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Population and Development Review, Volume 26, Issue 4 (Dec., 2000), 643-689.

Stable URL:
http://links.jstor.org/sici?sici=0098-7921%28200012%2926%3A4%3C643%3APARAEO%3E2.0.CO%3B2-B

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PARTHA DASGUPTA

POPULATION GROWTH ELICITS widely different responses from various observers. Some believe it to be among the causes of the most urgent problems facing humankind today (e.g., Ehrlich and Ehrlich 1990), while others permute the elements of this causal chain, arguing, for example, that contemporary poverty and illiteracy in poor countries are the causes, rather than the consequences, of rapid population growth.[1] Still others claim that even in the poorest countries population growth can be expected to provide a spur to economic progress.[2] Among the many who remain, there is a wide spectrum of views, both on the determinants of population growth and on the effects of that growth on the natural-resource base and human welfare. It would seem not only that our attitudes toward population size and its growth differ, but that there is no settled view on how the matter should be studied. As with religion and politics, many people have opinions on population that they cling to with tenacity.

In this article I bring together theoretical and empirical findings to argue that such divergence of opinion is unwarranted. In the first two sections I offer the conjecture that differences persist because the interface of population, resources, and welfare at a spatially localized level has been a relatively neglected subject. Neglect by experts is probably also the reason why the nexus has attracted much popular discourse, which, while often illuminating, is frequently descriptive rather than analytical.

It is not uncommon among those who write about population, resources, and welfare to adopt a global, future-oriented view: the emphasis frequently is on the deleterious effects a large and increasingly affluent population would have on Earth in the future.[3] This slant has been instructive, but it has drawn attention away from the economic misery and ecological degradation endemic in large parts of the world today. Disaster is not something for which the poorest have to wait; it is a frequent occurrence. Moreover, among the rural poor in developing countries, decisions on fertility,

on allocations concerning education, food, work, health care, and on the use of the local natural-resource base are in large measure reached and implemented within households that are unencumbered by compulsory schooling and visits from social workers, that do not have access to credit and insurance in formal markets, that cannot invest in well-functioning capital markets, and that do not enjoy the benefits of social security and old-age pension schemes. These features of rural life direct me, in the third section, to study the interface of population growth, poverty, and environmental stress from a myriad of household, and ultimately individual, viewpoints.

Women's education and reproductive health have come to be seen as the most effective channels for influencing fertility. In subsequent sections I provide an outline of the theoretical and empirical reasons why they are so seen. An interesting analytical feature of both education and reproductive health is that they can be studied within a framework where households make decisions in isolation from other households. Thus, the theory of demand for education and reproductive health can be treated as a branch of the "new household economics," which has been much engaged in the study of the isolated household.[4] But theoretical considerations suggest that a number of factors arising from interhousehold linkages could also influence fertility decisions. In this article I am much interested in exploring such linkages. Appropriately, they include those in which women's education and reproductive health play a role. The findings I report are consistent with the contemporary emphasis on women's education and reproductive health. These matters are explored in the final two sections and the Appendix. I conclude that there is substance to what has been called the population problem. I also argue that in the Indian subcontinent and in sub-Saharan Africa, the problem has for a long while been an expression of human suffering, and that the problem could well persist even if all regions of the world were to make the transition to low fertility rates.

Framing links between population, resources, and welfare

It is appropriate first to identify some of the ways social scientists have framed the links between population growth, resources, and human welfare. I review them in this section. This outline will enable us to compare and contrast the way the links have generally been framed with the way I frame them here.

There are three sets of examples to discuss here. They concern the way modern theories of economic growth view fertility and natural resources, the way population growth and economic stress in poor countries are studied by environmental and resource economists, and the way development economists accommodate environmental stress in their analysis of contemporary poverty. The examples are discussed in the next three sections. If I grumble, there is cause. Judging by level of analysis, most of those who

have been investigating economic growth, poverty, environmental stress, and fertility behavior have not read widely beyond their particular fields of interest. One cannot but think that this has impeded progress in our understanding of some of the most complex issues in the social sciences.

Population and resources in modern theories of growth

For the most part, modern theories of economic growth assume population change to be a determining factor of human welfare. A central tenet of the dominant theory is that although population growth does not affect the long-run rate of change in living standards, it adversely affects the long-run standard of living (Solow 1956).

Recent models of economic growth have been more assertive. They lay stress on new ideas as a source of progress, supposing that the growth of ideas is capable of circumventing any constraint the natural-resource base may impose on the ability of economies to grow indefinitely. Such models note too that certain forms of investment (e.g., research and development) enjoy cumulative returns because the benefits are durable and can be shared collectively. The models also assume that growth in population leads to an increase in the demand for goods and services. An expansion in the demand for and supply of ideas implies that, in the long run, equilibrium output per head can be expected to grow at a rate that is itself an increasing function of the rate of growth of population. (It is only when population growth is nil that the long run rate of growth of output per head is nil.) The models regard indefinite growth in population to be beneficial.[5]

Contemporary growth theory does not explicitly model the nature of new products. One can only conjecture that it assumes future innovations to be of such a character that indefinite growth in output would make no more than a finite additional demand on the natural-resource base. The assumption is questionable (Daily 1997; Dasgupta 2001). In any event, we should be skeptical of a theory that places such enormous burden on an economic regime not much more than 200 years old (Fogel 1994; Johnson 2000). Extrapolation into the past is a sobering exercise: over the long haul of history (some 5,000 years), economic growth even in the currently rich countries was for most of the time not much above zero. The study of possible feedback loops between poverty, demographic behavior, and the character and performance of both human institutions and the natural-resource base is not yet on the research agenda of modern growth theorists.

Demography and economic stress in environmental and resource economics

In its turn, the environmental and resource economics that has been developed in the United States has not shown much interest in economic stress

and population growth in poor countries. In their survey of the economics of environmental resources, Kneese and Sweeney (1985, 1993) and Cropper and Oates (1992) bypassed the subject matter of this article. They were right to do so, for the prevailing literature regards the environmental-resource base as an "amenity." Indeed, it is today a commonplace that "[economic] growth is good for the environment because countries need to put poverty behind them in order to care" (*Independent*, 4 December 1998), or that "trade improves the environment, because it raises incomes, and the richer people are, the more willing they are to devote resources to cleaning up their living space" (*The Economist*, 4 December 1999: 17).

I quote these views to suggest that natural resources are widely seen as luxuries. This view is hard to justify when one recalls that our natural environment maintains a genetic library, sustains the processes that preserve and regenerate soil, recycles nutrients, controls floods, filters pollutants, assimilates waste, pollinates crops, operates the hydrological cycle, and maintains the gaseous composition of the atmosphere. Producing as it does a multitude of ecosystem services, the natural-resource base is in large part a necessity.[6] A wide gulf separates the perspective of environmental and resource economists in the North (I use the term in its current geopolitical sense) from what would appear to be the direct experience of the poor in the South.[7]

Population and resource stress in development economics

Nor is the population–poverty–resource nexus a focus of attention among development economists. Even in studies on the semi-arid regions of sub-Saharan Africa and the Indian subcontinent (poverty-ridden land masses, inhabited by some 2 billion people and experiencing the largest additions ever known to their population; see Tables 1 and 2), the nexus is largely absent. For example, the authoritative surveys by Birdsall (1988), Kelley (1988), and Schultz (1988) on population growth in poor countries fail to touch on environmental matters. Mainstream demography also makes light of environmental stress facing poor communities in sub-Saharan Africa and the Indian subcontinent. Nor does the dominant literature on poverty (e.g., Stern 1989; Drèze and Sen 1990; Bardhan 1996) take population growth and ecological constraints to be prime factors in development possibilities.[8]

This situation is puzzling. Much of the rationale for development economics is the notion that poor countries suffer particularly from institutional failures. But institutional failures in great measure manifest themselves as externalities. To ignore population growth and ecological constraints in the study of poor countries would be to suppose that demographic decisions and resource use there give rise to no externalities of significance, and that externalities arising from institutional failure have a negligible effect

TABLE 1 Crude birth and death rates per 1,000 people

	Births		Deaths		Births minus deaths	
	1980	1998	1980	1998	1980	1998
China	18	16	6	8	12	8
Bangladesh	44	28	18	10	26	18
India	34	27	13	9	21	18
Pakistan	47	35	15	8	32	27
Sub-Saharan Africa	47	40	18	15	29	25
(Nigeria)	50	40	18	12	32	28
World	27	22	10	9	17	13

SOURCE: World Bank (2000: Table 2.2).

TABLE 2 Magnitude of poverty in extremely poor and poor regions, 1985

	Extremely poor			Poor		
Region	Number (million)	Headcount index (%)	Poverty gap (%)	Number (million)	Headcount index (%)	Poverty gap (%)
Sub-Saharan Africa	120	30	4	180	47	11
East Asia	120	9	0.4	280	20	1
China	(80)	8	1	(210)	20	3
South Asia	300	29	3	520	51	10
India	(250)	33	4	(420)	55	12
Middle East and North Africa	40	21	1	60	31	2
Latin America and the Caribbean	50	12	1	70	19	1
All developing countries	630	18	1	1,110	33	3

NOTES: The poverty line in 1985 purchasing-power-parity dollars is US$275 per capita per year for the extremely poor and US$370 per capita per year for the poor.
Headcount index is the percent of the population below the poverty line.
Poverty gap is the minimum amount of additional income, expressed as a percent of GNP, which, if it is distributed among the poor, can eliminate poverty.
SOURCE: World Bank (1990: Table 2.1).

on resource use and demographic behavior. I know of no body of empirical work that justifies such presumptions.

Population, food, and resources: Why global statistics can mislead

How is one to account for these neglects? It seems to me there are four reasons, one internal to the development of the "new household economics," the others arising from limitations in global statistics.

The first has to do with the preoccupation of those who developed the new household economics.[9] For reasons of tractability they studied choices made by isolated, optimizing households. Such predictions of the theory as that increases in women's labor productivity reduce the household demand for children are borne out in cross-country evidence (Schultz 1997). Nevertheless, the study of isolated households is not a propitious means by which to explore the possibilities of collective failure among households. For example, there have been few attempts to estimate externalities resulting from reproductive choices. One reason is that the theory of demographic interactions in nonmarket environments is still underdeveloped; and without theory it is hard for the empiricist to know what to look for.[10] I later point to scattered evidence, drawn from anthropology, demography, economics, and sociology, of externalities resulting from pronatalist attitudes among rural households in poor countries. I also try to develop some of the analytical techniques that would be required for identifying such externalities. The directional predictions of the resulting theory are not at odds with those of the new household economics (e.g., that an increase in women's labor productivity lowers the demand for children); but their predictions differ on the magnitude of household responses.

The second reason for the neglect of the population–poverty–resource nexus is the outcome of an inquiry made more than a decade ago into the economic consequences of population growth (National Research Council 1986). Drawing on national time-series and cross-regional data, the investigators observed that population size and its growth can have both positive and negative effects. For the purposes of interpreting the data, population growth was regarded as a causal factor in the study. The investigators concluded that there was no reason for concern over the high rates of growth being experienced in poor countries.[11]

But regression results depend on what is being regressed on what. So, for example, one can set against the National Research Council report more recent cross-country studies by Mauro (1995) and Eastwood and Lipton (1999), who have found a negative correlation between population growth and economic growth and a positive correlation between population growth and the magnitude of absolute poverty. In short, cross-country regressions in which population growth is a determining factor have given us mixed messages. Later in this article I show that even though we may have learned something from cross-country regressions, they have frequently misdirected us into asking wrong questions on demographic matters.

The third reason stems from a different set of empirical findings. With the exception of sub-Saharan Africa over the past 30 years or so, gross income per head has grown in nearly all poor regions since the end of World War II. In addition, growth in world food production since 1960 has exceeded the world's population growth by an annual rate of approximately

0.6 percent. This has been accompanied by improvements in a number of indicators of human welfare, such as the infant survival rate, life expectancy at birth, and literacy. In poor regions each of the latter improvements has occurred in a regime of population growth rates substantially higher than in the past: excepting East Asia and parts of South and Southeast Asia, modern-day declines in mortality rates have not been matched by reductions in fertility.

Table 3 presents total fertility rates (TFR), gross national product (GNP) per head, and growth in GNP per head in several countries and groups of countries.[12] Between 1980 and 1998 the TFR declined everywhere, but very unevenly. Sub-Saharan Africa has displayed the most acute symptoms of poverty: continued high fertility rates allied to declining GNP per head in a very poor continent. Nevertheless, as Table 3 confirms, the oft-expressed fear that rapid population growth will accompany deteriorations in living standards has not been borne out by experience when judged from the vantage of the world as a whole. It is then tempting to infer from this, as does Johnson (2000) most recently, that in recent decades population growth has not been a serious hindrance to improvements in the circumstances of living.

The fourth reason stems from economic theory and cross-country data on the link between household income and fertility. Imagine that parents regard children as an end in themselves; that is, assume children to be a "consumption good." If, in particular, children are a "normal" consumption good, an increase in unearned income would lead to an increase in the demand for children, other things being equal. This is the "income effect."[13] In his well-known work Becker (1981) argued, however, that if the increase

TABLE 3 Total fertility rates and GNP per head in a sample of countries and regions

	TFR		GNP per head[a]	Average annual percent growth of GNP per head[b]
	1980	1998	1998	1965–98
China	2.5	1.9	3,051	6.8
Bangladesh	6.1	3.1	1,407	1.4
India	5.0	3.2	2,060	2.7
Pakistan	7.0	4.9	1,652	2.7
Sub-Saharan Africa	6.6	5.4	1,440	–0.3
(Nigeria)	6.9	5.3	740	0.0
United States	1.8	2.0	29,240	1.6
World	3.7	2.7	6,300	1.4

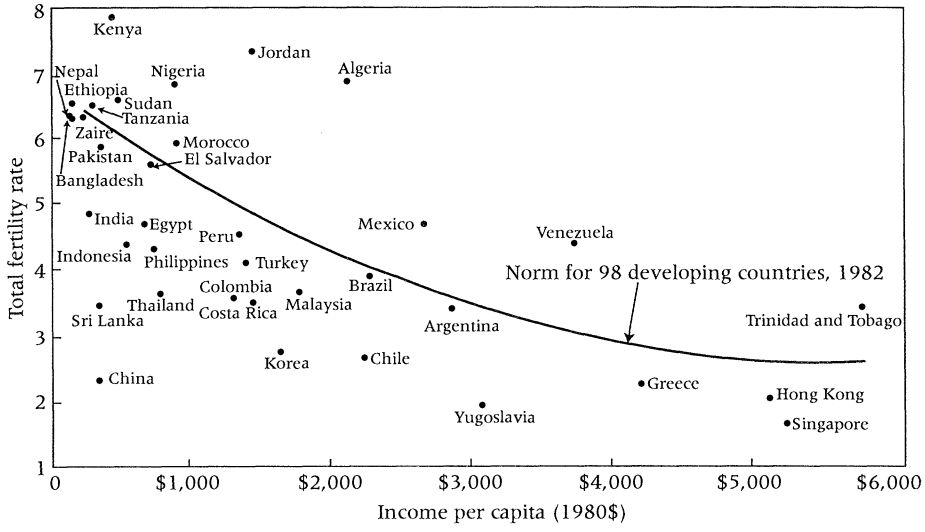
[a]Dollars at purchasing power parity.
[b]GNP growth calculated from constant price GNP in national currency units.
SOURCE: World Bank (2000: Tables 1.1, 1.4, and 2.16).

in household income were the result of an increase in wage rates (i.e., an increase in labor productivity), then the cost of children would increase, because time is involved in producing and rearing them. But other things being equal, this would lead to a decrease in the demand for children (this is the "substitution effect"). It follows that a rise in income owing to an increase in labor productivity would lead to a decline in fertility if the substitution effect were to dominate the income effect, a likely possibility.

Figure 1, taken from Birdsall (1988), shows that, among developing countries that in the early 1980s had incomes above US$1,000 per capita, those that were richer experienced lower fertility rates. A regional breakdown of even the Chinese experience displays the general pattern: fertility is lower in higher-income regions (Birdsall and Jamison 1983). These are only simple correlations and, so, potentially misleading. Moreover, they do not imply causality. But they suggest that growth in income can be relied upon to reduce population growth.

There are three weaknesses with the reasoning just outlined. First, conventional indexes of the standard of living pertain to commodity production, not to the natural-resource base on which production depends. Statistics on past movements of world or regional income and agricultural production say nothing about this base. They do not indicate whether or not increases in GNP per head in a country are being realized by means of a depletion of natural capital (e.g., ecosystem functioning). It could be, for

FIGURE 1 Fertility in relation to income in developing countries, 1982



SOURCE: Birdsall (1988: 482).

example, that increases in agricultural production are in part accomplished by "mining" soil and water. In relying on GNP and other current-welfare measures, such as life expectancy at birth, infant survival, and literacy, we run the danger of ignoring the concerns ecologists have voiced about pathways linking population growth, economic activity, and the state of the natural-resource base.[14]

It can be shown that the correct measure of a community's welfare over the long run is its wealth, where wealth is the social worth of the entire bundle of its assets, including manufactured, human, and natural capital (Dasgupta and Mäler 2000). A community's welfare over the long run would increase only if net investment per head in its capital base were positive. In other words, genuine investment is required if a community's well-being is to be sustainable. Since it is possible for a country's GNP to increase over an extended period even while its wealth is declining, time series of GNP per head could mislead.[15]

Hamilton and Clemens (1999) have provided estimates of genuine saving in a number of countries.[16] Among the resources that make up natural capital, only forests, oil and minerals, and pollution were included (not included were such vital resources as soil quality and water). So there is an undercount. Moreover, the accounting prices used to value natural capital were crudely estimated. Nevertheless, one has to start somewhere.

The first column in Table 4 contains estimates of genuine investment as a proportion of GNP in Bangladesh, India, Nepal, Pakistan, China, and sub-Saharan Africa over the period 1970–93. Notice that Bangladesh, Nepal, and sub-Saharan Africa have disinvested: their productive base has shrunk during the period in question. In contrast, genuine investment was positive in China, India, and Pakistan. This could suggest that the latter coun-

TABLE 4 Genuine investment and capital deepening in selected countries and regions: 1970–93

	I/Y[a]	g(L)[b]	g(W/L)[c]	g(Y/L)[d]	g(HDI)[e]
Bangladesh	–0.013	2.3	–2.60	1.0	3.3
India	0.080	2.1	–0.10	2.3	2.2
Nepal	–0.024	2.4	–3.00	1.0	5.3
Pakistan	0.040	2.9	–1.90	2.7	1.8
China	0.100	1.7	0.80	6.7	–0.2
Sub-Saharan Africa	–0.028	2.7	–3.40	–0.2	0.9

[a] I/Y: genuine investment as proportion of GNP. Source: Hamilton and Clemens (1999: Table 3).
[b] g(L): average annual percentage rate of growth of population, 1965–96. Source: World Bank (1998: Table 1.4).
[c] g(W/L): average annual percentage rate of change in per capita wealth. Assumed output–wealth ratio: 0.25.
[d] g(Y/L): average annual percentage rate of change in per capita GNP, 1965–96. Source: World Bank (1998: Table 1.4).
[e] g(HDI): average annual percentage rate of change in UNDP's Human Development Index, 1987–97. Source: UNDP (1990, 1999).

tries were wealthier at the end of the period than at the beginning. But when population growth is taken into account, the picture changes.

The second column in Table 4 contains the annual percentage rates of growth of population over the period 1965–96. All but China have experienced rates of growth in excess of 2 percent per year. Next I estimate the average annual change in wealth per capita during 1970–93. To do this, I multiply genuine investment as a proportion of GNP by the average output–wealth ratio of an economy to arrive at the (genuine) investment–wealth ratio, and then compare changes in the latter ratio to changes in population size. Because a wide variety of natural assets (human capital and various forms of natural capital) are unaccounted for in national accounts, there is an upward bias in published estimates of output–wealth ratios, which traditionally have been taken to be something on the order of 0.30. In Table 4 I have used 0.25 as a check against the upward bias in traditional estimates. This is almost certainly still a conservatively high figure.

The third column in Table 4 contains my estimates of the annual percentage rate of change in per capita wealth. The striking message is that all but China have decumulated their productive base during the past 30 years. Notice how misleading would be an assessment of long-term economic development in the Indian subcontinent if it were based on growth rates in GNP per head (column 4) or time series of UNDP's Human Development Index (HDI, column 5). Pakistan, for example, would be seen as a country where per capita GNP grew at a healthy 2.7 percent per year, implying that the index doubled in value between 1965 and 1996. Pakistan's HDI also improved over the past decade. Unhappily, though, the average Pakistani became poorer (in terms of wealth) by a factor of nearly two during the past quarter-century.

The second weakness with reasonings based on Figure 1 is that among poor countries the relationship between per capita income and fertility is not strong. In Figure 1 countries with GNP per head under $1,000 display nearly the entire range of fertility rates prevailing in the early 1980s: from 2 to 8 births per woman. Notice that countries lying above the fitted curve are in sub-Saharan Africa, those below are in Asia. I will seek an explanation for this. Admittedly, Figure 1 displays a bivariate distribution, which could be misleading for a problem requiring multivariate analysis. The figure nonetheless reflects the possibility that among poor households in rural communities the aforementioned substitution effect is not large and cancels the income effect. This could be because responsibility for childrearing is frequently diffused over the extended family.[17]

The third weakness with global statistics is that they are overly aggregative. They gloss over spatial variations and disguise the fact that even though the world economy as a whole has enjoyed economic growth over the past 50 years or so, large masses of people in particular regions have remained

in poverty (Tables 2–3). Economic growth has not "trickled down" consistently to the poorest, nor have the poorest been inevitably "pulled up" by it.

Population, poverty, and natural resources: Local interactions

In view of the aggregative nature of global statistics, a few investigators have studied the interface of population, poverty, and the natural-resource base at the local level. The ingredients of their work have been around for some time; what is perhaps new is the way they have been assembled. Several models have been constructed to develop the new perspective. We are still far from having an overarching model of the kind economists are used to in the theory of general competitive equilibrium.[18] Some models have as their ingredients large inequalities in land ownership in poor countries and the non-convexities that prevail at the level of the individual person in transforming nutrition intake into nutritional status and, thereby, labor productivity (Dasgupta and Ray 1986, 1987; Dasgupta 1993, 1997b). Other models are based on the fragility of interpersonal relationships in the face of an expanding labor market and underdeveloped credit and insurance markets (Dasgupta 1993, 1998a, 1999). Yet others are built on possible links between fertility behavior and free-riding on local common-property resources (Dasgupta and Mäler 1991, 1995; Nerlove 1991; Cleaver and Schreiber 1994; Brander and Taylor 1998). Although the models differ in their ingredients, they have in common a structure that is becoming increasingly familiar from the theory of locally interacting systems.[19] To put it in contemporary terminology, the new perspective on population, poverty, and natural resources sees the social world as self-organizing into an *in*homogeneous whole, so that, even while parts grow, chunks get left behind; some even shrink. To put it colloquially, these models account for locally confined "vicious circles."[20]

Later in this article I present an outline of this work when seen through a particular lens, namely reproductive and environmental externalities, and I emphasize the arguments that have shaped it and the policy recommendations that have emerged from it. The framework I develop focuses on the vast numbers of small, rural communities in the poorest regions of the world and identifies circumstances in which population growth, poverty, and resource degradation can be expected to interact with one another, cumulatively, over time. What bears stressing is that my account does not regard any of the three to be the prior cause of the other two: over time each of them influences, and is in turn influenced by, the other two. In short, they are all endogenous variables.

The models under discussion assume that people, when subjected to such "forces" of positive feedback, seek mechanisms to cope with the cir-

cumstances they face. The models also identify conditions in which this is not enough to lift communities out of the mire. Turner and Ali (1996), for example, have shown that in the face of population pressure in Bangladesh small landholders have periodically adopted new ways of doing things so as to intensify agricultural production. However, the authors have shown too that this has resulted in an imperceptible improvement in the standard of living and a worsening of the terms of land ownership, the latter probably owing to the prevalence of distress sales of land. Moreover, as Table 4 suggests, Bangladesh has decumulated its assets. These are the kind of findings that the new perspective anticipated and was designed to meet.

Economic demographers have given scant attention to reproductive externalities. An important exception was an attempt by Lee and Miller (1991) at quantifying the magnitude of reproductive externalities in a few developing countries. The magnitude was found to be small. The authors searched for potential sources of externalities in public expenditures on health, education, and pensions, financed by proportional taxation. But such taxes are known to be very limited in scale in poor countries. Moreover, the benefits from public expenditure are frequently captured by a small proportion of the population. So perhaps it should not be surprising that the reproductive externalities consequent upon public finance are small in poor countries. The externalities I study here are of a different sort altogether.

As we would expect from experience with models of complex systems, general results are hard to come by. The models that have been studied analytically are only bits and pieces. But they offer strong intuitions. They suggest also that we are unlikely to avoid having to engage in simulation exercises if we are to study models less specialized than the ones that have been explored so far.[21] This should have been expected. It would seem that for any theoretical inference, no matter how innocuous, there is some set of data from some part of the world over some period that is not consonant with it.[22] More than 40 years of demographic research have uncovered that the factors underlying fertility behavior include not only the techniques that are available to households for controlling their size, but also the household demand for children. The latter in particular is influenced by a number of factors (e.g., child mortality rates, level of education of the parents, rules of inheritance) whose relative strengths would be expected to differ across cultures, and over time within a given culture, responsive as they are to changes in income and wealth and the structure of relative prices. Thus, the factors that would influence the drop in the total fertility rate in a society from, say, 7 to 5 should be expected to differ from those that would influence the drop from 5 to 3 in the same society.

Across societies the matter is still more thorny. The springs of human behavior in an activity at once so personal and social as procreation are complex and interconnected, and empirical testing of ideas is fraught with

difficulty. Data often come without appropriate controls. So, what may appear to be a counter-example to a thesis is not necessarily so. Intuition is often not a good guide. For example, one can reasonably imagine that since religion is a strong driving force in cultural values, it must be a factor in fertility behavior. Certainly, in some multivariate analyses (e.g., Drèze and Murthi 2000, in their work on district-level data from India), religion has been found to matter (Muslims are more pronatalist than Hindus and Christians). But in others (e.g., Iyer 2000, in her work on household-level data from a group of villages in the state of Karnataka, India), it has not been found to matter. Of course, the difference in their findings could result from the fact that the unit of analysis in one case is the district, while in the other it is the household. But such a possibility is itself a reminder that complicated forms of externalities (e.g., externalities arising from conformist behavior) may be at work in fertility decisions.

Education and fertility control

Education and reproductive health programs together are a means for protecting and promoting women's interests. They were the focal points of the 1994 United Nations Conference on Population and Development in Cairo and are today the two pillars upon which public discussion on population is based.[23] Later in this article I show that the "population problem" involves a number of additional features. Here I review what is known about the influence of education and reproductive health programs on fertility.

Women's education and fertility behavior

In two classic publications, Cochrane (1979, 1983) studied possible connections between women's education and fertility behavior. She observed that lower levels of education are generally associated with higher fertility. Table 5, based on the Demographic and Health Surveys undertaken in Africa in the late 1980s, displays this relationship for Botswana, Ghana, Uganda, and Zimbabwe. The finding has proved to be intuitively so reasonable that social scientists have attributed causality—from education to reduced fertility.

What are the likely pathways of the causal chain? Here are some:

Education helps mothers to process information more effectively and so enables them to use the various social and community services that may be on offer more intensively. The acquisition of education delays the age at marriage and so lowers fertility. In populations with generally low levels of education and contraceptive prevalence, literacy and receptiveness to new ideas complement the efforts of reproductive health programs, leading to longer birth spacing.[24] This in turn reduces infant mortality, which in turn leads to a decline in fertility.

TABLE 5 Women's education and fertility rates: Selected countries where lower education is associated with higher fertility

Country	Education level (years)	TFR
Botswana	none	5.8
	1–4	5.5
	5–7	4.7
	8+	3.4
Ghana	none	6.8
	1–4	6.6
	5–7	6.0
	8+	5.5
Uganda	none	7.9
	1–4	7.3
	5–7	7.0
	8+	5.7
Zimbabwe	none	7.2
	1–4	6.7
	5–7	5.5
	8+	3.7

SOURCE: Jolly and Gribble (1993: Table 3.6).

Turning to a different set of links, higher education increases women's opportunities for paid employment and raises the opportunity cost of their time (the cost of childrearing is higher for educated mothers). Additionally, educated mothers would be expected to value education for their children more highly. They would be more likely to make a conscious tradeoff between the "quality" of their children and their numbers (Becker 1981).

Yet Cochrane herself was reluctant to attribute causality to her findings, as have been investigators studying more recent data (Cohen 1993; Jolly and Gribble 1993), for the reason that it is extremely difficult to establish causality.[25] Women's education may well reduce fertility. On the other hand, the initiation of childbearing may be a factor in the termination of education. Even when education is made available by the state, households frequently choose not to take up the opportunity: the ability (or willingness) of governments in poor countries to enforce school attendance or make available good educational facilities is frequently greatly limited. Economic costs and benefits and the mores of the community to which people belong influence their decisions. It could be that the very characteristics of a community (e.g., an absence of associational activities among women, or a lack of communication with the outside world) that are reflected in low educa-

tional attainment for women are also those giving rise to high fertility. Demographic theories striving for generality would regard both women's education and their fertility to be endogenous variables. The negative relationship between education and fertility in such theories would be an association, not a causal relationship. The two variables would be interpreted as "moving together" in samples, nothing more. In a later section I explore a theoretical framework that offers this interpretation.[26]

However, the links between women's education and fertility are not as monotonic as I have reported so far. Set against the positive forces outlined above is a possible effect that runs the other way: taboos against postpartum female sexual activity, where they exist, can be weakened through the spread of education. In sub-Saharan Africa, where polygyny is widely practiced, postpartum female sexual abstinence can last up to three years after childbirth. It is also not uncommon for women to practice total abstinence once they have become grandmothers. The evidence, such as it exists, conforms to theory: in Latin America and Asia, primary education, when compared to no education, has been found to be associated with lower fertility, but in several parts of sub-Saharan Africa (e.g., Burundi, Kenya, and Nigeria) the relationship has been found to be the opposite. Table 6 displays the latter.[27] The conventional wisdom that women's education is a powerful force against pronatalism needs to be qualified: the level of education can matter.

TABLE 6 Women's education and fertility rates: Selected countries where primary education is associated with higher fertility

Country	Education level (years)	TFR
Burundi	none	6.9
	1–4	7.1
	5–7	7.3
	8+	5.8
Kenya	none	7.2
	1–4	7.7
	5–7	7.2
	8+	5.0
Nigeria	none	6.5
	1–4	7.5
	5–7	6.0
	8+	4.5

SOURCE: Jolly and Gribble (1993: Table 3.6) and Cohen (1993: Table 2.4).

Family planning

Except under conditions of extreme nutritional stress, nutritional status does not appear to affect fecundity (Bongaarts 1980). During the 1974 famine in Bangladesh, deaths in excess of those that would have occurred under previous nutritional conditions numbered around 1.5 million. The stock was replenished within a year (Bongaarts and Cain 1981). Of course, undernourishment can still have an effect on sexual reproduction, through its implications for the frequency of stillbirths, maternal and infant mortality, and a possible reduction in the frequency of sexual intercourse.

An obvious determinant of fertility is the available technology for birth control. Cross-country regressions (e.g., Pritchett 1994) confirm that the fraction of women of reproductive age who use modern contraceptives is strongly and negatively correlated with total fertility rates. So it should not be surprising that family planning programs are often seen as a prerequisite for an effective population policy. But these regression results mean only that contraception is a proximate determinant of fertility, not a causal determinant. The results could mean, for example, that differences in fertility rates across countries reflect differences in fertility goals, and thus differences in contraceptive use. Of course, the causal route could go the other way. The very existence of family planning programs might influence the demand for children, as women come to realize that it is reasonable to want a small family (Bongaarts 1997).

People in all societies practice some form of birth control: fertility everywhere is below the maximum possible. Extended breastfeeding and postpartum female sexual abstinence have been common practices in Africa. Even in poor countries, fertility is not unresponsive to the relative costs of goods and services. In a study on !Kung San foragers in the Kalahari region, Lee (1972) observed that the nomadic, bush-dwelling women had an average birth spacing of nearly four years, while those settled at cattle posts gave birth to children at much shorter intervals. From the viewpoint of the individual nomadic !Kung San woman, the social custom is for mothers to nurse their children on demand and to carry them during their day-long trips in search of wild food through the children's fourth year of life. Anything less than a four-year birth interval would increase mothers' carrying loads enormously, threaten their own capacity to survive, and reduce their children's prospects of survival. In contrast to bush dwellers, cattle-post women are sedentary and are able to wean their children earlier.

Traditional methods of birth control include abortion, abstinence or rhythm, coitus interruptus, and prolonged breastfeeding.[28] These options are often inhumane and unreliable; modern contraceptives are in many respects superior. Nevertheless, successful family planning programs have proved more difficult to institute than could have been thought possible at first (Cochrane and Farid 1989). Excepting a few countries, fertility rates in

sub-Saharan Africa have not shown significant decline, despite reductions in infant mortality rates over the past few decades.

In a notable article, Pritchett (1994) analyzed data from household surveys conducted by the World Fertility Survey and the Demographic and Health Survey programs, which included women's responses to questions regarding both their preferences and their behavior related to fertility. Demographers had earlier derived indicators of the demand for children from these data. One such indicator, the "wanted total fertility rate" (Bongaarts 1990), can be compared to the actual total fertility rate for the purpose of classifying births or current pregnancies in a country or region as "wanted" or "unwanted." Regressing actual fertility on fertility desires in a sample of 43 countries in Asia, Africa, and Latin America, Pritchett found that about 90 percent of cross-country differences in fertility rates are associated with differences in desired fertility. Moreover, excess fertility was found not to be systematically related to the actual fertility rate, nor to be an important determinant of the rate. The figure of 90 percent may prove to be an overestimate, but it is unlikely to prove to be greatly so.[29] Even in poor households the use of modern contraceptives would involve only a small fraction (1 percent or thereabouts) of income.

Pritchett's finding is significant, if only because it directs us to ask why the household demand for children differs so widely across communities. We turn to this matter next.

The household and gender relations

The concept of the household is not without its difficulties. It is often taken to mean a unit of housekeeping or consumption. The household in this sense is the eating of meals together by members, or the sharing of meals derived from a common stock of food (Hajnal 1982). This definition has the merit of being in accordance with most modern censuses, but one problem with it is that in rural communities it does not yield exclusive units (Goody 1996). A household shares a "table" and may, for example, include live-in servants who do not cook for themselves. In many cases some meals are had in common, while others are not; and often raw and cooked food is passed to parents in adjacent cottages, apartments, or rooms. The boundaries vary with context, especially where food is not consumed together round a table (as in Europe) but in bowls in distinct groups (as in sub-Saharan Africa). In none of these cases is the housekeeping unit the same as the consumption unit, nor is the consumption unit necessarily clearly defined.

Economists have taken the household to be a well-defined concept, but have debated whether it is best to continue to model it as a unitary entity, in the sense that its choices reflect a unitary view among its members of what constitutes their welfare (the utility maximizing model) or

whether instead the household ought to be modeled as a collective entity, where differences in power (e.g., between men and women) manifest themselves in the allocation of food, work, education, and health care.

Of course, one cannot conclude that households are not unitary from the mere observation that intrahousehold allocations are unequal. Poor households would choose to practice some patterns of inequality even if they were unitary. For example, since children differ in their potential, parents in poor households would help develop the most promising of their children even if that meant the remaining ones are neglected. This is confirmed by both theory and evidence (Becker and Tomes 1976; Bledsoe 1994). Daughters are a net drain on parental resources in patrilineal and patrilocal communities, such as those in northern India (dowries can be bankrupting). This fact goes some way toward explaining the preference parents show for sons there (Sopher 1980a, 1980b; Dyson and Moore 1983; Cain 1984) and why girls of higher birth order are treated worse than girls of lower birth order (Das Gupta 1987). In northern parts of India the sex ratio is biased in favor of men.[30]

Nevertheless, the magnitude of the inequalities frequently observed is at odds with what would be expected in unitary households. The indirect evidence also suggests that the household is a collective entity, not a unitary one (Alderman et al. 1995). For example, if a household were unitary, its choices would be independent of which member actually does the choosing. But recent findings have revealed, for example, that income in the hands of the mother has a bigger effect on her family's health (e.g., nutritional status of children) than income under the control of the father (Kennedy and Oniang'o 1990).

Because gender inequities prevail in work, education, and allocation of food and health care, it should not surprise us that they prevail in fertility choices as well. Here also, women bear the greater cost. To grasp how great the burden can be, consider that in sub-Saharan Africa the total fertility rate has for long been between 6 and 8 (Figure 1). Successful procreation involves at least a year and a half of pregnancy and breastfeeding. So in societies where female life expectancy at birth is 50 years and the total fertility rate is 7, women at birth can expect to spend about half their adult lives in pregnancy or nursing. And we have not allowed for unsuccessful pregnancies.

In view of this difference in the costs of bearing children, we would expect men to desire more children than women do. Birth rates are expected to be lower in societies where women are more "empowered." Data from the 1980s on the status of women from 79 so-called Southern countries (see Table 7) confirm this and display an unmistakable pattern: high fertility, high rates of female illiteracy, low women's share of paid employment, and a high percentage of women working at home for no pay all go hand in hand. From the data alone it is difficult to discern which measures

TABLE 7 Fertility rates and indicators of women's status in 79 developing countries

TFR	No. of countries	Women's share of paid employment (%)	Women in unpaid family work (%)	Women's illiteracy rate (%)
>7.0	(9)	10.6	46.9	65.7
6.1–7.0	(35)	16.5	31.7	76.9
5.1–6.0	(10)	24.5	27.1	46.0
<5.0	(25)	30.3	18.1	22.6

SOURCE: IIED/WRI (1987: Table 2.3).

are causing high fertility and which are merely correlated with it. But the findings are consistent with the possibility that a lack of paid employment and education limits women's ability to make decisions—a condition that promotes high fertility.

Household decisions would assume strong normative significance if the household were unitary, less so if it were not. The evidence is that the unitary household is especially uncommon when the family is impoverished and the stresses and strains of hunger and illness make themselves felt. Despite these caveats, I adopt a unitary view of the household in what follows. Because I am concerned here with reproductive and environmental externalities, doing so helps to simplify the exposition without losing anything essential.

Motives for procreation

One motive for procreation, common to humankind, relates to children as ends in themselves. We are genetically endowed to want and to value them. It has also been said that children are the clearest avenue open to "self-transcendence" (Heyd 1992). Viewing children as ends ranges from the desire to have offspring because they are playful and enjoyable, to a desire to obey the dictates of tradition and religion. One such injunction emanates from the cult of the ancestor, which, taking religion to be the act of reproducing the lineage, requires women to bear many children.[31] The latter motivation has been emphasized by Caldwell and Caldwell (1990) to explain why sub-Saharan African societies have proved so resistent to fertility reduction.

The problem with this explanation is that, although it does well to account for high fertility rates in sub-Saharan Africa, it does not adequately explain why the rates have not responded to declines in infant mortality. The cult of the ancestor may prescribe reproduction of the lineage, but it does not stipulate an invariant fertility rate. Since even in sub-Saharan Africa fertility rates have been below the maximum possible, they should be

expected to respond to declines in infant mortality. This is a matter I return to below, where I offer one possible explanation for the resistance that the semi-arid regions of sub-Saharan Africa have shown to fertility reduction.[32]

But for parents, children are not only an end; they can also be a means to economic betterment. In the extreme, they can be a means to survival. Children offer two such means. First, in the absence of capital markets and social security, children can be a source of private security in old age. There is evidence that in poor countries children do offer such security (Cain 1981, 1983; Cox and Jimenez 1992). This fact leads to a preference for male offspring if males inherit the bulk of their parents' property and are expected to look after them in their old age.

Second, in agriculture-based rural economies children are valuable in household production. Evidence of this is extensive, although such evidence is, of course, no proof that parents have children in order to obtain additional labor. For example, people could have large numbers of offspring by mistake and put them to work only because they cannot afford to do otherwise. Or large families might be desired as an end in itself, and putting children to work at an early age may be the only avenue open for financing that end. However, these conjectures are hard to substantiate directly. The former is in any case difficult to believe, since it suggests an inability to learn on the part of parents in a world where they are known to learn in other spheres of activity, such as cultivation. But because the latter is not at variance with any evidence I know, I explore it in a later section.

Caldwell (1981, 1982) put forward the interesting hypothesis that the intergenerational transfer of resources flows from children to their parents in societies experiencing high fertility and high mortality rates, but that it flows from parents to their children when fertility and mortality rates are low. Assuming this to be true, the relationship should be interpreted merely as an association. The direction of intergenerational resource transfers would be endogenous in any general theory of demographic behavior; thus it would not be a causal factor in fertility transitions.

The historical change in the North in parents' attitudes toward their children (from regarding children as a "means" to economic ends, to regarding them simply as an "end") can seem to pose a puzzle, as can differences between the attitudes of parents in the North and South today. Some demographers have remarked that a fundamental shift in adults' "world view" must have been involved in such changes in attitudes, a shift that Cleland and Wilson (1987) have called an "ideational change."

These observers may be right. On the other hand, not only is the explanation something of a deus ex machina, it is also difficult to test. A different sort of explanation, one that is testable, is that children cease being *regarded* as productive assets when they cease *being* productive assets. When schooling is enforced, children are not as readily available for household and farm chores.

If the growth of urban centers makes rural children less reliable as old-age security (because children are now able to leave home and not send remittances), children cease being a sound investment for parents' old age.[33] In short, if children were to become relatively unproductive in each of their roles as an economic asset, their only remaining value would be as an end. No change in world view would necessarily be involved in this transformation.

The above argument does not rely on economic growth. It involves a comparison between the productivity of different forms of capital assets. Children could cease being a sound economic investment even if the economy remained poor.

Reproductive and environmental externalities

What causes the private and the social costs and benefits of reproduction to differ? One likely source of the distinction has to do with the finiteness of space (World Bank 1984; Harford 1998). Increased population size implies greater crowding, and households acting on their own would not be expected to "internalize" crowding externalities. The human epidemiological environment becomes more and more precarious as population densities rise. Crowded centers of population provide a fertile ground for the spread of pathogens, and there are always new strains in the making. Conversely, the spread of infections, such as HIV, would be expected to affect demographic behavior, although in ways that are not yet obvious (Ezzell 2000).

Large-scale migrations of populations occasioned by crop failure, war, or other disturbances are an obvious form of externality. But by their very nature they are not of the persistent variety. Of those that are persistent, at least four types come to mind. In the remainder of this section I look into them.

Cost-sharing

Fertility behavior is influenced by the structure of property rights, for instance rules of inheritance. In his influential analysis of fertility differences between preindustrial seventeenth- and eighteenth-century Northwest Europe, on the one hand, and Asiatic preindustrial societies, on the other, Hajnal (1982) distinguished between "nuclear" and "joint" household systems. He observed that in Northwest Europe marriage normally meant establishing a new household, which implied that the couple had to have, by saving or transfer, sufficient resources to establish and equip the new residence. This requirement in turn led to late ages at marriage. It also meant that parents bore the cost of rearing their children. Indeed, fertility rates in England were a low 4 in 1650–1710, long before modern family planning methods became available and long before women became widely literate (Coale 1969; Wrigley and Schofield 1981). Hajnal contrasted this situation

with the Asiatic pattern of household formation, which he saw as joint units consisting of more than one couple and their children.

Parental costs of procreation are also lower when the cost of rearing the child is shared within the kinship. In sub-Saharan Africa fosterage within the kinship is a commonplace: children are not reared solely by their parents; the responsibility is more diffuse within the kinship group (Goody 1976; Bledsoe 1990; Caldwell and Caldwell 1990). Fosterage in the African context is not adoption. It is not intended to, nor does it in fact, break ties between parents and children. The institution affords a form of mutual insurance protection in semi-arid regions. It is possible that, because opportunities for saving are few in the low-productivity agricultural regions of sub-Saharan Africa, fosterage also enables households to smooth their pattern of consumption across time (Serra 1996).[34] In parts of West Africa up to half the children have been found to be living with kin other than their parents at any given time. Nephews and nieces have the same rights of accommodation and support as do biological offspring. There is a sense in which children are seen as a common responsibility. However, the arrangement creates a free-rider problem if the parents' share of the benefits from having children exceeds their share of the costs. From the point of view of parents, taken as a collective, too many children would be produced in these circumstances.[35]

In sub-Saharan Africa, communal land tenure within the lineage social structure has in the past offered further inducement for men to procreate. Moreover, conjugal bonds are frequently weak, so fathers often do not bear the costs of siring children. Anthropologists have observed that the unit of African society is a woman and her children, rather than parents and their children. Frequently there is no common household budget for the man and woman. Descent in sub-Saharan Africa is for the most part patrilineal and residence is patrilocal. Patrilineality, weak conjugal bonds, communal land tenure, and a strong kinship support system of children, taken together, have been a broad characteristic of the region (Caldwell and Caldwell 1990; Caldwell 1991; Bledsoe and Pison 1994). They are a source of reproductive externalities that stimulate fertility. Admittedly, patrilineality and patrilocality are features of the northern parts of the Indian subcontinent also,[36] but conjugal bonds are substantially greater there. Moreover, because agricultural land is not communally held in India, large family size leads to fragmentation of landholdings. In contrast, large families in sub-Saharan Africa are (or at least were, until recently) rewarded by a greater share of land belonging to the lineage or clan.

Conformity and "contagion"

That children are seen as an end in themselves provides another mechanism by which reasoned fertility decisions at the level of every household

can lead to an unsatisfactory outcome from the perspectives of all households. The mechanism arises from the possibility that traditional practice is perpetuated by conformity. Procreation in closely knit communities is not only a private matter, it is also a social activity, influenced by both family experiences and the cultural milieu. Formally speaking, behavior is conformist if, other things being equal, every household's most desired family size is the greater, the larger is the average family size in the community (Dasgupta 1993: ch. 12). This is a "reduced form" of the concept, and the source of a desire to conform could lie in reasons other than an intrinsic desire to be like others. For example, similar choices made by households might generate mutual positive externalities, say, because people care about their status; and a household's choice of actions signals its predispositions (e.g., their willingness to belong) and so affects its status (Bernheim 1994; Bongaarts and Watkins 1996). In a world where people conform, the desire for children is endogenous.

Whatever the basis of conformism, there would be practices encouraging high fertility rates that no household would unilaterally desire to break. Such practice could well have had a rationale in the past, when mortality rates were high, rural population densities were low, the threat of extermination from outside attack was large, and mobility was restricted. But practices can survive even when their original purposes have disappeared. Thus, as long as all others follow the practice and aim at large family size, no household on its own may wish to deviate from the practice; however, if all other households were to restrict their fertility rates, each would desire to restrict its fertility rate as well. In short, conformism can be a reason for the existence of multiple reproductive equilibria (Dasgupta 1993: ch. 12). These multiple equilibria might even be Pareto rankable, in which case a community could get stuck at an equilibrium mode of behavior even though another equilibrium mode of behavior would be better for all.

Figure 2 depicts fertility choices in a stylized community where households are identical and are conformists and where the government has no population policy in place. The horizontal axis denotes $\bar{n}$, which is the average number of children born per household. It represents the TFR in the community. The vertical axis denotes n^*, which is the number of children desired by the representative household.[37] Since households are identical, every household is representative. Because n^* is a function of $\bar{n}$, we write it as $n^*(\bar{n})$. It is drawn as an increasing function, the distinctive feature of conformism. In Figure 2 it is drawn so that it intersects the 45° line at three points, $\bar{n}_1$, $\bar{n}_2$, and $\bar{n}_3$. Each is an equilibrium. To confirm this, imagine for example that each household expects all other households to have $\bar{n}_3$ children. Then $\bar{n}_3$ will be each household's choice, thus confirming the expectations. And so on for $\bar{n}_1$ and $\bar{n}_2$. Notice as well that $\bar{n}_1$, $\bar{n}_2$, and $\bar{n}_3$ are the only equilibria. Let us assume now that out-of-equilibrium households expect the TFR in each period to be the previous period's TFR (this is a special