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Fertility and Income

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Fertility and Income

T. Paul Schultz

Abstract

There is an inverse association between income per adult and fertility among countries, and across households this inverse association is also often observed. Many studies find fertility is lower among better educated women and is often higher among women whose families own more land and assets. What do we know about the social consequences of events and policies that change fertility, if they are independent of parent preferences for children or the economic conditions which account for much of the variation in parent lifetime fertility? These effects of exogenous fertility change on the health and welfare of children can are assessed from Kenyan household survey data by analysis of the consequences of twins, and the effect of avoiding unanticipated fertility appears to have a larger beneficial effect on the body mass index or health status of children in the family than would be expected due to variation in fertility which is accounted for by parent education and household land.

Keywords: Sources of Fertility Decline, Twins, Child Health, Kenya

JEL Codes : J13, I32, I12

Introduction

Fertility is often higher in poorer families within a society, and across countries those with higher average fertility tend to have lower average income. Do these associations imply that high fertility causes poverty among family members, or that poverty contributes to higher fertility, or both? Is the direct association between fertility and poverty a basis for assessing the value of policy interventions that reduce fertility by subsidizing the voluntary adoption of birth control, or by imposing on parents a quota of children which penalizes excess births, such as implemented by China?

It is hypothesized in this essay that some sources of family income encourage, and other sources discourage, fertility, because different sources of family income modify the economic opportunities parents must sacrifice to have another child, or the price of children in terms of parental time and market goods (Mincer 1963). For example, if an increment in family income is due to the rising value of women's time, this source of income not only expands income opportunities of the family but also raises the effective price of children to the family. Because it is empirically observed that higher values of women's time are associated with lower levels of lifetime fertility, it is inferred that the price effect of women's wages outweighs its income effect on fertility. In contrast, if an increment in total family income is due to an increase in the returns to physical assets-financial assets, business assets, land, and natural resources, such as oil, these income sources add to family endowments while not necessarily affecting the relative opportunity cost of children to parents, in which case these income sources are expected to be associated with higher fertility, other things being equal (P. Schultz 1981, 1994).

The effect of fertility on family income may differ depending on whether the variation in

fertility is due to parent reproductive choices (i.e., behavioral demands) or reproductive endowments (biological supply). Reproductive demands are likely to be coordinated with other family time and resource allocations, and reflect not only socioeconomic constraints on parent choice but also parents' heterogeneous preferences among various goals and outcomes. Reproductive supplies vary because of genetic differences in a couple's fecundity (reproductive capacity), and to a first approximation will be distributed randomly across a population. In other words, the supply is a form of biological endowment over which parents exercise no choice, but which they can influence to some extent, primarily with costly and uncertain birth control (Rosenzweig and Schultz 1985).

Figure 1 plots country observations in 1960 (circles) and in 2000 (pluses) for a sample of ninety-six countries in which real income and fertility are reported.[1] Income is expressed in logarithms (proportionately) of real gross domestic product (GDP) per person over age fifteen (i.e., productivity per adult), and fertility is measured by the total fertility rate (TFR) that sums the age-specific birthrates for all women aged fifteen to forty-nine. The TFR thus represents the number of children a woman would be expected to have if she survived to age fifty and experienced the current age-specific birthrate at each age. The solid line is the linear fit to the 1960 observations, and the dashed line is the linear fit to the 2000 observations. From this linear pattern in the data it appears that a 10% increase in a country's GDP per adult is associated with a 13% lower TFR in both 1960 and 2000. Does this relatively stable and statistically significant association across countries accurately forecast how income and fertility changed within countries during this time? Not very well, because log income per adult increased by 2.14 in forty years, implying a compounded rate of growth of about 5.3% per year, while TFR decreased

by two fifths, declining by about 1% per year.[2] If the cross-national relationship in either 1960 or 2000 had been used to forecast fertility, an even steeper decline in fertility would have been expected.

To assess the slope of the relationship between household income per adult and the number of children a woman bears over her lifetime, I will later examine a national representative survey of households. This 1997 Welfare Monitoring Survey of Kenya asks respondents about household income and consumption, and fertility. One approximation for the total income of households in poor countries is the consumption of all household members. Fertility is commonly measured by the number of children ever born to women who have completed their reproductive period, say older than forty-four; but to include younger women whose fertile period may not yet be complete, adjustments must be made for the age of the women as it affects fertility as well as household income per adult. In statistically fitting this relationship to household data, the association between log consumption per adult and fertility for women aged twenty-five to forty-four is represented by a less steeply negative slope, suggesting that a 10% increase in income is associated with a 1% decrease in fertility. Although the slope of the relationship at the household level has a smaller negative value than the slope across countries, both relationships are statistically very significant. In other words, the absolute value of the correlation exceeds what is likely to occur between two random variables. But the general argument advanced in this essay is that associations between two outcomes that are affected by coordinated family behavior should not immediately be interpreted as a causal relationship. Only if additional information is available on distinguishable sources of "outside" variation in income or in fertility that are plausibly independent of factors affecting the other

variable, or that arise from processes occurring outside of the family, is it possible to infer whether such "outside" shocks to income or to fertility are causally affecting the other family outcome variable.

To isolate the factors that have caused the demographic transition, it is important to describe briefly some of the underlying developments that are often used to explain the exceptional characteristics of our era of modern economic growth. Long-run growth in factor productivity in the twentieth century, given the inputs of labor hours and capital, has been attributed mainly to the growing stock of productive knowledge and its global diffusion, which may especially enhance the productivity of educated workers, thus strengthening the financial incentives to invest privately and publicly in education. Possibly as a result of this increased productive return to schooling, the difference in years of education attained by men and women virtually vanished in high-income countries during the twentieth century, and became much smaller in much of Latin America and East Asia. However, this equalization in educational attainment between young women and men has not advanced as rapidly in many of the countries in Africa, and South and West Asia, and these patterns of education of women and men account for much of the variation in fertility observed across countries (P. Schultz 1997, 2001).

Birth control technology improved markedly in the early 1960s, when techniques were developed that could be used by women independently of sexual intercourse, in the form of the pill (oral steroid) and the IUD (intrauterine device). These "best practice" methods were adopted in high-income countries along with irreversible sterilization, and their dissemination was subsidized for women in Asia and Latin America, and then in Africa, as demands for birth control emerged (National Research Council 2000). With the recognition by 1990 of the threat of

the HIV/AIDS epidemic, traditional condoms for men and reconfigured condoms for use by women were reemphasized in health and family planning programs. But these widening technological options may have encouraged women to plan more than their family size, helping them to invest in careers producing both in the home and outside of their family. Women's increasing education, access to new family-planning technologies, and accumulation of work experience outside of the home have increased the share of women's earnings in total family income. Studies suggest that this redistribution of economic power (from men) to women is associated with a reallocation of family expenditures toward children, while helping women with dependent children to head their own households if necessary, and further strengthening women's incentives to have fewer children over their lifetime because they expect to bear more of the cost of children (Becker 1981; P. Schultz 2001).

The Demographic Transition at the National Level and at the Family Level

In the aftermath of World War II, age-specific mortality rates declined, and population growth consequently increased in most low-income countries. Some observers expected economic pressures to reduce fertility in these low-income countries because of the rising costs of children in urban settings, and the individualistic desires of parents to promote the health and education of their children (Notestein 1945). The more common reaction to this "population explosion" followed the reasoning of Malthus ([1789] 1993), who expected fertility to remain at relatively high levels and rapid population growth to stifle improvements in the standard of living. The continuing decline in infant and child mortality in the 1960s caused the proportion of children in these low-income populations to increase. This rise in the dependency ratio (the ratio

of the young and old to those in the prime working ages of fifteen to sixty-five) was expected to depress the rate of private and public savings, curb investment in physical capital, and thereby slow economic development, unless new policies were able to bribe or coerce parents to curb their fertility (Coale and Hoover 1958; Enke 1960; Erhlich 1968). After a half-century, the empirical record shows crude period birthrates have declined rapidly in most parts of the low-income world, starting in the 1960s, and eventually the number of children born per woman has fallen by at least half in most countries. Sub-Saharan Africa entered only in the last decade or two into its phase of sharply declining child mortality and the beginning of its fertility transition (National Research Council 2000). Total fertility rates for several regions of the world are plotted from 1950-1955 through the median variant of the United Nations projections for 2000-2005 to illustrate these trends in fertility by region (United Nations 2003, vol. 1).

Aggregate Population Growth and Development

This essay focuses only on the relationship between fertility and welfare at the individual family level, and does not deal with the difficult-to-measure indirect spillovers from fertility at the societal level. In other words, if having an additional birth affects the economic well-being of others than the parents or their children, these spillovers are not considered in this essay. I think it is fair to say there is no consensus on how to assess the magnitude or even determine the direction of these spillover effects of fertility and population growth on social welfare. One recent review of the evidence concluded that population growth in excess of 2% per year might constitute a significant handicap limiting economic development in an impoverished country with a weak government (National Research Council 1986). By about 1990 there appears to be a

negative correlation between a country's rate of population growth and rate of economic growth in per-capita income (Kelley and Schmidt 1994), but this regularity was less evident in the 1960s, 1970s, and 1980s. Simon Kuznets (1967) has noted, as did the classical economists, that early periods of rapid population growth are often periods when per-capita economic growth is above average (Smith [1776] 1961; Malthus [1789] 1993). This cross-national negative pattern emerging in the 1990s may thus be a peculiar reflection of the fact that the countries for which population growth exceeds 2% per year are increasingly concentrated in sub-Saharan Africa, the one region that has experienced slow or negative rates of economic growth since the 1970s. The current cross-national inverse pattern between population and economic growth may, therefore, not be specifically due to population growth, but rather to other factors that are unusually common in Africa today, such as communicable diseases including malaria, TB, and HIV/AIDS, and prolonged disruptive wars and civil conflict. (Bloom and Sachs 1998). By concentrating on observations at the family level rather than observations at the country level, I can set aside some of these unresolved issues involving the determinants of aggregate economic growth, and focus on other questions–of disentangling causal effects between fertility and income at the family level.

Family-Level Measures of Welfare

At the level of the family, do higher levels of parents' economic prosperity lead parents to have a smaller number of children, and does lower fertility lead to improved developmental outcomes for children in those families? Interfamily welfare comparisons are often based on total expenditures per household in a given time period, such as a year. To these market expenditures

are then added home production, such as food that is produced and consumed in the home, and the imputed value of the consumer services that the household derives from its physical assets, predominantly in the form of owner-occupied housing and consumer durables. This measure of total market-purchased and home-produced consumption is a widely used approximation for "permanent income," or the present discounted value of average lifetime income opportunities, which is expected to influence the welfare of household members in the long run. In contrast, "current income" is heavily affected by temporary fluctuations in income that households are expected to try to smooth over time into their current flow of consumption, by adding to or drawing down life-cycle savings (debt). Lifetime expected income is therefore the family resource variable that should be related to lifetime fertility, and this lifetime income constraint is approximated by examining total household consumption.

This consumption is then divided by the number of adults in the household who share the consumption, to arrive at a measure of average consumption opportunities or, from the perspective of production, average adult productivity.[3] Because one objective of this essay is to examine the relationship between economic income and fertility, it is inappropriate to measure income as the household's per-capita consumption, allowing explicitly for the "needs" of children in the household. The convention of measuring parents' consumption opportunities in per-capita terms explicitly introduces parents' reproductive choices inversely into the measure of parents' consumption opportunities. If my goal is to estimate the causal relationship between parents' economic opportunities and their fertility, dividing consumption opportunities by the number of children they choose to have will interject a spurious negative partial correlation into the measured relationship. Consequently, household welfare is measured here by consumption

per adult.[4]

Sources of Fertility Variation: Reproductive Supply and Behavioral Demand

To understand how fertility is determined and how economic opportunities and constraints might be causally related to fertility outcomes, a simple model is needed in which the supply of births can be distinguished from the demand for births. Demographers distinguish between the proximate determinants of fertility, or the sequence of biological events that occur to produce a birth, and the variations in behavior that modify the occurrence of these proximate determinants (Bongaarts and Potter 1983). To model fertility behavior as an economic resources-constrained choice, one may assume each couple is assigned a reproductive endowment (supply) that is affected by a random fecundity shock, and the couple then practices birth control or modifies other behavior related to fertility in order to better realize the number of births they want (demand) (Rosenzweig and Schultz 1985). Although a couple does not initially know their supply, they may learn over time from experience.[5] Since we lack good proxies in a survey for the fecundity of couples, we assume that this reproductive endowment is persistent over time and is approximated by the past fertility "success" of the couple, holding constant for their past practice of birth control, which is itself selected by the couple in light of their fertility goals and evolving information about their reproductive endowment (Rosenzweig and P. Schultz, 1985, 1987).

Within this supply-demand framework there are two sources of variation in observed fertility. The first component is related to genetic and random differences in fecundity. The second component includes the effect of systematic behavioral changes, notably including the

adoption of birth control. But fertility is also affected by many other choices, such as age at marriage and duration of breast-feeding, which delays the resumption of ovulation. One way seemingly random supply variation among couples may impact their fertility is through their likelihood of having twins. Behavioral variation in fertility may respond to different perceived costs and benefits of children, including the pecuniary and psychic costs of using birth control. The former genetic variation in fertility supply may be thought of as an unanticipated shock, whereas the latter behavioral variation in fertility demand could respond to parents' perceived net benefit to having additional children, due either to observable factors (i.e., prices, wages, or wealth) or to unobserved preferences (i.e., tastes) of parents for children relative to other uses of their lifetime resources. In the case of the genetic variation in fertility supply, this source of fertility is not expected to be correlated with the parents' preferences or other unobserved behavioral constraints that could also modify family opportunities. The genetic variation in fertility would therefore operate like a randomized experiment.[6] If fertility is initially greater than parents want-in other words, if fecundity supply exceeds demand and birth control is costly-positive shocks of greater fertility associated with the arrival of twins, for example, would cause a welfare loss to parents.[7] Families would then need to reduce and reallocate their expenditures in response to the unwanted fertility shock, shifting resources away from activities that substitute for children, and shifting resources into activities that complement their additional children.[8] In contrast to this random genetic variation in fertility supply associated with the occurrence of twins, behavioral variation in fertility demand would be coordinated with other lifetime choices. Consequently, the association observed between this behaviorally determined fertility and other forms of family consumption or labor supply is not prescribed by any general

economic models of family choice, or readily interpreted as an indicator of the economic consequences of an additional child or sibling on an average parent or their child, respectively.

Whether fertility is a substitute or a complement for other family activities is an important distinction, which can be inferred by estimating how random shocks to fecundity affect other family choices. Many models of family behavior assume that parents view the number of children they have (quantity) and the human capital they invest on average in each of their children (child quality) as substitutes (e.g., Becker and Lewis 1974). If child quantity and quality are in fact substitutes, which empirical studies seem to confirm, then policies that raise the price of child quantity, such as those providing subsidies for birth control in a family-planning program, can be expected to help parents lower their fertility and to also foster their demand for more child quality. Conversely, reducing the cost of child quality, which societies might do by subsidizing schooling for children, would lead parents to invest more in the schooling of their children and reduce their fertility (P. Schultz 1981, 1997).

Economic theories of the allocation of time and physical wealth of families among production and consumption activities suggest additional potential connections between the economic opportunities and constraints facing a couple and their demands for children. Let me review a few of the predictions of the household demand framework, which help to interpret cross-sectional differences in fertility and changes over time:

1. Increasing the productive value of women's time, typically measured by their wage rate outside the home or by their schooling, raises the opportunity cost of childbearing, and leads parents to want and have fewer children, despite the offsetting effect coming from an increase in their incomes (Mincer 1963; P. Schultz 1981, 1985, 1997).

2. Increasing the family's nonearned income from physical capital is not expected to affect the costs of children relative to other goods, and may in some settings raise the value of child labor to the parents, and is generally associated with higher fertility (P. Schultz 1981, 1994).

3. Increasing the returns from goods and services that are substitutes for children, such as the human capital of their children (quality), old-age pensions, health care of the elderly, and improved intergenerational capital markets, is expected to reduce fertility (Becker 1981).

4. Improving birth-control techniques reduces pecuniary and psychic costs of effective control. This fourth factor reduces fertility and uncertainty regarding the timing of births, and thereby assists women in planning their families, careers, and vocational training (Gertler and Molyneaux 1994; P. Schultz 1997).

5. As the levels of women's labor productivity and wages relative to men's increase, the opportunity costs of having children increase, thus strengthening women's influence over family resources and raising the share of household expenditures allocated to each child (Becker 1981; P. Schultz 1985, 2001).

Empirical counterparts for these theoretical price, income, technology, environment, and policy constraints, which are expected to influence lifetime fertility, have been imperfectly measured in many settings in both industrially advanced and low-income countries. They are found, in combination, to explain much of the variation in fertility, thus increasing our confidence that the household demand approach to fertility determinants offers a promising explanation for the fertility differences across a society or over time (P. Schultz 1994). The key empirical regularity is that where the productivity or schooling of women increases relative to

men, fertility is likely to fall, especially if the most productive activities open to women are outside the home and thus cannot be readily combined with her traditional child care activities. Empirical studies are largely engaged in accounting for fertility differences across women in a single society, though some studies deal with populations at all stages of economic development or with subregions of a specific country over time (e.g., P. Schultz 1985).

Measuring the Household Connections Between Fertility and Income in Kenya

Sub-Saharan Africa is the last region of the world to benefit fully from health advances that have reduced child mortality from more than 20% to less than a few percent. Kenya is one of the first African countries in which fertility has declined markedly, starting probably in the early 1980s (Brass and Jolly 1993). While comprehensive economic and demographic household surveys from Africa that permit an examination of the relationships between fertility and family income are rare, the Kenyan Welfare Monitoring Surveys II and III, conducted in 1994 and 1997, allow exploration of some of the issues discussed above (P. Schultz and Mwabu 2003). The fraction of a woman's completed pregnancies (parities) that resulted in a multiple birth is one supply variable that should vary independently of family preferences and choices.[9] The effect of this "per pregnancy probability of having twins" on the woman's total number of births will be positive, but presumably less than 1.[10] The association between one additional birth when twins are born and family income expresses the impact expected from a "thought experiment" that randomly increases an average person's fertility by one birth. In reality, however, the extra child resulting from the birth of twins might constitute a minor inconvenience for some parents who want many children and who have twins from an early pregnancy and subsequently can

easily adjust their use of birth control to achieve their lifetime reproductive goal. The arrival of twins could be a major setback for other parents who want few births and are thus more likely to have twins from a pregnancy that was intended to be their last; this second group of parents has little recourse but to have more children than they wanted because they had twins.

Population policies, however, more commonly seek to reduce fertility by helping couples avoid "unwanted births" through encouraging the diffusion of new, more effective family-planning methods. These population policies will thus have the opposite-signed effect on family welfare from what was inferred here from the study of the consequences of twins. As with the "twin shock," the exogenous improvement in birth control may be expected to benefit different parents differently. For parents who want few children, the provision of more effective birth control is a greater benefit than for parents who want more children, other things being equal.

Kenyan women between the ages of twenty-five and forty-four, for whom fertility is known, are analyzed, forming a sample of 5,400 women in 1994 and 4,528 in 1997. Having twins appears to increase a woman's number of children by .74 in 1994 and by .89 in 1997, suggesting that the average Kenyan couple is able to offset, through birth control and other compensating behavior, between 26% and 11% of the effect of the unanticipated birth of twins, as it affects their cumulated fertility at the time of the survey. All of the "associations" reported are estimated after controlling for the schooling of mother and father, their ages, rural/urban residence, and five regions of Kenya. The fertility increase associated with the occurrence of twins is not significantly correlated across women with their household's consumption per adult. But having one more child is significantly related to diminished consumption per adult, -1.9% per birth in 1994 and -2.5% in 1997, confirming the impression stated at the outset of this essay:

higher fertility is associated with lower consumption and greater poverty. But it is notable that this negative association is not evident with respect to the random variation in fertility due to twins, suggesting that consumption is not lower if the increase in fertility occurs randomly. Unobserved factors that influence the decisions of people to have more (or fewer) children are also factors that are associated with being poorer (or richer), and among these factors I would expect the diversity of preferences for children and of productive capabilities to be important.

Household consumption per adult, my initial indicator of parent income, is significantly positively associated with the ownership of land, and the receipt of agricultural and nonagricultural rents. These three physical asset sources of income are generally positively related to fertility in Kenya. A 10% increase in household consumption per adult, arising from these asset sources of income, is associated with an increase in fertility of .19 child in 1994 and .17 child in 1997, where the average fertility in the survey samples is about four children. But a 10% increase in household consumption per adult from sources other than the three asset variables is negatively related to fertility, reducing fertility by .20 child in 1994 and by .18 child in 1997. In other words, the estimated effect of increasing assets is to increase fertility, whereas increasing other sources of income, such as labor earnings, decreases fertility, and both relationships are highly significant in both surveys.[11] An increase in the mother's schooling attainment by one year is associated with her household consumption per adult rising by 4.1% in 1994 and by 4.9% in 1997, and these effects are larger than those associated with the schooling of the father. If the household consumption effect of the woman's schooling is held constant, each additional year of her schooling has an additional effect of reducing her fertility by .12 child in both 1994 and 1997. These estimates underscore how different sources of income and

human capital exhibit markedly different partial associations with fertility. It is important, therefore, to distinguish among the different sources of income in order to understand the impacts of economic development on fertility and the timing of the demographic transition in a particular society.

A second indicator of family outcome is drawn from the survey's reports on the height and weight of children under five years of age. A common anthropometric indicator of the health and nutritional status of children from ages six to sixty months is the ratio of a child's weight to height (W/H).[12] One more child born to a Kenyan woman is associated with a -.032 standard deviation change in the W/H of her young children in 1994 and a -.037 standard deviation change in 1997. This anthropometric indicator tends to be positively associated with the child's chances of survival, later health status, subsequent performance in school, and eventual productivity as an adult worker. Thus, a decline in W/H associated with a rise in fertility suggests that an additional child may involve a real cost in terms of child health. But when one focuses only on the fertility variation associated with twins, the child nutrition effect is much larger: -.11 and -.20 standard deviation in 1994 and 1997, respectively.

The purpose of distinguishing between the random event of a birth of twins and other sources of behaviorally influenced fertility variation is to show that the supply and demand components of fertility are related differently to one widely used measure of child welfare, W/H. The estimated overall association of fertility to W/H is negative, but a small fraction of that associated with the random supply shock of twins. Evidently, the distinction between the behavioral demand and random genetic supply variation in fertility is critical. If we want to assess the impact of how a population policy is likely to affect the health and nutritional welfare

of a woman's children, or her household's consumption, it is important to understand the source of the change in fertility. A national family-planning program that reduced the effective cost of birth control sufficiently to reduce the average number of births among Kenyan women by 1 would, according to these estimates, raise the W/H of the next generation of Kenyan children by .1 to .2 standard deviation, and increase overall consumption opportunities per adult in the average Kenyan household.

Conclusions

Forecasting the consequences of economic development on Kenyan fertility is complicated. First, one must know the sources of that economic growth. If growth is achieved by increasing the income returns from land, for example, it is likely that Kenyan fertility will remain high, perhaps because parents view land and the labor of children as complementary factors in their meager production. If economic growth is stimulated by extending additional education to women, the resulting relative rise in the price of children will favor a continuing decline in fertility, as observed in many studies within a low-income country and estimated across countries and over time (P. Schultz 1994, 1997).

Most parents benefit from an improvement in birth control that allows them to avoid unwanted births at less cost. Analogously, a policy that could miraculously reduce the incidence of twins not only would reduce fertility but also might raise family income, as measured in Kenya by consumption per adult, and improve child nutrition and health status, as measured by W/H, which in turn should enhance the child's productivity as an adult. However, a policy that reduces the level of fertility by constraining parents' demands for children, such as by

implementing quantitative restrictions and tax penalties for out-of-plan births, as in China, may not advance family welfare, and could diminish it.

Fertility and income are caused by many factors. To account for the impact of fertility on society, it is useful to distinguish between genetically determined variation in the supply of births that is more or less random, and behavioral variation in the demand for births that is coordinated with many other choices parents make over their lifetimes. In the case of economic development and the growth in income, social scientists should distinguish among the various sources of modern economic growth that do not appear to have the same effects on fertility. In particular, income that flows from the human capital of the mother and father, and income that flows from stocks of physical capital, land, and other natural resources, are not likely to contribute to similar behavioral responses in fertility.

Figures

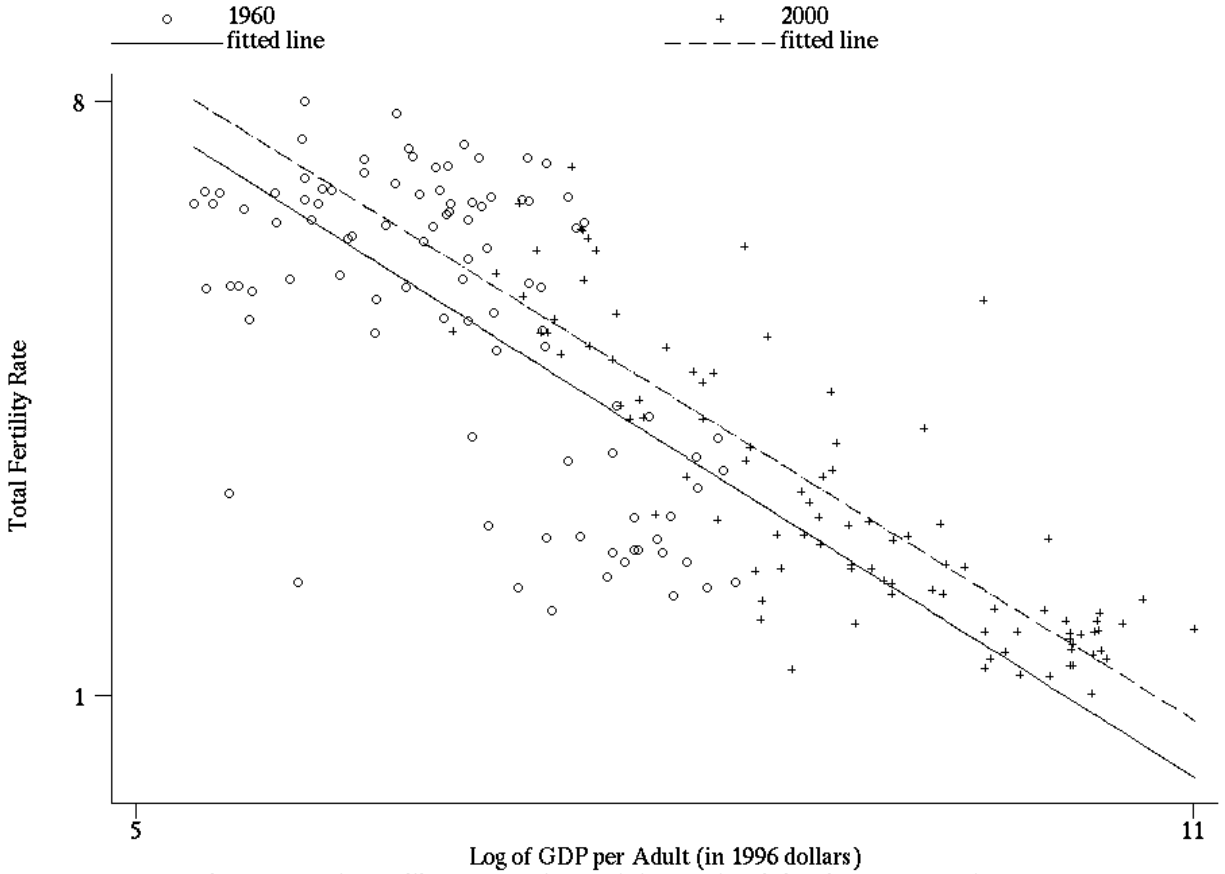

Fig. 1 Total Fertility Rates by Adult Productivity in 1960 and 2000

Fig. 2 Total Fertility Rates by Region

Notes

1. I have included all ninety-six countries for which Penn World Tables (PWT) 6.1 provides estimates of GDP per adult in purchasing power parity 1996 dollars for both 1960 and 2000, and I could obtain the proportion of the population age fifteen or over from World Development Indicators of the World Bank, and their total fertility rates from the U.N. Population Division database.

2. TFR in the world declined about 46% from 1960 to 2000, from 4.97 to 2.69 (UN 2003), but growth in real income in the world is more difficult to measure; it may have grown by 4-5% per year, when the incomes of countries are weighted by their populations (P. Schultz 1998).

3. Studies of household expenditure patterns frequently define welfare by deflating observed household consumption by the consumption "needs" of the household members. Consumption needs for several demographic groups are derived in equivalent units, where the needs of male adults are typically used as a benchmark and set to 1 (Deaton, 1997). Because food consumption is a large share of total consumption in a low-income country, on the order of 70% in Kenya in 1994 (Kenyan Central Bureau of Statistics 1996, 152), and about 60% in India in 1983 (Thomas 1986, 237), estimated nutritional requirements determined initially by average weight of different demographic groups-such as adult males, adult females, and children-may approximate the household's overall consumption requirements. Of course, this approximation of equivalent caloric "needs" for men and women to maintain their body weight ignores individual differences in weight within distinguished groups, as well as individual differences in the strenuousness of work (caloric demands of labor, childbearing, and breast-feeding) and the burdens of disease (fighting infection consumes calories). Moreover, as the food share of total expenditures declines

with economic development, these demographic consumption units based on body weight and calorie requirements become even less satisfactory (Thomas 1986).

4. There are many reasons that consumption per adult does not perfectly measure the welfare opportunities of the parents. For example, in low-income countries, children may be important contributors to household income through their labor. Thus the causality could flow from fertility back to household consumption per adult. Nonetheless, consumption per adult is better for my purposes than consumption per capita or per adult equivalent, including children.

5. An implication of this framework is that those with greater fecundity are more likely to adopt more effective methods of birth control at a smaller family size, holding constant for the environmental conditions that are expected to influence their demand for children (Rosenzweig and Schultz 1987).

6. Twins tend to occur in 1-3% of pregnancies, but with the recent developments in drug treatments to deal with infertility problems, the frequency of multiple births has increased and would no longer be expected to occur randomly in some high-income populations. Small variations in the probability of twins are observed according to the mother's parity and age, but these are neglected here, given the size of the samples later examined.

7. If fertility supply is lower than demanded by parents, the arrival of twins may increase welfare.

8. If we could ignore the welfare loss associated with the fertility shock (i.e., the income effect), the sign of the cross-effect of the genetic fertility variation on the other forms of family behavior would signal whether the other form of behavior was a substitute (negative) or complement (positive) for children in the parents' utility function. This implication of random rationing of the provision of a household good (children), regardless of the demand for that good, was analyzed

by Tobin and Houthakker (1950-1951), and applied by Rosenzweig and Wolpin (1980). Their study confirmed that the birth of twins led Indian rural families to retrench on the schooling of their children, suggesting that numbers of children and their schooling are substitutes, neglecting the income loss associated with unanticipated twins.

9. It would be preferable to consult a pregnancy roster for each older woman who has completed her childbearing, and analyze the number of children she has ever borne and the number of twins she has had over her entire reproductive lifetime. Unfortunately, the Kenyan surveys did not collect this information, and our calculations are based on the number of surviving children of the woman enumerated as members of her household. The ages of women analyzed are restricted to between twenty-five and forty-four to minimize the likelihood that some of their children would have left the household. Control variables for age and age squared of the mother and father are included to reduce the problems of younger women not having completed their childbearing. In 1994 is it possible to compare these survey enumerated measures of surviving children with the responses of women to the question of how many live children they have ever borne and how many have died. Within the sample of women ages twenty-five to forty-four, the observed and ever-borne measures of fertility are correlated at .97 or higher. A second measurement problem arises from the nonuniform distribution of the probability of the birth of twins, which is concentrated at points such as 0, .50, .33, .25, .20, .16, .66, and .40. We use a transformation called a polyfraction exponential approximation to smooth this distribution and avoid statistical bias due to its nonsymmetric form. If we had a sufficiently large sample and the full roster of each woman's pregnancy history, we could have focused only on the effect of twins-on-first-parity, which is a better measure because it includes all women with at least one

child, each one time (Olsen 1980; Royston and Altman 1994).

10. The first study I know of to examine the effect of twins on fertility and family outcomes was based on a rural Indian survey from 1971 (Rosenzweig and Wolpin 1980), in which twins are associated with a mother having .8 more children, and with the woman's other children having a significantly lower educational attainment, presumably due to the twins. Other studies have shown that fertility variation that is not explained by birth-control practices and socioeconomic controls is negatively associated with child health and schooling in Malaysia (Rosenzweig and Schultz 1987). Studies of high-income countries have examined the consequences of twins on decisions regarding marriage and receipt of public assistance (Bronars and Grogger 1994).

11. This procedure of including the asset-identified income and the residual income among the explanatory variables in the fertility equation is analogous to the Hausman (1978) specification test in which one rejects the exogeneity of income as a determinant of fertility.

12. This variable is transformed into a Z score, defined as a deviation of the child's W/H from the median value in a reference population of children of the same age and sex, and divided by the standard deviation of W/H in each age and sex category. The World Health Organization's (1986, 1995) recommended strategy is to compare the child's growth with a population of healthy children, and a common standard is provided by the Centers for Disease Control and Prevention in Atlanta, based on large samples of U.S. children. Alternatively, we used the Kenyan survey itself to provide a smoothed estimate by gender of the age curve for W/H and its standard deviation, since we are more interested in relative ranking of nutritional status among the Kenyan children than in comparing Kenyan children against an international standard

derived from a relatively well-nourished population. Both standardized indicators of W/H, based on the U.S. and Kenyan populations, yielded very similar results, though not precisely the same across genders or rural-urban differences.

Bibliography

Becker, Gary. A Treatise on the Family. Cambridge, Mass.: Harvard University Press, 1981.

Becker, Gary, and Gregg Lewis. "Interaction Between Quantity and Quality of Children." In The Economics of the Family. Edited by T. W. Schultz. Chicago: University of Chicago Press, 1974.

Bloom, David, and Jeffrey Sachs. "Geography, Demography, and Economic Growth in Africa." Brookings Papers on Economic Activity 2 (1998): 207-273.

Bongaarts, John, and Robert G. Potter. Fertility, Biology, and Behavior. New York: Academic Press, 1983.

Brass, William, and Carole L. Jolly, eds. Population Dynamics of Kenya. Washington, D.C.: National Academy Press, 1993.

Bronars, Stephen, and Jeff Grogger. "The Economic Consequences of Unwed Motherhood: Using Twin Births as a Natural Experiment." American Economic Review 84 (5) (1994): 1141-1156.

Coale, Ansley, and Edgar Hoover. Population Growth and Economic Development in Low-Income Countries. Princeton, N.J.: Princeton University Press, 1958.

Deaton, Angus. The Analysis of Household Surveys. Baltimore: Johns Hopkins University Press, 1997.

Ehrlich, Paul. The Population Explosion. New York: Simon and Schuster, 1964.

Enke, Stephen. "The Economics of Government Payments to Limit Population." Economic Development and Cultural Change 8 (4) (1960); 339-348.

Gertler, Paul, and John Molyneaux. "How Economic Development and Family Planning Programs Combined to Reduce Indonesian Fertility." Demography 31 (1) (1994): 33-63.

Hausman, Jerry. "Specification Tests in Econometrics." Econometrica 46 (6) (1978): 1251-1271.

Kelley, Allen, and Robert Schmidt. "Population and Income Change: Recent Evidence." World Bank discussion paper 249, Washington, D.C.: World Bank, 1994.

Kenyan Central Bureau of Statistics. Welfare Monitoring Survey II, 1994. Basic Report. Nairobi: Ministry of Finance and Planning, Republic of Kenya, 1996.

Kuznets, Simon. "Population and Economic Growth." Proceedings of the American Philosophical Society 111 (3) (1967): 170-193.

Malthus, Thomas. An Essay on the Principle of Population [1789]. Oxford: Oxford University Press, 1993.

Mincer, Jacob. "Market Prices, Opportunity Costs and Income Effects." In Measurement in Economics. Edited by C. Christ et al. Stanford, Calif.: Stanford University Press, 1963.

National Research Council. Population Growth and Economic Development: Policy Questions. Washington, D.C.: National Academy Press, 1986.

National Research Council. Beyond Six Billion. Washington, D.C.: National Academy Press, 2000.

Notestein, Frank. "Population-The Long View." In Food for the World. Edited by T. W. Schultz. Chicago: University of Chicago Press, 1945.

Olsen, R. J. "Estimating the Effects of Child Mortality on the Number of Births." Demography 17 (4) (1980): 429-444.

Rosenzweig, Mark, and Paul Schultz. "The Demand and Supply of Birth: Fertility and Its Lifecycle Consequences." American Economic Review 75 (5) (1985): 992-1015.

Rosenzweig, Mark, and Paul Schultz. "Fertility and Investment in Human Capital: Estimates of the Consequences of Imperfect Fertility Control in Malaysia." Journal of Econometrics 36 (1987): 163-184.

Rosenzweig , Mark, and Kenneth Wolpin. "Testing the Quality-Quantify Fertility Model." Econometrica 48 (1) (1980): 227-240.

Royston, P., and D. G. Altman. "Regression Using Fractional Polynomials of Continuous Covariates." Applied Statistics 43 (3) (1994): 429-467.

Schultz, Paul. Economics of Populations. Reading, Mass.: Addison-Wesley, 1981.

Schultz, Paul. "Changing World Prices, Women's Wages and the Fertility Transition." Journal of Political Economy 93 (1985): 1126-1154.

Schultz, Paul. "Human Capital, Family Planning and Their Effects on Population Growth." American Economic Review 83 (1994): 255-260.

Schultz, Paul. "The Demand for Children in Low-Income Countries." In Handbook of Population and Family Economics. Edited by M. R. Rosenzweig and O. Stark. Vol. 1A, chap. 8. Amsterdam: North-Holland, 1997.

Schultz, Paul. "Inequality in the Distribution of Personal Income in the World." Journal of Population Economics 11 (3) (1998): 307-344.

Schultz, Paul. "Women's Roles in the Agricultural Household: Bargaining and Human Capital Investments." In Handbook of Agricultural Economics. Edited by B. Gardner and G. Rausser. Vol. 1A, chap. 8. Amsterdam: North-Holland, 2001.

Schultz, Paul, and G. Mwabu. "The Causes and Consequences of Fertility in Contemporary Kenya." Unpublished paper, Yale University, 2003.

Schultz, Theodore W. "Fertility and Economic Values." In Economics of the Family. Edited by Theodore W. Schultz. Chicago: University of Chicago Press, 1974.

Smith, Adam. The Wealth of Nations [1776]. Edited by E. Cannon. London: Methuen, 1961.
Thomas, Duncan. "The Food Share as a Welfare Measure." Ph.D. dissertation, Princeton University, 1986.

Tobin, James, and Hendrick Houthakker. "The Effect of Rationing on Demand Elasticities." Review of Economic Studies 18 (1950-1951): 140-153.

United Nations. World Population Prospects: The 2002 Revision. Vol. 1. New York: United Nations, 2003.

World Health Organization. "Use and Interpretation of Anthropometric Indicators of Nutritional Studies." Bulletin of the World Health Organization 64 (6) (1986): 929-941.

World Health Organization. Physical Status: The Use and Interpretation of Anthropometry. WHO Technical Report Series no. 854. Geneva: World Health Organization, 1995.