined process lead to a few simple empirical predictions, if it is assumed that the resource intensity of childbearing is not also a choice variable. Nonhuman wealth exerts only an income effect on the derived demand for children, increasing desired fertility. Increases in the wage rates of parents must have a less stimulating effect on the demand for children, due to the additional offsetting effect of the price-of-time. Plausible assumptions concerning sex roles and market rewards lead to the prediction that the elasticity of demand with respect to the wife's wage will probably be negative, but under most conditions it will be at least less positive (algebraically smaller) than the elasticity with respect to the husband's wage.

Cross-sectional studies of individual countries at all levels of economic development have confirmed the qualitative predictions of this rudimentary demand theory of fertility.[1]

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[1] I have excluded from this survey cross country comparisons of fertility and its determinants because of my uneasiness with the data. Not only do the usual problems of relative prices and inconvertible exchange rates make international comparisons of income levels treacherous, but also most of the additional data required to test the propositions discussed in this paper are not meaningfully culled from standard international compendiums. For example, no experienced demographer would accept registered birth and death rates as satisfactory evidence of fertility and mortality levels in most low income countries, yet official or registered vital rates are the basis for many international cross-sectional regression analyses. Education statistics have their own problems; female labor force participation rates reflect

In part because of the difficulties of measuring a permanent wage rate, particularly for women not currently in the paid labor force, education has often been assumed to be a satisfactory proxy for lifetime wage rates. When fertility is then regressed on the educational level of men and women, the women's education coefficient tends to be negative, as anticipated, and several times its standard error, while the men's education coefficient is smaller in absolute magnitude and generally less significant statistically.[1] When regression analysis deals with average earnings for men and women within regional population aggregates, or earnings of individual couples where the husband and wife are currently working, the estimated elasticity of fertility with respect to women's earnings is negative and with respect to men's earnings the elasticity is either positive or small and negative.[2]

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local conventions; wage rates for men and women are rarely compiled and when they are available, they tend to represent only a small segment of the labor force, such as that in modern manufacturing. All of the criticisms raised later with reference to cross-sectional studies of regional populations within one country, apply with greater force to cross-sectional studies which span the even greater diversity of national institutions, statistical conventions and cultures.

[1]See for example where both male and female education is considered: Ben-Porath (1970, 1973) on Israel; DeTray (1973) U.S. counties; Gardner (1972, 1973) rural U.S.; Hashimoto (1973) Japan; Maurer, et.al. (1973) Thailand; Michael (1971) Suburban U.S.; and Schultz (1973) Taiwan (see Appendix Tables A and B).

[2]See for example where income, earnings or wage rates of males and females are considered: Cain and Weininger (1971) U.S. SMSAs; DaVanzo (1972) Chile; DeTray (1973) U.S. counties; Gardner (1973) rural N.C.; and Hashimoto (1973) Japan. Male income and female education are analyzed for the U.S. by Sanderson and Willis (1971); Simon (1972); and Willis (1971, 1973). (See Appendix Tables A and B.) Because simultaneous equations bias is probably severe when both education and wages are included as explanatory variables in ordinary regressions on fertility, the empirical results of such studies are difficult to interpret and are not reported here.

The predicted positive association between fertility and exogenous differences in nonhuman wealth is less often tested because of the scarcity of information on personal nonhuman wealth and the endogenous nature of related savings behavior. Although wage and wealth effects are a help in accounting for cross-sectional differences in fertility in high-income countries, mortality has been perhaps the most important factor affecting reproductive behavior in low income countries. This "demographic" variable, whose recent and sudden change is the proximate cause for the "population explosion" in much of the world, affects in many complex ways the structure of incentives for reproduction. The next section surveys current efforts to incorporate this factor into the economic model of fertility determination.

IV. CHILD MORTALITY

If we assume that parents are motivated to bear children to accrue benefits from their mature surviving offspring, the effects of child mortality on desired fertility can be divided into two partially offsetting effects on (1) the demand for survivors and (2) the derived demand for births. Child mortality decreases the number of survivors demanded by increasing the expected cost per survivor; it increases the derived demand for births by increasing the number of births required to obtain a survivor. The final derived demand for births will respond positively to the incidence of child mortality only if the product of the relative change in expected cost per survivor and the price elasticity of demand for survivors is less than unity (in absolute value). In other words, if a given percentage decline in child mortality reduces by the same relative amount the expected cost to parents of rearing a child to maturity, and the decline in child mortality induces a decline in desired births, then parent demand for additional surviving children must be inelastic (less than one in absolute value). In the event that the family reduces its completed fertility (i.e. births) as the incidence of child mortality declines, this tendency toward demographic stability within the family may be interpreted as evidence that parents' demand for surviving children is relatively

price inelastic (Donald J. O'Hara, 1972; Ben-Porath and Finis Welch, 1972).[1]

No one can doubt that parenthood is one of the most risky undertakings that economists have proposed to study, yet the above formulation implicitly assumes that parents are risk neutral, that is, it assumes that parents consider only the expected value of outcomes and ignore the variance (or higher moments) and co-variance effects. The potential importance of uncertainty for understanding shifts in fertility has been stressed in the context of low-income countries where child mortality has declined sharply (T. Paul Schultz, 1969), but theoretical analysis of the relationship between uncertainty and reproductive behavior is of recent origin (O'Hara, 1972; Ben-Porath and Welch, 1972), and I know of no empirical evidence that separates the effect on fertility of the mean value of mortality in the family or region from the effect due to some subjective measure of the uncertainty attaching to that level of mortality.

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[1]The elasticity of demand for births, B, with respect to the probability of a child's survival to maturity, P, can be expressed as follows:

$$\eta_{BP} = \eta_{SC}\eta_{CP} - 1$$

where S is the number of births that survive from which parents are assumed to derive utility under risk neutral assumptions, and C is the expected cost of a surviving child which is assumed to depend inversely on P, and be independent of family size. Since it is known that η_{SC} and η_{CP} are both less than zero, if their product is less than unity, the elasticity of demand for births with respect to the probability of survival will be negative. Ben-Porath and Welch (1973) illustratively assume that $\eta_{CP} = -1$, whereas O'Hara indicates why it might exceed in absolute value unity. The positive relationship observed between child mortality and fertility is therefore suggestive of an inelastic demand for surviving children, i.e. $|\eta_{SC}| < 1$.

However, multivariate statistical analyses based on both individual and grouped data indicate that the relationship between fertility and child mortality is positive and statistically highly significant in such varied environments and time periods as Bangladesh (1951-1961), Puerto Rico (1950-1960), Taiwan (1964-1969), Chile (1960), and the Philippines (1968). In these studies, the explanation of birth rates on the probability of birth is improved by lagging the incidence of child mortality two to four years. This is, of course, roughly the average time required for a mother to bear another child. There is reason, moreover, to anticipate that older mothers with nearly completed families will weigh heavily the survival or death of earlier children in their decision whether to have an additional (marginal) child. Consistent with this sequential and adaptive view of reproductive behavior, the estimated responsiveness of births to child deaths is greater and more significant statistically for women over 30 years of age (Julie DaVanzo, 1972; Schultz and DaVanzo, 1970; Schultz, 1971, 1972). Among these older women, the response of birth rates is also more pronounced to male child deaths than to female child deaths (Schultz and DaVanzo, 1970; Schultz, 1972), presumably reflecting preferences for family sex composition.

The death of a young child may also stimulate a <u>biologically</u> independent feedback mechanism that will increase the mother's fecundity. If the child was still fed from the breast at the time of his death, the termination of lactation may shorten

the mother's period of postpartum sterility and increase her subsequent fecundity and consequent fertility. But this biological mechanism can play only a relatively small role in the widely noted robust relationship between birth rates and prior child deaths, for the behavioral factors, such as the mother's age and the sex of the child that died, continue to explain a statistically significant share of the variation in birth rates.

This evidence implies that birth rates of older mothers adapt promptly to offset some of the increase in population growth rates that occurs because of increased survival of children in low income countries. But in the two to five year periods studied in these investigations, the overall response of birth rates does not appear to be of a sufficient magnitude to prevent population growth rate from increasing. Longitudinal studies are now needed of cohort fertility to appraise the longer-run adjustment of fertility to changing levels of child mortality.[1] Future rates of population growth in much of the world hinge on the magnitude of these adjustments in reproductive behavior and on the rate at which they occur.

A reduction in death rates at all ages also increases the returns to parents of such long term investments as those in child schooling and vocational training relative to the returns from having a greater number of children. If child "quality" investments and the quantity of children are close substitutes to parents, this shift in the relative returns to these two activities may motivate parents to seek fewer children, in order to augment the resources they have available to invest in each of their

[1]Ben-Porath's paper in this volume is an example of the longer-run analysis that will be insightful.

offspring (O'Hara, 1972). Increased life expectancy for parents may in addition contribute to their greater valuation of long gestation investments such as child quality, since they have an increasing chance of being alive at any future date to enjoy these distant returns.

In sum, mortality exerts diverse influences on the family formation process and the incentives for associated savings and investment behavior in the household sector. Although the dramatic postwar change in mortality constitutes a significant and pervasive shift in the intertemporal constraints on household behavior in low income countries, this phenomenon has received scant attention from economists.

The consistent effects on fertility of the shadow price (wage) of husband's and wife's time, and child mortality, account for a statistically significant share of cross-sectional variation in aggregate and individual reproductive behavior. Encouraging though these empirical results may seem, there still are ambiguities and limitations to this conceptual approach and its current empirical application. I shall now comment on a few of the unresolved problems that I find most challenging.

V. THE RESOURCE INTENSITY OF CHILD REARING

Earlier it was suggested that viewing children as a homogeneous commodity from which parents obtained a uniform flow of "child services" neglects the qualitative dimensions of child-rearing over which parents exercise some choice. Reproductive motivations are closely related to the amount of time, energy, and resources parents want to invest in each of their offspring (Becker, 1960). Widely observed empirical regularities suggest that parents have a tendency to trade off resource intensity per child for numbers of children (e.g. Schultz, 1969, 1970, 1971; DaVanzo, 1972).[1] Understanding the determinants of this tradeoff promises to account for much systematic variability in fertility in both high and low income countries.

Progress in this direction, however, has been slow for at least two reasons. Unrealistic restrictions must be posited, apparently, to obtain refutable predictions from models of family choice in which both parents may contribute through their market

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[1]Child schooling rates are often more highly (negatively) correlated with fertility than are educational attainments of mothers. Conversely, a positive partial correlation is generally observed between fertility and the rate at which young children enter the labor force in low income countries. See for example, Schultz (1969, 1979, 1971); Nerlove and Schultz (1970); DaVanzo (1972); Maurer, et.al. (1973). One might conjecture that parents in some poor populations borrow, on balance, from their children over their lifetime rather than invest in them (Schultz, 1971). Increased attention to the implicitly producer good (capital) attributes of children may yield additional insights into the determinants of fertility in low-income countries. I have not seen any evidence of a theoretical or empirical nature that might distinguish whether children should be treated as a consumer or producer durable good in the refinement of a demand theory of fertility.

earnings and own-time to the production of three final consumption commodities, say for example, the number of children, child quality, and other commodities.[1] Second, and more obvious, the lack of agreement on how to quantify the resource cost or consumer value of child "quality" has deterred relevant empirical research.

The most interesting theoretical effort to restrict the general three-good model to obtain an analytical reduced-form expression for the derived demand for numbers of children is by Willis (1971). He assumed that the husband does not contribute to household production, holding fixed his full-time labor force participation. With standard assumptions regarding linear homogeneous, separable, production functions and nonreversal of factor intensities, the derived demand for numbers of children is analytically deduced for (1) households in which the wife works in the labor force and (2) for households in which she does not. Two novel implications follow: An increase in the husband's lifetime wage increases the demand for children by a greater amount if the wife engages in market work; an increase in the wife's education (i.e. market-specific human capital) reduces demand for children only if she is engaged in market work.

[1] Without additional restrictions, the only qualitative prediction is the positive sign of the effect of nonhuman wealth on the demand for both quality and quantity. DeTray (1973) estimated a special form of this model with U.S. county aggregate data and found that the wealth elasticity of demand for quality per child was not significantly different from zero.

Becker and Gregg Lewis (1973) and Willis (1973) have also explored the implications for demand analysis of the multiplicative interaction between child quality and quantity that enters the household's budget constraint if it is assumed that to marginally change child quality, a parent must also change the quality investments in all intramarginal children.

Further extensions of this work (Willis, 1973) treat the wife's labor force participation decision as endogenous and jointly determined with desired fertility, but this important step toward greater realism is achieved with a serious loss of refutable predictions.

The merit of this model for empirical work rests on the degree to which wives who are out of the labor force are engaged solely in the production of nonmarket (untradable) consumption commodities, in Becker's (1965) sense of the word. If instead, nonparticipant wives are producing at the margin substitutes for market goods and services, as well as final consumption commodities, then the process of factor price equalization and the determinants of derived demands are identical for the two classes of households. In high-income societies the analogy between labor force activity and home production, on the one hand, and Becker's market goods and nonmarket commodities, on the other, has some appeal. But it is hazardous to extend this formulation to low-income societies where handicrafts, cottage industries, and local barter markets provide many points of contact between relative market prices and the allocation of a housewife's time. In the low-income environment where market specialization is less developed, it is hardly surprising that both spouses will typically produce at home some goods that the household will also purchase or sell in the market. The converse hypothesis might also warrant investigation in high income countries, namely, as market specialization proceeds, husbands will increasingly have a

comparative advantage to contribute their time to the production of more nonmarket consumption commodities, including perhaps children. The realism of Willis' model for high income countries is, therefore, also conjectural.

If further refinement of the three-good model is not to rely entirely on "corner solutions", empirical research may have to provide sharper guidance on how theoretical restrictions are to be imposed. What are the economies of scale in the production of numbers of children and child quality? How are these outputs interrelated to other houshold consumption activities? Can production tradeoffs be estimated from changes in the relative prices of these other, more nearly marketed, household activities? Can one infer, directly or indirectly, more about the manner in which parents assess quality in their offspring, which ultimately must motivate their transmission to children of genetic potential, inherited wealth, education advantage, economic opportunity and culture? Perhaps an entirely new approach to the quality-quantity dilemma will be required?

VI. PROBLEMS OF EMPIRICAL INFERENCE AND MODEL SPECIFICATION

As the framework of constrained choice has been adapted to analyze a growing body of data on reproductive behavior, it has become clear that it is difficult to infer the direction, magnitude and timing of causality from partial correlations among the seemingly relevant variables in a cross section. Elements of the approach require reformulation, the distinction in each specific context between endogenous and exogenous variables requires more explicit consideration, and finally, improved statistical techniques appear necessary to estimate the underlying structural relations without substantial bias.

Observations on exogenous differences in wage rates and nonearned income, from which price and income effects might be estimated without simultaneous equations bias, are hard to come by. Virtually all of the decisions parents make over their lifetime affect the subsequent structure of incentives bearing on fertility, and most individuals recognize that their current choices modify these future options. Therefore, many attributes of the household and its members that reflect past or current choices cannot be treated as exogenous to lifetime fertility decisions.[1] Proxies that appear initially useful as measures

[1]Ordinary least squares estimates of the structural relationship determining fertility will not have the desirable property of "consistency" unless all explanatory variables are uncorrelated with the disturbance in the fertility equation. Nor can lagged values of endogenous variables be treated as independent of the disturbance in relationships accounting for the same or related forms of current behavior, for well known reasons. For example,

of the opportunity cost of children or of given resource constraints must ultimately be treated as endogenous variables in a broader simultaneous system of behavioral relations.

Mate selection, the life cycle timing of marriage and the allocation of both spouses' time between market and nonmarket activities are decisions that are intimately related to similar price and income variables as well as underlying tastes.[1] The extension of fertility models to encompass additional areas of jointly and simultaneously determined household choices has confirmed the importance of interactions among at least three forms of behavior: reproduction, the incidence of marriage (legal and consensual, where distinguished) and the sex division of labor market participation (DaVanzo, 1972; Alan Frieden, 1972; A.J. Harman, 1970; K.M. Maurer, et.al. 1973; Marc Nerlove and Schultz, 1970; Schultz, 1970). Beyond this core, models of

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the probability that a woman works in the paid labor force will in general not be independent of the disturbance in the relation accounting for her fertility. Labor force participation patterns earlier in her life cycle are also influenced by observed and unobserved features of her environment that will be highly serially correlated, and that will continue to affect not only her labor force participation but also reproductive behavior. Clearly, individual tastes for children and more generally tastes for a wider array of market and nonmarket goods may be such an unobserved variable influencing both forms of behavior. In such a dynamic system of household behavioral relations, simultaneous equations estimators would appear generally appropriate for the study of structural equations determining fertility.

[1]For example, the educational attainment of the wife, which I regarded above as an exogenous determinant of the opportunity cost of her time in childbearing, is <u>not</u> an exogenous variable with respect to her husband's wage rate, education, or tastes for children. The selection of mates is undoubtedly responsible for the high simple correlation between educational attainments of spouses.

household decision-making might be reasonably extended to incorporate additional allocative choices that are also probably endogenous to the determination of fertility, such as savings and nonhuman capital formation, migration and, as emphasized in the preceding section, the resource intensity of the child-rearing process.

But these simultaneous-equations models tend to be formulated in static terms and tested, most often, against cross-sectional data from one point in time. Though I would not deny that this abstraction has proven a powerful generalizing device, little attention has as yet been given to the question of what economic theory and statistical techniques can say about dynamic models of behavior. Reproduction occurs sequentially, and the constraints on childbearing affect many other areas of economic and demographic decision-making in the household and are influenced themselves by past reproductive behavior.[1]

In cross-sectional studies, explanatory variables are at best discretely lagged a few years, as noted with regard to child death rates, to represent the time required for reproduction to respond and for birth control information to take effect (Schultz, 1971). But the stochastic biological nature of the reproductive process and the numerous neglected features of the individual that could affect reaction times suggest that a distributed lag would be more appropriate to the study of changes in fertility.

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[1]Sanderson and Willis (1971) use numerical simulation and dynamic programming techniques to explore this sequential family formation process, but unfortunately there is no empirical foundation for most of their specifications.

Identification and estimation of these lag structures are, nonetheless, difficult because of the limited availability of time-series information and the strong positive serial correlation (over time) of relevant characteristics of regional populations or individuals, such as wages, nonhuman wealth, industrial structure, and schooling.

There is as yet little evidence on the magnitude of parameter bias introduced by misspecifying the dynamic process determining fertility by static approximations estimated from a single cross section of observations. In one instance, I present a demand model for birth rates in Taiwan estimated first on the basis of cross-sectional data, and then reestimated on the basis of a dynamic formulation using a combined time-series of cross sections (T. Paul Schultz, 1973). Parameter estimates shift substantially between the static pooled cross-sectional formulation and the dynamic specification that utilizes both dimensions of the time series of cross sections. The changes in parameter estimates conform to those predicted by theory when appropriate weight is ascribed to time series variation in the estimation procedure. Cross-sectional estimates of the impact on birth rates of slowly changing environmental constraints, such as child mortality[1]

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[1]For example, the systematic portion of the regime of mortality is determined by such slowly changing factors as long-term investments in public health, sanitation, water supplies and transportation, or geography and climate, or socioeconomic characteristics of the population, and thus interregional differences in child mortality contain a relatively stable component over time. High positive serial correlation in regional differences in

and wage rates, tend to be biased upward or distorted (see Table A, columns 8a and 8b). Conversely, the influence of factors that are less highly correlated serially over time, such as recent family planning activities, tend to be underestimated. According to this study, estimates of the parameters to a dynamic behavioral process, such as fertility determination, may be seriously biased, if they rely only on the information contained in a single cross section.

Finally, the character of family size suggests that linear demand models are too restrictive for the study of fertility. Both theoretical arguments (Willis, 1973) and empirical evidence (Ben-Porath, 1973; Masanori Hashimoto, 1973; Julian L. Simon, 1972) have been presented for nonlinearity between explanatory variables and fertility. But at a more fundamental level, there is the question of how to specify the utility function with regard to numbers of children, and how the production function for

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mortality implies that cross-sectional observations on mortality in any single time period contain substantial information about the interregional differences that existed five, ten and perhaps even 20 years earlier. If the factors increasing mortality over the long term were associated with higher levels of fertility in the cross section, the positive observed relationship between child mortality and fertility would overestimate the direct short run influence of a change in child mortality on fertility. If the association between the long term determinants of mortality and fertility were causal, then the observed cross-sectional relationship between child mortality and fertility would also spuriously overstate the long run influence of mortality on fertility.

children changes with scale.[1] Linear demand models presuppose that the desirability of all increments to family size are affected identically by shifts in economic constraints. It seems reasonable to me, to now study separately the sequential binary choices made in the family formation process; this approach would in fact determine whether price and income effects differ by birth order.

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[1]Recently Leibenstein (1973) has proposed a new economic framework within which to interpret fertility declines that stress the benefits and costs of having children of a specific order. He suggests that the marginal cost declines with additions to the family, and the marginal benefit may increase before it ultimately declines. But the principal thesis of the paper is the importance of "status goods" which, it is asserted, claim an increasing share of expenditures in a given status group as development compresses the social structure of personal incomes. Until further theoretical elaboration of his approach is set forth, or empirical proxies and methods of application are proposed, I do not see how the framework could be challenged (or illuminated) by obvious sources of data.

VII. EMPIRICAL APPLICATIONS OF THE FRAMEWORK

I have summarized in Appendix Tables A and B some of the salient empirical findings of several recent investigations into the determinants of fertility that have been guided by this model of constrained choice. Great caution should be exercised in interpreting these distilled results, for analytical detail and the questions addressed by the authors differ. Since no consensus has yet emerged on the "appropriate" specification of the demand model of fertility, investigators have made do with very different sources of data, different proxies for the essential economic variables, and different "control" variables. Nonetheless, the collected tableau suggests patterns as mentioned earlier in the paper, and may provide a convenient set of references to a scattered literature. Table 1 reports the range across studies of the elasticity estimates of fertility with respect to the variables that are consistently emphasized in the economic view of the fertility determination process.

TABLE 1

RANGE OF ESTIMATES OF THE ELASTICITY OF FERTILITY WITH RESPECT TO THE CENTRAL VARIABLES IN DEMAND MODEL[a]

Explanatory Variable	Level of Per Capita Income	
	Low (Table 1)	High (Table 2)
Women's Education	-.17 to -.06	-1.1 to -.19
Men's Education	-.98 to +.55	-.4 to -.06
Women's Wage	-.16 to -.35	-.6 to -.17
Men's Wage	+.05	-.11 to +.23
Family Income	---	+.09 to +.38
Mortality	+.05 to +.28	---

Explanatory Note:

[a]Certain of the estimates appears to not be comparable because of functional form of model estimated or nature of proxy variables analyzed. The studies of Willis (1971) and DeTray (1972) fit a model partially in logarithms. Willis obtained an unusually large elasticity of fertility with respect to his proxy for female full-time potential market earnings of -1.99. DeTray obtained elasticity estimates that are within the ranges reported. The interaction model estimated by Sanderson and Willis (1971) are reported without elasticities or variable means, and are hence not represented in the table. Cain and Weininger (1970) female education variable is not comparable with the other average or median years of schooling variables (see note d, Table B). The Kibbutzim case (Ben-Porath case 1c) is excluded as noncomparable. The non Jewish communities in Israel are classified with the studies of low income countries although they are reported in Table B. Median years of schooling in these communities is 4.9 for males and .7 for females, contrasted with between 8 and 10 for both sexes in the Jewish settlements of Israel.

VIII. IMPLICATIONS FOR PUBLIC POLICY

There are several ways a society may go about influencing its level of fertility and rate of population growth, if it decides such a change is socially desirable. It may legalize and subsidize the dissemination of birth control knowledge and related goods and services, making it easier for people to avert unwanted births. A society may decide to go further and try in addition to influence the number of children parents want, sensing that at this time a divergence exists between private and social interests in having additional children. Two options are then open. Payments and/or penalties may be introduced to elicit directly from individual parents the desired change in reproductive behavior. Alternatively, social policy may be promoted that changes the structure of household opportunities in order to affect indirectly the number of children parents want. Although it would be premature to suggest that the demand approach to understanding the determinants of fertility has yet shed much light on the design and evaluation of population policy, this general theoretical approach might help in the future to choose among these classes of policy measures and aid in their individual effectiveness evaluation.

Family Planning Evaluation

The most common approach to evaluating family planning programs is to measure the program's output of services per unit of input. Information on the age of individuals accepting a

method of birth control in the program and the clinically estimated effectiveness of the method they adopt can be converted to a sophisticated measure of the potential number of births averted by the program's services given the biological fecundity of "acceptor" population. But no method has been devised to estimate the extent to which program subsidized services replace or substitute for other higher cost and perhaps less reliable sources of birth control available in the private marketplace. The more price inelastic is parent demand for children, the smaller would be the actual effect of a family planning program on the birth rate, as a fraction of the potential contraceptive effect of the program's services, and the larger would be the "substitution" effect.

If the evaluation of population policies is to be substantially improved, the tenuous link between the distribution of family planning activities and the resultant decline in births must be verified statistically. In this instance, it is not feasible to measure directly the unobserved relationships that constitute the chain of events linking policy instruments to policy objectives. Indirect procedures of statistical inference are, therefore, unavoidable. But if these procedures are applied with care, they might greatly increase the precision with which family planning programs are currently evaluated.

The demand approach to fertility determination stresses the need to identify and to allow for the influences of changing economic and demographic constraints on the household sector that

are likely to modify reproductive goals. In most countries, family planning activity is likely to be correlated with the level of these socioeconomic constraints and their change over time, giving rise to differential rates of birth control practice and program acceptance by region and class. To infer what independent contribution a family planning program has made to the level of fertility, it is necessary, therefore, to analyze simultaneously the (exogenous) factors affecting the demand for births and the family planning program inputs in conjunction with regional, class and, if possible, individual fertility behavior (Schultz, 1972, 1973).

Summarizing the success of population policy in terms of its impact on the birth rate, one may overlook the important distributional consequences of public family planning programs. An economic analysis of family planning might view this activity as an investment, augmenting and diffusing a useful stock of new knowledge about techniques of birth control, not unlike technical assistance through farm extension agents. By lowering the fixed informational costs and perhaps also subsidizing the marginal user costs of modern methods of birth control, this investment should contribute to more efficient patterns of birth control adoption. However, there is growing evidence that suggests the distribution of benefits among segments of the population from a national family planning program favors the poor and disadvantaged. These personal distributional effects of a family planning program may be as important as any overall measure of the program's

effectiveness in reducing the birth rate. Although all classes might benefit from the reduced marginal user costs, the fixed informational costs are probably a particularly severe barrier to adoption among segments of the population that reside in remote rural areas and have less sophisticated skills for searching out and evaluating the benefits of new products and services. I would hazard to guess that in a dynamic society the benefits in terms of reduced fixed informational costs are likely to be greatest among the lowest classes. If this is true, the highest payoff to family planning over a period of generations, will be in slowing or reversing the disconcerting growth of economic disparities among classes in a society.[1]

Policies May Modify Both the Demand and Supply of Births

The past search for policy options to cope with rapid population growth mirrors a natural but nonetheless one-sided technocratic view of the complex social problem. It seems far simpler to disseminate a better birth control technology, which is already operational in developed countries, than to modify parent reproductive goals by processes of social change that tend to be unique to each culture. For example, expenditures on family planning that seek to lower the supply price of modern birth control technology and hence reduce the cost (pecuniary and subjective) of restricting fertility are a widely approved

[1]See for example the illustrative simulations of income and wealth inequality performed under different class structures of fertility by Pryor (1973).

policy response. Alternatively, expenditures on, say, public health that seek to reduce child death rates, contributing to a downward shift in parent demand for numbers of births, is thought to be a counterproductive or at best a controversial policy strategy. Both sets of policy options--the "supply" and "demand" sides--need further quantitative study if decision-makers are to be able to select an equitable and efficient mix of family planning and development policies for each social setting.

A controversial dimension of the problem is forecasting technological change. In my judgment, further improvements in birth control technology cannot continue to reduce the cost and increase the acceptability of newer control techniques as they have in the last two decades. Given the apparent price inelasticity of parent demand for children, one may doubt whether further improvements in birth control technology will be responsible for a continuing fall in desired or actual fertility. The distinct possibility exists, therefore, that if family planning programs throughout the world succeed during the next few decades in transmitting their more-or-less fixed stock of information and services to all social strata, further activity in the family planning field will have a sharply diminishing payoff. This is already evident in a small country such as Taiwan that has had a massive and an unusually effective national family planning program (Schultz, 1973).

The relative emphasis that a society should attach to population policy interventions that operate through the demand and supply of births depends on numerous factors, but these conditions and underlying relationships are amenable to study and measurement. If, as is often asserted, familial behavior, involving marriage, reproduction, and women's role in the labor force, is particularly resistant to environmental changes associated with alternative development strategies, then to align development policies to foster the adoption of smaller family size goals may be ineffectual. Public policy would then wisely emphasize, for the moment, improvements in birth control technology and the dissemination of these improved techniques to all strata of society. Alternatively, if demand for children is price inelastic, as appears to be the case, and family size goals are insensitive in the long run to the available mode of birth control, widespread acceptance of better birth control methods may not independently accomplish substantial reductions in the level of fertility.

A common reaction to the apparent declining efficacy of improved birth control technology in the aftermath of a successful family planning program is to explore direct economic incentives to change parent reproductive behavior. The common "economic welfare" arguments used in this regard to buttress the case for slowing rapid population growth are seriously flawed.[1] In applying

[1]The micro economic approach calculates the present value of preventing a birth, as advanced by Stephen Enke, but ignores the nonpecuniary returns from children, and presumes that parent resources expended on their own children are somehow social costs. The second approach constructs a macro economic growth model and simulates the effect of population growth, as pioneered by Coale and Hoover (1961). Social benefits are essentially measured in terms of per capita income which also excludes, conveniently,

economic logic to the evaluation of the consequences of population growth, the unacceptable assumption is implicitly made that children are nothing more than a pecuniary investment. Although these average productivity or efficiency arguments for slowing population growth by direct incentive payments to parents are conceptually inadequate and empirically misguided, the consequences of rapid population growth on the personal distribution of income and wealth are less ambiguous. Moreover, in the long run these equity effects of population growth are possibly more important.

The attraction of the demand model of fertility is that it identifies environmental conditions that presumably motivate parents to want fewer children and invest more in each child, and moreover, these conditions are generally linked to eminently desirable social investment programs that should contribute in the future to a less unequal personal distribution of income. Support is growing for such programs as, for example, promoting the health and nutrition of mothers and young children, accelerating the growth of educational opportunities at the elementary and secondary level for women as well as for men, facilitating the entry of women into the labor force, and strengthening the economic and legal status of women and children. Such fundamental changes in any social order will meet with substantial resistance, and as levers to lower fertility, these changes may perhaps absorb more resources per averted birth than alternative options. But the returns to promoting such changes in social organization and

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the nonpecuniary returns parents obtain from their offspring. See R. Blandy (1974).

household resource allocation are broader than their effect on birth rates. To compare the social returns from direct incentive payments to parents to avert births with indirect investments in social change that promise, among other goals, to reduce desired family size will require two major advances in the social sciences. First, agreement must be reached on how to characterize a society's interpersonal and intergenerational goals and their tradeoffs. Second, a much improved understanding will be required of how economic and demographic variables are influenced by, and affect, reproductive behavior both at the level of the family and the community.

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APPENDIX

An Outline of the Household Production Approach to Fertility[1]

This framework is typically stated in terms of a single period integrated family utility function, a series of production functions for final untraded consumption commodities, and a budget constraint expressed in terms of both the time of family members and market goods.

$$U = U(Z_1, Z_2, \ldots, Z_n) \tag{1}$$

$$Z_i = f_i(x_i, M_i, F_i), \quad \text{for } i = 1, 2, \ldots, n \tag{2}$$

$$Y = \sum_i x_i p_i = W_m N_m + W_f N_f + V \tag{3}$$

$$\sum_i M_i + N_m = \sum_i F_i + N_f = T \tag{4}$$

where $U(\cdot)$ is the family utility function; Z's are final consumption commodities; f's are production functions using market goods, x's, husband's time, M's, and wife's time, F's; Y is money income; p's are money prices of market goods; N_m and N_f are husband and wife time allocated to market activities for money wages of W_m and W_f, respectively; V is the return on the family's nonhuman wealth; and T is the total available time each spouse has to allocate between market and nonmarket activities.[2]

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[1]The origins to this approach may be found in Mincer (1963) and Becker (1965), and are stated in the simplified manner presented below by Ben-Porath (1973) and elaborated in different directions by Willis (1971, 1973), DeTray (1973), Michael (1971) and Becker and Lewis (1973).

[2]Utility is maximized subject to technology, time, and income constraints when

$$\frac{\partial U}{\partial Z_i} = \lambda\left(\pi_i \cdot \frac{\partial x_i}{\partial Z_i} + \frac{\mu_m}{\lambda} \cdot \frac{\partial M_i}{\partial Z_i} + \frac{\mu_f}{\lambda} \cdot \frac{\partial F_i}{\partial Z_i}\right), \text{ for } i = 1, 2, \ldots, n$$

Assume that there are only two nonmarket commodities, the number of children, C, and all other commodities, G, and that both production functions are linear homogeneous and independent of each other. The full price of the ith commodity is

$$Z_i \pi_i = M_i W_m + F_i W_f + p_i x_i \; ; \quad i = C, G. \tag{5}$$

Full income, I, of the household is then defined as

$$I = \pi_c C + \pi_g G = TW_f + TW_m + V \; ; \tag{6}$$

the full price elasticity of demand for the jth commodity is

$$\eta_{j\pi_j} = \frac{d\, Z_j}{d\, \pi_j} \cdot \frac{\pi_j}{Z_j} \; ;$$

and the full income elasticity of demand for the jth commodity is

$$\eta_{jI} = \frac{dZ_j}{dI} \cdot \frac{I}{Z_j} \; .$$

The income elasticity is positive if j is not an inferior commodity. The own-price elasticity, holding income constant, must be negative. The elasticity of demand for children with respect to nonhuman wealth, V, is

$$\eta_{CV} = \frac{V}{C} \cdot \frac{dC}{dV} = \eta_{CI} \; , \tag{7}$$

---

where λ is the marginal utility of income, and μ is the marginal utility of time. The ratio of marginal products of all inputs in each activity are equal to the ratio of their shadow prices when the optimum allocation conditions are satisfied; for example for the male,

$$\frac{\partial Z_i / \partial M_i}{\partial Z_i / \partial x_i} = \frac{\mu_m / \lambda}{\pi_i} = \frac{W_m}{\pi_i} \quad \text{for } i = 1, 2, \ldots, n.$$

See Gronau (1970) for an empirical application of this simple model to the study of single person households or Becker (1965) for further elaborations of the framework.

and if children are not an inferior commodity, as seems plausible, this expression should be positive in sign.

The shares of the total cost of the ith commodity accounted for by the husband's and wife's time input are

$$S_{mi} = \frac{M_i W_m}{Z_i \pi_i} ,$$

$$S_{fi} = \frac{F_i W_f}{Z_i \pi_i} , \text{ respectively.}$$

Following Ben-Porath (1973), the elasticity of demand for children with respect to a change in the husband's or wife's wage can be expressed in terms of these value shares, the shares of full income earned in the market by each spouse, and the compensated (holding full income constant) price and income elasticities of demand for children.[1]

$$\eta_{CW_m} = \frac{W_m}{C} \cdot \frac{\partial C}{\partial W_m} = \eta_{C\pi_c}(S_{mC} - S_{mG}) + \frac{N_m W_m}{I} \eta_{CI} \qquad (8)$$

$$\eta_{CW_f} = \frac{W_f}{C} \cdot \frac{\partial C}{\partial W_f} = \eta_{C\pi_c}(S_{fC} - S_{fG}) + \frac{N_f W_f}{I} \eta_{CI} . \qquad (9)$$

The elasticity of demand for children with respect to a change in the return, r, on the household's nonhuman wealth, A, where $r = V/A$, is

$$\eta_{Cr} = \frac{r}{C} \cdot \frac{\partial C}{\partial r} = \frac{V}{I} \eta_{CI} . \qquad (10)$$

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[1]The expression for the derived demand of a factor also includes the possibilities for substitution between husband's and wife's time in production. The above expression for the elasticity of demand for children permits only the substitution in consumption to occur along a given production isoquant. The compensated price elasticity may be alternatively defined as the product of the share of income spent on other household commodities and the elasticity of substitution between children and other household commodities (but with the opposite sign).

Generally it may be assumed that $N_m W_m > N_f W_f$, since both males' wages and market hours worked tend to exceed those of females. The positive income effect associated with a change in male wages will, therefore, usually exceed that associated with a change in female wages, but the price effects are more complex.[1] If it is assumed that the difference between the female time intensity of children and that of other nonmarket goods equals or exceeds the difference between the male time intensity of children and that of other nonmarket goods, or, in other words, that

$$(S_{fC} - S_{fG}) > (S_{mC} - S_{mG}) ,$$

then the relative magnitude of the income effect prevails and

$$\eta_{CW_m} > \eta_{CW_f} . \tag{11}$$

This formulation of the determinants of consumer demand in terms of price and income effects yields regrettably few refutable empirical propositions. The effect of an exogenously determined increase in the net price of a child, whether it stems from a shift in anticipated costs or benefits, should decrease demand for children. The effect of an unanticipated permanent increase in income, holding prices constant, should relax the family's resource constraint and stimulate increased demand for children and other ordinary goods. However, depending upon the ultimate

[1] If one assumes that only one spouse, say the wife, allocates time to the production of C and G, stronger conclusions obtain (see Rybczynski, 1955; Gronau, 1970, 1973; Willis, 1971, 1973), notably when the wife ceases to work in market activities altogether.

source of the increase in income an offsetting increase in the opportunity cost or time-price of a child may also take place, weakening or even reversing the net effect of the increased income.

Given plausible parameter values for relative wages, market work and time intensity of nonmarket goods, one might anticipate that the effect on demand for children of a change in male wages should be more positive than that of a change in female wages. Indeed, even if price and income elasticities of demand for children were of approximately the same absolute magnitude (but of opposite sign), increases in male wages could increase demand for children, and increases in female wages could decrease demand because of the different value shares attached to each.[1] If the

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[1]A numerical example may clarify how these relationships might work. Let us assume that men receive a wage 50 percent greater than women (say \$3 versus \$2); and men work four times as much in market activity as do women (4/5 as compared with 1/5 of their allocatable time); and women allocate six tenths of their time to child rearing and men only one tenth, with the remainder used in the production of other nonmarket goods; one fifth of the household's market income is spent on children; and nonhuman wealth income (per similar time units as were used to measure wages) amounts to \$.2, then approximately $S_{fC} = .571$, $S_{fG} = .129$, $S_{mC} = .143$, $S_{mG} = .097$, and $I = \$5.20$. Assuming the same absolute magnitude for income and price compensated elasticities, say $\eta_{CI} = .3$ and $\eta_{C\pi_c} = -.3$, we obtain the results by plugging in the illustrative values:

$$\eta_{CW_f} = (-.3)(.442) + (.077)(-.3) = -.110$$

$$\eta_{CW_m} = (-.3)(.046) + (.46)(.3) = +.124 \text{ and}$$

$$\eta_{Cr} = (-.3)(0.0) + (.04)(.3) = +.012$$

In this example the negative price effect associated with the male wage is less than 3 percent of the price effect associated with the female wage, whereas the male wage income effect is more than five times the female wage income effect. Consequently,

income elasticity were absolutely smaller than the price elasticity as seems likely, the relevant wage effects on the demand for children would all be reduced, or more negative.

The only observable source of exogenous variation in the relative price of children is associated with the value of time parents allocate to the care and enjoyment of their children. No progress has been made in measuring the pecuniary or subjective returns derived from children as either producer or consumer goods, respectively. At this point one is again confronted by the jointness of parent choices regarding the number of children they want and the resource intensity of child rearing they deem optimal. Almost any observable measure of differential costs of child rearing implicitly reflects some degree of parent choice, and is hence endogenous to the decision-making process that the demand model of fertility seeks to explain.[1]

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the sex specific relative magnitudes of both the price and income effects contribute to the more positive (less negative) effect on the demand for children of a change in men's wages compared with women's wages. Because of the small share of household income that was assumed to flow from nonhuman assets, the magnitude of a change in the (interest rate) return on these assets elicits a small, but necessarily positive effect. An unanticipated change in asset level would, of course, effect the demand for children directly via the assumed income elasticity of +.3.

It might be more realistic to assume that the income elasticity of demand was much smaller, say +.05. In this case, the elasticity of demand with respect to female wages would be -.13, with respect to male wages +.01, and with respect to a change in interest rates +.002.

[1]One can imagine that regional differences in climate and agricultural conditions might exogenously dictate regional differences in the productivity of child labor with associated effects on desired fertility levels. Analysis of the structure of wages by age, sex and education in low income countries is an important but neglected field of economic study.

TABLE A FOOTNOTES

[a]Form of estimation equation such as reduced-form equations (only exogenous explanatory variables) which may be estimated by ordinary least squares (OLS), structural equations (including endogenous explanatory variables) estimated perhaps by an instrumental variable technique such as two stage least squares (TSLS), solved reduced-form equations, derived from the simultaneous equations estimates of the related structural equations (generally without t statistics), and when a time series of cross sections are pooled for either a reduced form or a structural equation, estimates may be reported using a generalized least squares procedure (GLS) that assumes a Nerlovian two-component stochastic structure to the disturbances. For instrumental variable estimates asymptotic t statistics are reported.

[b]For definition of explanatory variables, including those not reported in table, see original studies.

[c]Asymptotic significance of entire equation can be evaluated with the F ratio when TSLS estimates are computed. See Dhrymes (1969). For OLS and GLS of reduced form equations, R^2 can be used to test the equation's overall statistical significance.

[d]Arithmetic sum of lagged coefficients, and averaged t statistics.

[e]Child death rate entered regression as the reciprocal of child survival rate. For comparability and ease of interpretation, the second elasticity estimates are with respect to the child death rate.

[f]Arithmetic average of regression coefficients, t statistics, elasticities and R^2 from five annual cross-sectional regressions.

[g]The women's wage was treated as endogenous to this investigation and is therefore estimated as a linear function of exogenous variables such as women's education, etc.

[h]The solved reduced-form equations are reported without asymptotic standard error estimates. The elasticity estimates for education variables incorporate also the effect of an additional variable that is nonlinear in male and female education, namely, the relative educational attainment of women to that of men.

APPENDIX TABLE A

SUMMARY OF EMPIRICAL FINDING FOR LOW INCOME COUNTRIES ON THE DETERMINANTS OF FERTILITY

(After each regression coefficient the absolute value of the t ratio is reported in parentheses and elasticities at regression means is in brackets)

	(1)	(2)	(3)	(4)
Author (year; page)	Schultz (1969; 171)	Schultz (1970; 43)	Nerlove-Schultz (1970; 45)	Harman 1970; 29-30
Population (time)	Puerto Rico (1951-1957)	Egypt (1960)	Puerto Rico (1950-1960)	Philippines (1968)
Observations (number)	Regions (75*7)	Regions (41)	Regions (78*11)	Individuals (250)
Equation (estimators)[a]	Reduced Form (OLS)	Reduced Form (OLS)	Structural (TSLS/GLS)	Structural (TSLS)
Dependent Variable	Births per 1000 Population	Children (0-9) per Women (15-49)	Births per 1000 Population	Children Ever Born per Women aged 35-39
Explanatory Variables[b]				
1. Adult Education	-1.58 (5.3) [.15]		-1.95 (3.2) [.20]	
2. Women's Education		-65.2 (4.0) [.087]		-.092 (1.6) [.094]
3. Women's Wage				
4. Men's Education				
5. Men's Wage				
6. Death Rate	1.18 (3.5) [.27][d]		.302 (1.6) [.082][d]	5.76 (3.9) [1.0] [.048][e]
R^2 (F;df)[c]	.46	.537	(27.3)	(3.5)

APPENDIX TABLE A

SUMMARY OF EMPIRICAL FINDING FOR LOW INCOME COUNTRIES ON THE DETERMINANTS OF FERTILITY

(After each regression coefficient the absolute value of the t ratio is reported in parentheses and elasticities at regression means is in brackets)

	(5)	(6)	(7)	(8a)	(8b)	
	Schultz (1971; 61)	DaVanzo (1972; 80)	Maurer, et al. (1973; 20-29)	Schultz (1972; 36)	Schultz (1972; 38)	
	Taiwan (1964-1968)	Chile (1960)	Thailand (1960)	Taiwan (1964-1969)	Taiwan (1964-1969)	
	Regions (361)	Regions (50)	Regions (71)	Regions (361*7)	Regions (361*7)	
	Reduced Form (OLS)	Structural (TSLS)	Solved Reduced Form (TSLS)	Reduced Form (OLS)	Reduced Form (GLS)	
	Normalized Births per 1000 Women aged 35-39	Children Ever Born per 1000 Women aged 35-39	Children Ever Born per Women aged 35-39	Births per 1000 Women aged 35-39	Births per 100 Women aged 35-39	
1						
2	.422 (1.97) [1.8][f]		-.0926 [.13][h]	98.2 (9.2) [.37]	-45.4 (2.78) [.17]	
3		-1589 (1.84) [.35][g]	-22.6 [.16][h]			
4			.526 [.55][h]	-274 (16.0) [1.4]	-174 (7.9) [.98]	
5		170 (.33) [.054]				
6	5.61 (9.3) [5.5][f] [.41][e]	7.65 (2.72) [.28]		432 (17.9) [3.9] [.28][e]	172 (8.2) [1.5] [.11][e]	
	.433[f]	(14.4; 6,3)	(13.9; 7,4)	.461	.809	

APPENDIX TABLE B

SUMMARY OF EMPIRICAL FINDING FOR HIGH INCOME COUNTRIES ON THE DETERMINANTS OF FERTILITY

(After each regression coefficient the absolute value of the t ratio is reported in parentheses and elasticities at regression means in brackets)

	(1a)	(1b)	(1c)	(2)	(3)
Author (Year; page)	Ben Porath (1970 & 1973; S210-S211)	Same	Same	Cain & Weininger (1970; Table 3)	Willis (1971; 61a)
Population (Time)	Israel (1961)	Same	Same	U.S. - Urban White Census (1960)	U.S. White Census (1960)
Observations (Number)	Regions: Jewish Towns and Moshavim (429)	Non Jewish (133)	Kibbutzim (180)	Major Cities SMSA (100)	Aggregated Cells (1920)
Equation (Estimators)[a]	Reduced Form (OLS)	Same	Same	Reduced Form (OLS)	Reduced Form (OLS)
Dependent Variable	Age Normalized Birth Rate	Same	Same	Children Ever Born per 1000 Women Ever Married Aged 35-44	Children Ever Born per Women Aged 35-44, Married 22 years or More
Explanatory Variables[b]					
1. Women's Education	-.132 (10.) [1.1]	-.039 (4.2) [.05]	.046 (1.5) [.5]	-53.9[d] (5.4) [.04]	---
2. Women's Wage/Earnings	---	---	---	-27.2 (3.97) [.33]	-1.99[e] (3.38)
3. Men's Education	-.049 (2.6) [.4]	.022 (1.8) [.11]	.009 (.4) [.1]	---	---
4. Men's Wage/Earnings	---	---	---	9.7 (1.84) [.23]	-.0289[ef] (1.17)
5. Interaction (1*4)	---	---	---	---	---
6. Family Income/ Consumption	---	---	---	---	.496[g] (284)
R^2 (F;df)[c]	.533	.120	.017	.52	n.a.

APPENDIX TABLE 3

SUMMARY OF EMPIRICAL FINDING FOR HIGH INCOME COUNTRIES ON THE DETERMINANTS OF FERTILITY

(After each regression coefficient the absolute value of the t ratio is reported in parentheses and elasticities at regression means in brackets)

(3)	(4a)	(4b)	(4c)	(5)	
Willis (1971; 61a)	Sanderson & Willis (1971; Table 1)	Same	Same	Michael (1971; 26)	
U.S. White Census (1960)	U.S. White Married Once Husband Present Census (1960)	Same	Same	U.S. Surburban Survey (1958)	
Aggregated Cells (1920)	Husband Occupation by Wife's Education Categories (101)	Same (98)	Same (98)	Micro Households (513)	
Reduced Form (OLS)	Reduced Form (OLS)	Same	Same	Reduced Form (OLS)	
Children Ever Born per Women Aged 35-44, Married 22 years or More	Children ever Born per Women aged 35-44	Children Ever Born per Women Aged 44-54	Children Ever Born per Women Aged 55-64	Number of Children in Household per Women Aged 35-39	
—	-.175 (4.67)	-.192 (7.04)	-.155 (4.43)	-.0617 (2.18) [.29]	1.
-1.99[e] (3.38)	—	—	—	—	2.
—	—	—	—	-.0124 (.47) [.064]	3.
-.0289[ef] (1.17)	-1.77 (2.25)	-.192 (3.27)	-1.65 (2.47)	—	4.
—	.151 (2.66)	.150 (3.62)	.094 (1.58)	—	5.
.496[g] (284)	—	—	—	.160 (1.80) [.086]	6.
n.a.	.253	.437	.448	.018	

Appendix Table B (Continued)

	(6a)	(6b)	(7a)	(7b)	(8)	(9)
Author (Year; page)	Gardner (1972; 522)	Gardner (1972; 522)	Ben Porath (1973; S221)	Same	De Tray (1973; 597)	Friedan (1973; Table 9)
Population (Time)	U.S. Urban Census (1960)	U.S. Rural Farm Census (1960)	Israel (1963/1964)	Same	U.S. Census (1960)	U.S. Census (1960)
Observations (Number)	States (45)	Same	Urban Families of Wage Earners Married In Israel (152)	Same	County (516)	County
Equation (Estimators)[a]	Reduced Form (OLS)	Same	Reduced Form (OLS)	Same	Reduced Form (OLS)	Structural (TSLS)
Dependent Variable	Children Ever Born per Women Aged 40-44	Same	Children Ever Born per Married Women Aged 40 or Over	Same	Children Ever Born per 1000 Married Women Aged 35-44[e]	Births per 1000 Women Aged 15-45
Explanatory Variables[b]						
1. Women's Education	-6.5 (.5)	-17. (2.3)	-47.2[i] (1.44) [.17]	-223.[i] (1.96) [.33]	-.030 (3.19) [.32]	-1.15 (2.95) [.19]
2. Women's Wage/Earnings	-40. (5.6)	-39 (4.0)	---	---	-.30[e] (12.5) [.30]	-7.0 (7.0) [.26]
3. Men's Education	1.6 (.4)	26. (2.6)	---	---	.0277 (.74) [.08]	---
4. Men's Wage/Earnings	---	---	-26.8 (1.38) [.11]	-2.44 (.41) [.05]	.074[e] (2.12) [.07]	---
5. Interaction (1*4)	---	---	555. (1.28)	2632[j] (1.89)	---	---
6. Family Income/ Consumption	3.6 (3.0)	2.5 (1.4)	---	---	.065[eh] (2.73) [.07]	1.1[h] (5.5) [.22]
χ^2 (P;df)[c]	.70	.76	.306	.313	.75	11.7; 7, 3)

Appendix Table B (Continued)

(8)	(9)	(10a)	(10b)	(10c)	(11)	
De Tray (1973; S97)	Frieden (1973; Table 9)	Gardner (1973; S105)	Gardner (1973; S106)	Gardner (1973; S112)	Willis (1973; S50-S52)	
U.S. Census (1960)	U.S. Census (1960)	Rural North Carolina Families, Where Wife Reported Some Labor Earnings (1967-1970)	Rural N. C. Families, (1967-1970)	Rural N. C. Families, (1967-1970)	U.S. Census (1960)	
County (516)	County	Families (240)	Families (511)	Families (511)	Individual Urban White, Once Married Woman, Living With Husband (9169)	
Reduced Form (OLS)	Structural (TSLS)	Reduced Form (OLS)	Reduced Form (OLS)	Reduced Form (OLS)	Reduced Form (OLS)	
Children Ever Born per 1000 Married Women Aged 35-44[a]	Births per 1000 Women Aged 15-45	Children Ever Born per Currently Married Women Aged 30-49	Children Ever Born per Currently Married Women Aged 30-49	Children Ever Born per Currently Married Women Aged 30-49	Children Ever Born per Currently Married Women Aged 35-64	
-.030 (3.19) [.32]	-1.15 (2.95) [.19]	-.15 (2.7) [.5]	-.14 (3.7) [.5]	-.17 (4.0) [.6]	-.176 (14.0) [.41]	1
-.30[a] (12.5) [.30]	-7.0 (7.0) [.26]	-.43[k] (2.0) [.2]	---	-.020[k] (3.0) [.6]	---	2
.0077 (.74) [.03]	---	-.05 (.9)	-.09 (2.6) [.3]	-.09 (2.2) [.3]	---	3
.074[a] (2.12) [.07]	---	-.06 (.6)	---	-.17 (2.2)	-.248 (7.35) [.067]	4
---	---	---	---	---	.0202 (7.33)	5
.065[eh] (2.73) [.07]	1.1[h] (3.5) [.22]	21 (3.2) [.32]	.16 (4.1) [.28]	.26 (4.5) [.32]	---	6.
.75	11.7; 7, 9)	.23	.19	.25	.047	

TABLE B FOOTNOTES

a, b and c
See Table A.

[d]Women's education variable expressed as percentage of females with less than five years of schooling. Variable is thus an inverse measure of educational attainment among the lower tail of the distribution and the regression coefficient has the opposite sign from the other studies that use average or median years of schooling. Its sign has been reversed here to facilitate comparisons.

[e]Variables expressed in logarithms.

[f]Wife's potential market wage was constructed from 1960 data on the earnings of employed wives adjusted for hours worked per week and weeks worked last year to obtain a full-time yearly earnings potential of wives cross classified by urban/rural residence, and the education or occupation of the husband (Willis, p. 54).

[g]This coefficient is obtained from a supplemental regression of the occupation/education dummy variable estimates from the fertility equation against mean income of husbands in these 24 occupation/education categories, which is assumed to be a satisfactory proxy for the husband's permanent income.

[h]Median value of owner occupied housing which is interpreted as a proxy for the wealth or consumption level of families in the county. In Frieden's (6) study, housing value also affects (negatively) the proportion married, and therefore its net (reduced form) impact on births is about ten percent less than that reported here.

[i]The schooling variable is transformed according to five steps into an approximation of the monthly full-time wage rate for women.

[j]The women's schooling (wage rate) variable is squared to capture the nonlinearity in the relationship between the woman's wage rate and her fertility. The interaction term (variable 5) also approximates this quadratic term since husband and wife educational attainment (and wage rates) are highly correlated.

[k]In study 10a the wife's wage is directly observed for the sample of North Carolina families where the wife reported some labor earnings, whereas in 10c for the entire sample of families the wife's wage is approximated by the county wage rate for off-farm employment to others than the farm head. The county wage should be a better approximation for an exogenous measure of the value of time that will not be systematically related to the woman's past labor force experience and consequently jointly determined with her family planning and fertility.