ECONOMIC ANALYSES OF RAPID POPULATION GROWTH

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The economic growth of Western Europe and North America during the eighteenth and nineteenth centuries was accompanied by the first steady and sustained increase of population the world had ever known. Malthus's gloomy prediction, made in 1801, that population growth would run up against the fixity of the earth's resources and condemn most of humankind to poverty and recurring high death rates, was proved wrong. Indeed, Kuznets (1966) defined modern economic growth in 1966 as a sustained increase in population attained without any lowering of per capita product; he viewed population growth as a positive contributor to economic growth.

But population growth in industrializing Europe was slow, seldom exceeding 1 percent a year, compared with the rapid growth of developing countries in the period after World War II. In the postwar period, as mortality rates declined dramatically in most developing countries and fertility rates remained high or even rose, population growth rose to between 2 and 4 percent a year. Economists began to consider systematically whether and under what circumstances this rapid population growth was contributing to economic growth and development.

This article reviews what is now a rich body of literature by economists on the consequences of rapid population growth for economic development.[1] Discussion of the consequences of rapid population growth is organized according to various views: pessimists, optimists, and what might be called revisionists. More detailed discussions are in a recent review of the economic literature (McNicoll 1984) and in two assessments of the consequences of rapid population growth: the World Bank's 1984 report on popula-

Public Disclosure Authorized

tion and development and the National Academy of Science's 1986 report (National Research Council 1986). The implications of that literature for public policies to reduce fertility are then reviewed, using a welfare economics framework.

The Consequences of Rapid Population Growth

There is no consensus on the effects of rapid population growth on economic growth in developing countries. The assumption that rapid population growth was detrimental prevailed in the 1950s and 1960s—when the literature emphasized lack of capital (and savings) coupled with surplus labor in agriculture as the major constraints to economic growth. In the late 1970s, with attention shifting to the efficiency of resource use and the policies to promote it, concern about population abated. Recent analyses have been characterized as "revisionist" Malthusian: population growth is viewed as only one among several factors that slow development, and not as a threat to natural resources.[2] The debate has become quantitative: are the effects of rapid population growth large or small?

Such a debate is not likely to be resolved easily. The amount of solid empirical work on the subject is limited, especially for developing countries, partly because the subject is not really a tractable one for quantitative analysis. In the real world, population change is not only a cause of economic change, but a consequence as well; it cannot be shifted up or down as an exogenous variable in a simple experiment. The only natural experiment available for analysis is human history; cross-section analyses are a poor substitute. But long time series of demographic and economic data are rare.[3] Moreover, because population change is both consequence and cause of economic change, its effects are hard to trace. For example, an increase in fertility that raises population in an agricultural area, and thus lowers potential per capita income in the short run, is likely to lead quickly to emigration, new agricultural techniques, or other adjustments—including a subsequent decline in fertility.[4] And it is not only families that can adjust their own demographic behavior in response to the economic forces arising from population change. Institutions and policy also play a role, for example, through new investments in the search for new technologies to raise agricultural production.

Much of the work on consequences has been in the form of macroeconomic-demographic models. To be tractable, such models require simplifying assumptions: on the substitutability of labor for capital in production, for example, and the rate and sources of technological change. The assumptions themselves often determine the particular results regarding population effects. Even the few

large and sophisticated macro models that avoid this weakness cannot capture the complexity of the real world and have had little influence on the debate.[5] Empirical work on the partial effects of rapid population growth—on natural resources, education, and income distribution, for example—has been more illuminating. But by its nature it has been far from definitive on the macroeconomic effects of rapid population growth.

A simple comparison of countries' GNP growth with population growth during the 1970s and 1980s illustrates the problem. There is no clear association between the two rates (table 1). In the 1970s, population growth was high in both the low-income countries and in better-off middle-income countries; in the middle-income countries, GNP growth was much higher. In the industrial countries, both rates were relatively low. Insofar as the two rates are independent

Table 1. ***Rates of Growth of Population, GNP, and GNP per Capita, Selected Countries, 1973–83***

Country	*GNP per capita, 1983 (U.S. dollars)*	*Population growth rate, 1973–83 (percent)*	*Real GNP growth rate, 1973–83 (percent)*	*Real GNP per capita growth rate, 1973–83 (percent)*
Low-income countries				
Bangladesh	130	2.4	5.5	2.9
India	260	2.3	4.2	1.9
Sri Lanka	330	1.7	5.2	3.4
Kenya	340	4.0	4.7	0.6
Pakistan	390	3.0	6.2	3.1
Middle-income countries				
Indonesia	560	2.3	6.8	4.4
Egypt	690	2.5	9.1	6.4
Philippines	750	2.7	5.3	2.5
Nigeria	770	2.7	1.5	−1.1
Thailand	820	2.3	6.3	4.0
Peru	1,040	2.4	1.3	−1.1
Costa Rica	1,070	2.4	2.4	−0.1
Colombia	1,410	1.9	4.1	2.1
Brazil	1,870	2.3	4.4	2.0
Korea, Republic of	2,010	1.6	7.0	5.4
Mexico	2,180	2.9	5.0	2.0
Venezuela	3,830	3.5	2.4	−1.1
Industrial countries				
United Kingdom	9,180	0.0	1.0	1.0
Japan	10,110	0.9	4.2	3.3
France	10,480	0.4	2.4	2.0
Germany, Fed. Rep.	11,400	−0.1	2.1	2.1
Sweden	12,440	0.2	1.0	0.8
United States	14,080	1.0	2.4	1.3

Source: World Bank 1986b.

of each other, slower population growth would raise per capita income faster (or prevent its decline). But in at least one sense the two rates are probably not independent; economic growth is likely to contribute to lower death rates and thus faster population growth.

Malthus and Other Pessimists

In his *Essay on Population*, Malthus had a simple model in which aggregate economic and demographic change were tied together by reproductive behavior at the family level. His model incorporated the classical wage theory, that the supply of labor was completely elastic at the subsistence wage level. In good times—when average incomes rose above subsistence level—marriage occurred more often and earlier, and couples had more children. Thus higher income per capita led to an increase in population and in the supply of labor. But population increase eventually brought falling wages and rising food prices as an increasing supply of labor ran up against the fixity of land and, given diminishing returns, labor productivity fell. With falling consumption, marriage and fertility rates fell and mortality rose, completing the cycle. Malthus thought that total economic output could increase, but the standard of living for most families would not permanently rise; the long-run equilibrium standard of living was at the subsistence level.

Malthus assumed that people would not exercise "preventive checks" to reduce births (his axiomatic "fixity of passion"). That, combined with the assumption of diminishing returns in agriculture, made his gloomy prediction a logical necessity.

As a description of trends in the several centuries preceding his 1801 essay, Malthus was largely correct. Data pieced together by demographers and economic historians, on wages, rents, food prices, and fertility and mortality in England from the fourteenth century through the eighteenth century, fit well with parts of the Malthusian model.[6] In the fourteenth century, the Black Death brought a largely exogenous increase in mortality; as population fell, wages rose. By the mid-sixteenth century mortality was lower and the population was recovering; land rents and the relative price of food were rising, wages were falling. Late in the seventeenth century, population growth slowed again; wages rose and food prices fell.[7]

As a predictor, however, Malthus was wrong,[8] both about diminishing returns and about human reproductive behavior. Even as he wrote, the Industrial Revolution in England was ushering in a period of sustained improvements in technology, yielding gains in labor productivity that outstripped any effect of diminishing returns and brought increases in per capita income. And by the end of the nineteenth century, couples were consciously controlling fertility

within marriage, which led to smaller family size. By the beginning of the twentieth century, the economic and demographic characteristics of modern industrial economies were set: steady but slow population growth, low fertility, sustained productivity increases, and rising consumption for the majority.

Malthus and the classical economists were writing at a time when in England population growth was accelerating. With the new burst of population growth in developing countries after World War II, economists returned to the Malthusian tradition. Leibenstein (1954) and Nelson (1956) reintroduced population as an endogenous variable influenced by income. In their models, small increases in income for populations at the subsistence level lead to increases in labor supply that swamp small increases in capital or other stimuli to the economy. The result: a low-level equilibrium trap. Only massive capital formation or a major stimulus can ensure that countries avoid the trap.

Early one-sector neoclassical growth models (Solow 1956) were similarly Malthusian. For them, the faster the rate of population growth (and thus of labor supply compared with capital formation), the lower the level of per capita consumption. With constant returns to scale and a constant rate of saving, faster growth of the labor force implies a lower capital-labor ratio and lower productivity of labor. More resources must be used to maintain capital per head, thereby restraining consumption. Thus rapid population growth is harmful even in the absence of diminishing returns. These neoclassical steady-state models treated population growth as exogenous: they did not try to incorporate the determination of population growth through the effects of economic change on mortality, fertility, or marriage rates.

Population growth is also treated as exogenous, and has similar negative effects, in two-sector growth models (Lewis 1954, Ranis and Fei 1964). In them, surplus labor from farming is absorbed into manufacturing only if savings and thus capital grow faster than population, or if technological change in manufacturing offsets the combined effects of diminishing returns in agriculture and of population growth. Other things being equal, the shift of labor into manufacturing occurs more rapidly the slower the growth of population.

These early growth models treated population growth and labor force growth as equivalent and ignored the age structure of a country's population. In his overlapping generations model, Samuelson (1958) introduced a crude approximation of age structure. He posited two age groups, a younger working population and an older retired population. The younger generation transfers consumption "loans" to the older generation, the "loans" to be repaid by the

subsequent generation of younger workers. A sustained increase in population growth raises the proportion of the younger group, and results in higher consumption transfers to the old. If a faster rate of population growth persists, each generation benefits. Thus Samuelson came to the opposite conclusion from that reached in the neoclassical growth models: a sustained higher population growth rate leads to higher lifetime economic welfare.

Samuelson ignored dependent children; in effect he assumed they pose no costs to parents or to the wider economy.[9] In fact, however, higher population growth that results from higher fertility will increase the proportion of children in a population (and not increase labor supply for about fifteen years). To the extent that children consume more than they produce, their existence must reduce the consumption or the savings of workers and retired people.

In a wholly different tradition, Coale and Hoover (1958) developed a model highlighting the fact that children are costly and that high fertility increases the proportion of children in the population. They maintained that in high-fertility societies, the disproportionate consumption needs of children (including their need for education and health services, which Coale and Hoover in effect treated as consumption rather than investment) will reduce average savings. So they built into their simulation model of India the assumption that savings and investment per capita fall as the proportion of nonworking dependents in the economy rises. They then projected per capita income for India under low, medium, and high (exogenous) fertility assumptions. They concluded that, over a thirty-year period, per capita income could be as much as 40 percent lower with high fertility than with low fertility.

The Coale and Hoover model and the standard neoclassical growth models share one characteristic. As long as there is (a) little room for adjustment in the capital-labor ratio and (b) constant or increasing capital-output ratios, the impact on total income of higher fertility (and, with a fifteen-year lag, of faster labor force growth) is bound to be close to zero. Thus the impact on per capita income is negative, even without taking account of any negative effect of higher fertility on the savings rate and thus on capital formation. The impact is negative even if a production function allowing adjustment in the capital-labor ratio is used, as long as there is a negative effect of population growth on savings and thus insufficient growth of the capital stock. In these models, the only escape is technological progress. If there is sufficient technological progress, and it is responsive to factor scarcities and thus labor-intensive, additional labor can lead to increases in per capita income even without equivalent growth in capital.

The 1958 Coale and Hoover study was followed by others in the

1960s and 1970s. They simulated the effects of alternative future paths of fertility (and thus of changing age structures) on the budgetary costs of education and health services, job opportunities, and so forth in different countries.[10] Generally, as in Coale and Hoover, changes in mortality and fertility were treated as exogenous to the economic system, although they could be affected by family planning policies. Analysts then compared the costs of a family planning program with the projected savings in health, education, or job creation costs associated with lower fertility. In a related study, Enke (1966) made a cost-benefit analysis of family planning. Using estimates of the cost of family planning programs, and his own estimate of the benefit of "averted births," he concluded that spending on family planning was 100 to 500 times more effective than other forms of development spending.

This conclusion is undoubtedly exaggerated (or public spending on family planning in developing countries would be much greater than it is, even allowing for political and religious barriers). First, the real costs of family planning programs are not easy to estimate (particularly where family planning is part of a health program) and are extremely sensitive to the chosen discount rate.[11] Enke probably understated the true costs. Second, estimates of the benefits of an averted birth are sensitive to assumptions about future costs in health, education, and other areas. Third, and most important, estimates of the benefits of an averted birth are conceptually flawed, since most societies value children per se in addition to consumption of goods and services.[12]

The models that provided the basis for the pessimists' views have not been and cannot easily be tested empirically. Moreover, the Coale and Hoover model (and others designed to illustrate the negative consequences of population growth[13]) can be criticized on the grounds that its assumptions—such as the limited substitutability of capital and labor, the negative effect of a high dependency ratio on savings, and the limits of technological change—are incorrect and also on the grounds that fertility is not exogenous.

Despite these problems, however, these models did influence thinking substantially in the 1960s and 1970s. Among those concerned with international development policies, the work reawakened interest in population growth as a potential policy variable; highlighted the importance of growth rates and age structure as well as size of populations, making population an issue for Latin America and Africa as well as the densely populated countries of Asia; and contributed to the view, especially in the rich countries, that rapid population growth was exacerbating development problems in the poor countries (see, for example, National Academy of Sciences 1971).

The Optimists

The pessimists' views have not gone unchallenged. Optimists about the effects of population growth have emphasized as the critical contributors to economic growth such factors as innovation, efficiency in the use of resources, human as opposed to physical capital, and technological change rather than investment per se. Optimists argue that a growing population is a net contributor to economic growth for two principal reasons: (a) a larger population brings economies of scale in production and consumption (note that the neoclassical models are all scale-neutral); (b) population pressure and scale economies are likely to encourage technological innovation and organizational and institutional change, particularly in agriculture. In addition, optimists argue that a growing population can stimulate demand and thus reduce investment risk and that a growing population permits constant improvement of the labor force with better-trained workers.[14]

These arguments have echoes from the classical period. Adam Smith invoked scale and resultant induced innovation not only to explain economic growth itself but also as arguments for a positive effect of population growth on economic growth. He noted that a growing population, by widening the market and fostering creativity and innovation, facilitates the division of labor—and thus leads to higher productivity. Later, Marshall also emphasized scale and innovation, noting that "while the part which nature plays in production shows a tendency to diminishing returns, the part which man plays shows a tendency to increasing returns."[15]

Among modern economists, Kuznets (1966), Hirschman (1958), and others (for example, Hansen 1939) have also emphasized the potential contribution of a growing population to scale economies and to innovation. There have been some efforts to test the scale effect empirically. Glover and Simon (1975) report a strongly positive elasticity of road density with respect to population density in a cross-national analysis that controlled for income. Simon (1977), using Denison's data on the sources of postwar economic growth in industrial countries, has also estimated positive, though small, elasticities of economic growth with respect to population size (not population growth).[16] It does seem likely that transport and other infrastructure investments and public services such as health and education have scale economies up to a certain population size—which means that greater population density could improve the potential for economic growth in thinly populated rural areas (for example, in parts of Africa).

The most effective argument that population growth may encourage innovation has been made by Boserup (1965, 1981), for agri-

culture. She suggests that increasing population density induces a shift to more labor-intensive farming systems; the shift from long fallow to more frequent cropping then confronts farmers with new possibilities for innovation. The shift initially requires each worker to work longer hours and results in diminishing returns to labor; therefore, it will not occur unless rising population pressure necessitates it. Once such a shift does occur, however, the use of new tools and techniques (for example, the plow) brings large increases in productivity.[17]

Some examples appear to refute the Boserup argument. There are cases—nineteenth-century China, twentieth-century Bangladesh, and parts of Africa in the past few decades—in which population growth has probably contributed to declining returns. For Bangladesh, a country in which there is already high population density in rural areas and labor is already used very intensively, it is difficult to imagine what new technologies or tools could be both more labor-intensive and allow higher labor productivity.[18] Finally, except in the case of agriculture, it is difficult to show that population pressure, rather than other factors, has been the major impetus to innovation.[19]

In his influential book, *The Ultimate Resource*, Simon (1981) also ties innovation to population size. He argues that, other things being equal, larger population, and thus more people using their minds, implies greater knowledge. Simon constructs a simulation model in which technological innovation is a function of population size. He finds "moderate" population growth (less than 2 percent a year) to have a positive effect on welfare in the "medium-run," that is, after a "short-run" period of thirty to eighty years.[20] As with the neo-Malthusian simulation models discussed above, however, it is the assumption built into the model which drives the particular result.

In short, the argument of the optimists regarding the advantages of greater population density in rural areas has empirical support. But the other arguments, though of intuitive appeal, are as poorly supported empirically (and as intrinsically difficult to support) as are the arguments of the pessimists. The arguments rest largely on theory. Yet in theory, the things that population growth may encourage—technological innovations and scale economies—can also be encouraged independent of rapid population growth, especially through economic policy.

As with the pessimists in the 1960s and 1970s, the optimists have made their mark on the policy debate. In the 1980s, at least in the United States, optimists' views have caused considerable questioning of the earlier consensus that rapid population growth slows development.[21]

The Revisionists

The revisionists view population change as the aggregate outcome of many individual decisions at the micro or family level, and thus as one aspect of a larger complex system.[22] The micro or family-level decisions are made in response to signals provided by the larger system; under the Smithian logic of an invisible hand, these family decisions should be presumed to maximize not only individual welfare, but also social welfare, unless there are clear market failures. Among revisionists, differences on the negative effects of rapid population growth depend on differences about the pervasiveness and relevance of market failures. The World Bank (1984) and Demeny (1986), for example, emphasize market (and institutional) failures; the National Research Council of the National Academy of Sciences (1986) emphasizes the ability of the market and institutions to adjust.

The revisionist emphasis on micro decisions leads to two related conclusions about the effect of population growth on development. First, rapid population growth is not a primary impediment to economic development—though it can exacerbate the effects of failings in economic and social policy. Second, the negative effects of rapid population growth are likely to be mitigated, especially in the long run, by family and social adjustments.

Revisionists thus resist generalization; the effects of population growth vary by time, place, and circumstance and must be studied empirically. Most empirical work has been done at the sector level, in contrast to the economywide models of the optimists and pessimists. The sector studies tend to show what is wrong with extreme optimism and extreme pessimism.

SAVINGS AND PHYSICAL INVESTMENT. Neoclassical growth theory and intergenerational transfer models point to a negative effect of rapid population growth on aggregate savings and investment. In the case of savings, there is little empirical evidence to support this conclusion. Cross-country studies of the effects of a high dependency burden on aggregate savings have generally found little or no negative effect (except in rich industrial economies, where the high dependency burden is associated with a large proportion of elderly, not with a large youthful population and high fertility).[23] This is not really surprising. For one thing, business savings are not likely to be related systematically to population growth. In addition, government can to some extent change a country's savings rate by fiscal and monetary measures, irrespective of demographic conditions. At the household level, savings in poor countries are probably confined to a small proportion of relatively rich households among whom

fertility is already low. For poorer households, with limited or costly access to banking and credit systems, accumulation of land, tools, or other assets is a more likely form of "savings" than financial savings. For households with little or no savings, children come at the cost of lower per capita consumption rather than lower savings. In less poor households, a child's anticipated needs (especially schooling) could induce parents to work harder and save more rather than less (Kelley 1980). Indeed, children may themselves provide a relatively safe form of savings (for example, for old age) in places where it is risky or impossible to save for future consumption (Cain 1983). Finally, at the household level, the association between savings and fertility is probably not causal. Rather, both are influenced as development proceeds by improvements in financial markets, more women taking jobs, and so on (Hammer 1986).

As for investment, Coale and Hoover (1958) argued that high fertility would deflect public investment from "productive" purposes to spending on the education and health of the young. But education and health are themselves investments. Indeed, they may well have higher returns than physical investments.[24] The argument from neoclassical growth models is that investment per worker will be lower the faster the labor force grows (assuming a savings rate independent of population growth). But the net effect on output depends on the substitutability of labor for capital and on the capital-output ratio; for realistic assumptions about both, the effect has been shown to be small.[25] Pessimists argue that developing economies are unlikely to "choose" the labor-intensive technologies that are appropriate for their abundance of labor. The revisionist counterargument is that to the extent that inappropriate choice is due to government subsidies to the urban, capital-intensive sector, the fundamental problem is not rapid population growth but poor economic policies.[26] A more straightforward counterargument comes from the simple arithmetic of investment rates in relation to GDP. The different rates of population growth in rich and poor countries have little effect on capital accumulation, compared with the effects of the different initial levels of GDP. In 1980, Kenya, with gross domestic investment equal to 22 percent of GDP, still could have spent only about $5 per potential new worker (and, even with half as many new workers, could spend just $10 per worker); whereas the United States, with a lower investment ratio of 18 percent, could spend almost $200, because of its much higher GDP.

NATURAL RESOURCES AND THE ENVIRONMENT. The revisionist view is straightforward: for nonrenewable resources, such as minerals and oil, over which property rights are generally well established, the market works. The price mechanism ensures that any

change in the scarcity value of such a natural resource will reduce consumption and impel a search for substitutes. Rapid population growth may shorten the period during which people consume a particular commodity, but will not reduce overall welfare since the same number of people benefit from that consumption.[27] Indeed, greater use in one period may be economically justified given the needs of a rapidly growing population and the likelihood that a rising price will speed the discovery of substitutes. The only (weak) counterargument is that a longer period might allow more time for serendipitous technological advances; but there is no evidence that such advances come from serendipity rather than the pressures of scarcity.

For renewable resources—land, forests, and fisheries—the problem is more complicated. Greater use of renewable resources in one period need not reduce use in the future—unless use exceeds the rate of regeneration. With a large and rapidly growing population, the risk of excessive use and thus of permanent degradation is high. Though some irreversible overuse may be economically sensible when population growth is rapid, the benefits must be great if they are to justify the loss of the stream of resources that would otherwise be available in perpetuity.

Where property rights are well defined, private landowners or public managers will normally resist degradation of their property in order to protect its long-run value. But if property rights are not well defined and resources are held in common, the risks of degradation are greater. There can occur a "tragedy of the commons" (Hardin 1968); individual users have no incentive to restrict their own use, knowing others will not, and all abuse the commons. This is the classic prisoner's dilemma.

One such case may be the African Sahel, where the combination of rapid population growth and uncertain property rights is contributing to overgrazing of cattle during drought (and some say to permanent desertification). There, as elsewhere in Africa, low population density has historically mitigated the need to define individual property rights and to create the legal and organizational mechanisms to protect such rights. The revisionist argument would be that the fundamental problem is not rising population but the absence of well-defined property rights. A sophisticated pessimist would reply that, under some not unusual conditions, rapid population growth contributed to permanent degradation faster than the institutional mechanisms could be developed to define rights and control access.[28] Either way, population growth is seen as exacerbating a more fundamental problem rooted in market failure. It is hard to measure the relative contribution of population growth to the overall problem.

HEALTH AND EDUCATION. The pessimists' concern—that a high dependency burden will cut public spending on health and education—is only weakly borne out. For education, Schultz (1985) reports that a cross-country regression shows that higher population growth has no effect on enrollment rates though some negative effect on spending per student.[29] There is no comparable analysis for health spending; anyway, health spending seems to have little relationship to health conditions, probably because it is often absorbed by urban-based curative services that reach only a small minority. Easily as much an improvement in health conditions would come from reforms in health care delivery as from any increase in health spending per capita that lower population growth might afford.

For health and education, the revisionist emphasis on family-level decisions does lead to concern about the potential drawbacks of high fertility—through its effects on family (not government) budgets. There is substantial evidence that children from large families have lower educational attainment and poorer health, in industrial as well as developing countries.[30] Though many studies take inadequate account of parents' income and education, there is some evidence that harm is greater the poorer the family, and particularly applies after four children (Birdsall 1980a and studies cited in Birdsall 1977). Since families in developing countries are on average poorer and larger than those in industrial countries, the negative consequences of large families will have particular weight in the developing world.

Nonetheless, the strong cross-section association should not be interpreted necessarily as a causal one running from family size to health and education. It is possible that parents decide jointly and simultaneously on both the number of children to have and the size of their investment in health and education, in effect trading off between quantity (more children) and quality (more input per child) (see Becker and Lewis 1973). Low income, low returns on education and health spending, and reasonable concern about their own long-term security could lead parents to decide to have many children and to spend little on each child.

So do parents consciously trade off quantity (more children) against quality (higher inputs per child)? The question is an important one for policy. If there is such a tradeoff, the damage that large families can have on children's health and education may signal a market failure that could justify public interventions to protect children, such as mandatory school attendance or quotas on family size.[31] But if in fact parents are "altruistic"—so that they incorporate their children's utility into their own (Becker 1981)—then efforts to force parents to spend more on child health and education could

simply reduce family welfare.[32] From a welfare point of view, it is reasonable to assume (except in the case of "unwanted" children) that parents have another child only when they feel that the benefits to the family as a whole exceed the costs.

Governments have generally taken the view that parents are altruistic—or if they are not, that they still retain total rights over their own reproductive lives. The most widespread form of population policy is public support for voluntary family planning programs. These are justified as a means to assist parents in avoiding unwanted children while also reducing the social costs of extra births. If some children are unwanted, then even altruistic parents must take the number of children as given. They may then be forced into lower investments in child health and education than they would otherwise have made. In a few countries, especially in Asia (where governments view the social costs of high fertility as substantially larger than the private costs), government spending on family planning has another rationale. It provides information and "education" to parents about the likely effects of their own high fertility on the health and education of their own children.

The best evidence that unwanted births do reduce parental investments in children comes from a study on twins in India. Rosenzweig and Wolpin (1980) posit that the birth of twins sometimes constitutes the exogenous imposition of an "unwanted" child. They report that, for families in which the most recent birth was of twins, the children were significantly less likely to be in school. The implication is that the elimination of unwanted births—through, for example, a reduction in the cost of family planning—would raise average education levels among children.

How might the apparent adverse consequences of high fertility for individual families slow a whole country's development? Kuznets (1966) and others have argued that the effects of the quality of human capital on aggregate economic growth are substantial; the loss of individual potential due to poor health or lack of education can be translated into lower aggregate labor productivity and less potential for entrepreneurial and technological advance.

INCOME DISTRIBUTION. Does high fertility among the poor in all countries, and in poor countries relative to rich, make it harder to reduce income inequality?[33] Most studies that have included population growth in cross-national empirical studies of inequality do report a positive effect, in both single-equation studies (Adelman and Morris 1973) and simultaneous-equation ones (Repetto 1979). One exception was Rodgers (1984). However, the single-equation studies can be faulted for failure to take into account the possible (also positive) effect of an unequal income distribution on fertility;

and the simultaneous-equation studies can be faulted for arbitrary use of identifying restrictions. Moreover, all cross-national studies on this subject are reportedly sensitive to the sample of countries chosen (Lam 1985). Macro-level studies are thus far from definitive; and micro studies cannot address this essentially macro question.

However, the theory linking rapid population growth to greater income inequality is straightforward. In the short run, and other things being equal, increases in the supply of labor relative to capital and land will reduce the return to labor and increase the returns to the other factors. (This is not true when there is perfect substitutability between labor and other factors in production.) This would imply a period of increasing income inequality, since in poor countries a high-income minority generally owns a disproportionate share of capital and land. As discussed earlier, this Malthusian scenario apparently applied in preindustrial Europe; and in modern agriculture, returns to labor may have fallen relative to returns to other factors, at least in densely populated areas of Asia (such as Bangladesh).

A more relevant indicator of inequality may now be changes in the income shares of different types of labor—educated and uneducated, skilled and unskilled—since in today's economies a large share of income accrues to labor. There is some empirical evidence that higher fertility rates reduce the share of less-educated workers, presumably increasing income inequality. Williamson and Lindert (1980) report that, in the United States, increases in the wages of skilled workers relative to the unskilled have been a positive function of the rate of population growth. For Brazil, Behrman and Birdsall (1988) report that wages of uneducated workers are lower if they belong to a large cohort; this is not true of educated workers.

The effects of high fertility on inequality will depend on the distribution of fertility levels and on any fertility change across income classes.[34] It is often the case that aggregate high fertility is an average of high fertility among the poor majority and low fertility among the rich minority. The effect of high fertility on inequality is then heightened, since on a per capita basis poor households will have even lower incomes. The opposite will occur if, in the later stages of the fertility transition, fertility declines disproportionately among the poor. If the fertility change is induced by a subsidized family planning service, itself a form of income to households, both these effects will be exaggerated (National Research Council 1986). For example, if the poor are the beneficiaries of such subsidies (the rich obtaining services through private physicians), then family planning subsidies can be said to reduce inequality.

Finally, it is worth noting the long-run effect on income distribution that would result if the adverse effects of high fertility on

children's health and education are greater in poor families, as implied by evidence discussed above. If low parental income and high fertility are combined over a long period, and high fertility is also associated with lower spending on children's human capital, it is possible to imagine an enduring syndrome of poverty and large families. This would produce a permanent underclass which, barring any change, would grow larger and poorer.[35] There is, however, no evidence that this has occurred in any society.

The Welfare Economics of Policies to Reduce Fertility

In the absence of market failures, family decisions can be presumed to maximize not only individual welfare, but also social welfare—and the macroeconomic consequences of population growth, whether good or bad, would have no implications for optimal public policy. A public policy to influence private fertility behavior is usually justified on grounds of one of two types of market failures: externalities—that the social costs of children may exceed their private costs—and market imperfections in the availability of information about the means of fertility control

Externalities

In principle, a difference between the private and social costs of children could justify public intervention. If parents do not internalize all the costs of children, they are likely to have more children than is socially optimal. The opposite can also apply: if private benefits fall below social benefits (as may be the case in parts of Europe, where fertility is now below replacement), parents will not have enough children from society's point of view.

There are at least three situations where externalities may arise.[36]

- *The classic "tragedy of the commons."* This applies where a renewable resource is commonly owned and property rights to the resource are not defined (Hardin 1968; and see the discussion above of natural resources and the environment).
- *Congestion of government services such as health and schooling.* This situation is formally identical to the first if government spending on social welfare is viewed as a common resource. For several reasons, governments subsidize such services as education, health, urban transport, and sanitation. In many countries it is reasonable to suppose that the present value of the cost of a lifetime of these services to a newborn citizen will exceed the present value of the citizen's lifetime tax contributions. In that case, government services are subject to congestion, so that, for example, each additional child dilutes the educational services

available to his classmates. In principle, the congestion problem would be eliminated if the subsidy were set at the socially optimal level. But such subsidies are seldom designed to take account of potential congestion; they are more likely to be a response to external benefits and natural monopolies, or to capital market failures. Government efforts to compensate for poor access to capital markets in developing countries may similarly contribute to capital dilution in agriculture and industry (World Bank 1984). Again this problem is not caused by population growth, but probably is exacerbated by it. The argument then is that rapid population growth reduces the amount of physical capital available per worker, as well as the amount of human capital available.

- *A "pecuniary" externality in the labor market.* As population and thus labor supply increase, wages of labor (especially in rural areas) fall and rents rise. Individually, it is rational for landless or land-poor laborers to have many children as a strategy for maximizing the family's wages as well as their own security in old age. When everybody pursues this strategy, however, wages are depressed: one poor family's decision to have children imposes costs on others.

  Such a decline in returns to labor relative to other factors is classified as a pecuniary externality, rather than a true one, since its consequences are fully reflected in the market. Although wages are depressed by population growth, rents are boosted, so landowners or capitalists gain. Only if one views a reduction in poverty as a public good can the effect of population growth on wages be construed as a true (nonpecuniary) externality. In any case, decreasing the proportion of the population living in poverty by slowing population growth, though low-cost and (perhaps) politically feasible, is a slow-acting alternative to measures such as land reform.

Economists have recently developed new analytic models to examine more closely the social optimality of individual decisions about family size. These models incorporate the overlapping generations framework (Samuelson 1958) and the idea that parents fully incorporate their children's utility (Becker 1981), and, most important, they take into account the endogenous nature of decisions about family size. Theoretical work suggests that under certain conditions individual decisions will be optimal from a social point of view—that externalities due to diminishing returns to land, for example, are not a problem (Nerlove, Razin, and Sadka 1987). Unfortunately, there has been virtually no empirical work on the magnitude of any possible childbearing externalities—for industrial or developing countries (though see Lee 1988).

Fertility Control and Market Failure

The second rationale for public family planning programs is that contraceptive information is inadequately conveyed, so people have more children than they would want were they better informed.[37] There is no opportunity for profit (and thus no private market) from informing people about such means of contraception as rhythm and withdrawal, which involve no sale of a product. Even in industrial countries, information about contraceptives is limited; for example, advertising of contraceptives continues to be frowned upon in the United States, even in the face of the rising social costs of adolescent fertility and of AIDS.

The argument that the market for contraceptive information is flawed, justifying public intervention, is sometimes extended to the notion that the market for certain contraceptive services is flawed (World Bank 1984). Such contraceptive methods as the pill and the intrauterine device (IUD) require medical backup; in effect they are jointly produced along with health care. Where the demand for private health care is limited—as in rural areas of developing countries—the demand for these contraceptives is therefore unlikely to be met in the private sector.[38]

The result of poor markets for information and services can be "unmet need" for family planning. This concept denotes a specific empirical measure—the number of eligible women (of reproductive age, not pregnant, and so forth) in a sample who say they want no more children or want to delay childbirth, but are not using contraception. Unmet need is not equivalent to the economic concept of unmet demand, as it does not take into account the effect of costs in reducing demand. Unmet need is estimated to be in the range of 10 percent (in Africa) to 30 percent (in such countries as Peru and Bangladesh) of married women age 15 to 49 (World Bank 1984).

Specific Policies

Four types of policies to reduce fertility can be distinguished by their potential effects on social welfare.

FAMILY PLANNING INFORMATION AND SERVICES. Assuming state subsidies are financed appropriately (that is, the tax system is not highly regressive) and programs are voluntary, public involvement in family planning as a means to reduce fertility is likely to improve individual welfare. This principle is generally endorsed in the economics literature, even when the evidence on the size and importance of externalities is disputed (see, for example, Srinivasan 1988). However, Bauer (1985) worries that in many countries of Asia and

Africa, advice, education, and persuasion "in practice shade into coercion."

ENTITLEMENTS. These are rewards for particular types of behavior. Chomitz and Birdsall (1987) distinguish two types of incentives for individuals: those that reduce barriers to contraceptive use (such as time and travel costs, lack of information, and psychic costs) and those that change the relative costs of children and thus directly reduce the demand for children.

In the first category would be payments to people who attend a session providing information on contraception or compensation for time and travel costs to those who go to a family planning clinic. These "entitlements" are relatively easy to justify, particularly if they are merely for receipt of information. But the most common form of entitlement is designed to compensate for time and travel costs of clients undergoing irreversible sterilization. Such payments are as much as 20 percent of public spending on family planning programs in India and Sri Lanka. Because sterilization is irreversible, they do raise a danger. If the desperately poor have difficulty borrowing, as they often do, such payments may be coercive. They may "entrap" the myopic into forgoing the long-term benefits of additional children for the sake of short-term cash.

In the second category would be payments to individuals (immediate or deferred) for limiting the size of their families. The classic example is the Chinese practice of giving better housing, higher wages, and education privileges to families with only one child. This form of incentive is justified from the standpoint of efficiency only if there are externalities—that is, if there are savings to society when the parents forgo a birth. The optimal incentive payment is the amount at which the gain to society of the last birth averted just offsets the forgone benefits to parents of that birth.

The approach to population policy implicit in this welfare-economic approach is very different from the standard one. Population policies commonly set a target for reducing the birth rate; how the reduction is allocated among families is treated as a secondary consideration. However, the welfare-economic approach is concerned not with the total reduction in births, but with ensuring that the private and social value of each birth is identical.

TAXES AND DISINCENTIVES. A child tax is a disincentive with potential efficiency gains analogous to incentives—but only under perfect market conditions. The same is true of any outright penalty or loss associated with children, such as reduction of maternity benefits. Disincentives have been used in China and Singapore (including restricted educational opportunities for later-born children).

Disincentives in the form of outright penalties pose an obvious distributional problem. Child taxes are likely to affect the poor most severely. Disincentives, such as rising costs of education for each additional child in a family, are likely to penalize the wrong generation: the children whose welfare a population policy is intended to improve.

In addition, unless capital markets are perfect, disincentives can become coercive, with big welfare losses. For the poor much more than the rich, children are a valuable source of old-age income and security. Yet in no society, developed or developing, is it easy to borrow against the future earnings of one's children. Because of this failure of capital markets, a small tax (if nonoptimal from a social point of view) could force a poor couple to forgo the birth of a child whose financial value alone would be greater than the tax.

The potential coercive effect of disincentives contrasts with the overall improvement in welfare that comes from incentives. With laissez-faire choice, a couple can decide whether to have two children at income Y, or three children at income Y. An incentive payment clearly improves the choice: to have two children at income Y plus the payment, or to have three children at income Y. In contrast, a disincentive worsens the choice: to have two children at income Y, or three children at income Y minus the payment. As the disincentive gets larger, the effective area of choice gets smaller; the line between disincentive and coercion is then merely one of degree.

Obviously, the system of financing incentives or disincentives can affect the family's choice and thus modify these simple conclusions.[39] If incentives are financed by taxes, or disincentives are distributed as rebates, the overall effects on social welfare are less clear. Finally, at least in principle, if there are large negative externalities associated with childbearing, the immediate impact of a disincentive could be offset by a family's share in the social gains of slower population growth.

QUOTAS. On the face of it, a quota on the number of children any couple can have seems "fairer" than incentives, since rich and poor are equally constrained. In fact, a quota is less fair. In developing countries, it would deprive the poor of the benefits of additional children—and without any compensation; the rich are less reliant on having many children for economic reasons (and have more consumption options as well).

In addition, quotas are far less efficient than incentives. They impose potentially heavy welfare costs on many couples and thus on society as a whole. Quotas, to be efficient, would require that the shadow cost of the quota were identical for all individuals and similarly that the marginal benefits of the additional child or chil-

dren were identical. This is most unlikely to be the case. With a quota, some individuals will be rationed; others might anyway have chosen the number of children permitted, or fewer. In short, quotas eliminate any use of the market, with the typical associated losses in consumer welfare.

Conclusions

The long debate over population growth and development is entering a new phase. The emphasis is now on the interaction of rapid population growth with market failures. Research is concentrating on the quantitative importance of population growth in particular settings and time periods and among particular groups such as the poor, given likely market failures. The issue is whether population growth is so interlinked with other problems—such as poor macroeconomic policies, weak political institutions, or such correctable market failures as poorly defined property rights—as to hardly merit specific attention; or whether the effects of population growth are large enough to justify special policies to reduce fertility.

The issue warrants new empirical research for two types of economies: First are those in which it is likely that the social costs of high fertility exceed the private costs. This might be signaled by social and parental difficulties in educating children (for example, in Bangladesh and in parts of sub-Saharan Africa, where population growth rates remain high and per capita income is low). Second are those economies in which market failures such as lack of property rights or distortions that discourage labor-using technology are likely to heighten any negative effect of rapid population growth.

At least three avenues for new work on the consequences of population growth appear promising. First is analysis of long time-series (covering at least seventy years) of aggregate economic and demographic data, in which exogenous and endogenous components of population change can be distinguished. Such long series should allow a general equilibrium analysis of both indirect and direct effects of population growth. Though simulation models of this type have not been particularly useful or convincing, they have tended to rely on cross-section data and intelligent guesses as a basis for parameter estimates.

Second is analysis of family or household data in which any component of exogenous mortality or fertility can be isolated, and its effects examined. There are very few studies of the long-term consequences for parents and children of large or small family size—in terms of parents' old age security, children's education, and so on.

Third is development of models that link population growth to

changes in social and political institutions and to creation and adaptation of new technology. Such models would do much to enrich the current debate.

The new emphasis on market failure and its interaction with population change has recently inspired concern by economists to consider the optimal public policy regarding fertility. Economic studies of the welfare effects at the individual and family level of public policies that promote family planning or give incentives to alter fertility are still, however, rare.

Abstract

Discussion of the macroeconomic consequences of rapid population growth is organized into three schools: pessimists, optimists, and the recent revisionists. For the revisionists, differing views are presented about the pervasiveness and relevance of market failures, such as the negative externalities of childbearing, and about the ability of families and institutions to adjust rapidly to changes brought on by rapid population growth. A welfare economics approach is used to review the merits of various public policies to reduce fertility, including public financing of family planning services and taxes and incentives associated with childbearing.

Notes

This article is based on "Economic Approaches to Population Growth," a chapter by the author in *Handbook of Development Economics*, edited by H. B. Chenery and T. N. Srinivasan (Amsterdam: North-Holland, 1988).

1. For a summary description of demographic trends in developing countries over the last three decades, see World Bank 1984.

2. See, for example, the report of the National Academy of Sciences (cited as National Research Council 1986) and World Bank 1984, ch. 5. Kelley, in King and Kelley 1985, has characterized both reports as revisionist.

3. See Kelley and Williamson 1974 for one of the few cases of a general equilibrium model of economic and demographic change built and tested using historical series—of industrializing Japan. Of course these difficulties apply to other subjects as well—for example, to studies of the effect of education on development.

4. Indeed, the fundamental behavior is at the "micro" or family level, and many of the difficulties of the "macro" literature arise because the latter is not grounded in any behavioral formulation. An obvious example is a tendency in much of the literature on macroeconomic consequences not to distinguish a population increase due to declining mortality from one due to rising fertility—even though the economic conditions producing and resulting from one have tended to be very different.

5. For useful critical reviews of large interactive economic-demographic models, see Sanderson 1980 and Arthur and McNicoll 1975.

6. The data provide support for the Ricardian idea of diminishing returns to labor embedded in Malthus's model, but do not actually support Malthus's idea that mortality responds to changes in wages. See Lee 1980 for analysis of a time series of real wage and population figures for England.

7. See World Bank 1984, p. 57, box 4.2. The data for that box were assembled by Peter Lindert.

8. Malthus actually revised his views in a subsequent essay. See Birdsall and others 1979 for a discussion and citations to Malthus's subsequent essay.

9. For a steady-state analytic model in which production and consumption are spread more realistically over the life cycle, see Arthur and McNicoll 1978. They find that under typical demographic structures, the net intergenerational transfer effect of higher population growth is likely to be negative.

10. Such studies are cited in Birdsall 1977, itself a review article.

11. Estimates of the cost of averting a birth through provision of family planning services ranged, for example, from $1 to $400 in the mid-1970s.

12. Estimates of the benefits of averting a birth ranged from $100 to $900 in the mid-1970s.

13. See also *The Limits to Growth* (Meadows and others 1972), an elaborate but essentially mechanical modeling exercise, in which fixed factors of production and fixed absorptive capacity of the environment were assumed.

14. Leibenstein 1967 provides the arithmetic for the latter argument.

15. Smith 1776 and Marshall 1920, cited in United Nations 1973, p. 44.

16. See Simon 1977, p. 69. See also Chenery 1960, who reports a small partial elasticity of manufacturing output with respect to population. McNicoll 1984 discusses some possible disadvantages of demographic scale economies and notes that there are other routes to expansion of market size, including of course, higher per capita income (p. 39).

17. For formal modeling of the Boserup approach, see Robinson and Schutjer, 1984. Note that Robinson and Schutjer, however, fail to distinguish between the shift in farming systems and the introduction of new tools and techniques, lumping both together as "technological change" that shifts the production function outward. For Boserup, only the latter implies the outward shift in production function.

18. Cassen 1978 (pp. 226–27) makes a related point—that rapid population growth leads countries such as India to a quicker shift to capital-intensive production, which is less "appropriate," given the greater availability of labor compared with capital, but more efficient as measured by total cost. Agriculture in India has become more capital-intensive in order to maintain per capita output, as efficient labor-intensive means have been exhausted.

19. The modern economic theory of induced technological change ties the rate and factor bias of innovation to factor prices and research investments, but research investment strategies are driven not only by factor prices but also by policy views. See Binswanger and Ruttan 1978.

20. See Simon 1977 for a more technical presentation than in the popularized *The Ultimate Resource*. See Sanderson 1980 for a useful critique of Simon's model and of neo-Malthusian simulation models.

21. For a sense of the debate, see Wattenberg and Zinsmeister 1985 and the reviews of the National Research Council study in *Population and Development Review* (1987). The views of the optimists were embodied in the official position taken by the United States at the international conference on population sponsored by the United Nations in Mexico City in August 1984.

22. For a recent review of the microeconomic literature on the determinants of fertility, see Birdsall 1988.

23. Leff 1969 reports a negative effect of the dependency ratio on savings, but the effect disappears if a few East European countries (with high savings and a low dependency ratio) are excluded from the regression (see Bilsborrow 1973). Mason 1985 finds a negative effect of the old-age dependency burden on savings in industrial countries, but among developing countries, a negative effect only under certain conditions of rapid economic growth.

24. Wheeler 1985 concludes, for example, that a "social investment" package of education and family planning has much higher returns, on the basis of an econometric simulation model.

25. See National Research Council 1986, p. 42: "Per capita income in a population growing at 3 percent a year would be only 13 percent lower than in one growing at 1 percent a year."

26. This counterargument fails to note that low capital-labor ratios using existing technology do not necessarily coincide with (efficient) low capital-output ratios, if only technologies appropriate for industrial economy factor endowments are available. As noted in Sen 1975, p. 47, early vintage labor-intensive methods of presently industrialized countries may be inefficient and noncompetitive in today's international markets.

27. Indeed, application of any positive discount rate would imply more rapid population growth is welfare-enhancing. See National Research Council 1986, pp. 15–16.

28. See World Bank 1986a. The unsophisticated version, at least from an economist's point of view, is the standard argument of ecologists that more people implies more rapid resource depletion.

29. Simon and Pilarski 1979 found a negative effect of higher population growth on secondary enrollment and a positive effect on primary enrollment.

30. Work on the consequences of high fertility for child health and development has been largely the domain of psychologists, public health specialists, and demographers. See Blake 1983 and Maine and McNamara 1985.

31. The market failure would be, for example, a negative intertemporal externality arising because parents do not believe they can capture the returns on investing in their children's health and education.

32. A whole range of pricing policies could affect parental demand for the number and "quality" of children, as shown in Birdsall and Griffin 1988.

33. The effects of population growth on the distribution of income (that is, on income of units relative to each other) must be carefully distinguished from effects on absolute poverty. The latter is closer to effects on "development" broadly defined. For a review of concepts and evidence see Rodgers 1983. For reviews of the relationship between population growth and income distribution, see Rodgers, Boulier 1977, and Lam 1985.

34. See National Research Council 1986, p. 63. Effects are difficult to establish in any case because measures of inequality such as the Gini coefficient are sensitive to the definition of income—whether on a household or per capita basis (Kuznets 1976)—and are often ambiguous, indicating greater inequality in some cases even though the income of the nonrich is increasing. Lam 1985 shows why almost no definitive conclusion can be drawn about the effects of fertility change on income distribution using cross-section and time series data.

35. Assortative mating, in which the sons of rich parents are more likely to marry the daughters of rich parents and also are likely to have fewer children, would further exaggerate this effect. See Meade 1964, pp. 46–48. For an exploration of the effects of the combination of high fertility, low human capital expenditures, and assortative mating on intergenerational mobility using empirically derived estimates, see Birdsall and Meesook 1986.

36. The following discussion relies heavily on Chomitz and Birdsall 1987.

37. Other kinds of information that would reduce fertility may also be unavailable, or available at too high a cost for individuals. Examples are information about declining infant mortality (reducing the need for additional births to ensure a particular number of surviving children) and information about possible negative health effects for the infant of stopping breastfeeding (breastfeeding inhibits conception).

38. It could be argued that jointness arises not in production but in consumption (that is, to be effective the pill and IUD must be used along with medical care), and that therefore demand for the pill and IUD are reduced. In fact, however, in the case of the pill, there is evidence of demand independent of medical backup; for example, more than one-half of all purchases of the pill in Brazil are directly from pharmacists and without prescription. The absence of a comparable private market outside Latin America may be due either to heavier government regulation or, in fact, to insufficient demand.

39. Another argument is that incentive payments in poor societies pose a "tragic choice"—a morally unacceptable choice for example between food for the desperately poor and childbearing. The framing of such choices raises ethical issues beyond the scope of welfare economies.

References

Adelman, I., and C. T. Morris. 1973. *Economic Growth and Social Equity in Developing Countries*. Palo Alto, Calif.: Stanford University Press.

Arthur, W. B., and G. McNicoll. 1978. "Samuelson, Population and Intergenerational Transfers." *International Economic Review* 19, no. 1:241–46.

———. 1975. "Large-scale Simulation Models in Population and Development: What Use to Planners?" *Population and Development Review* 1, no. 2:251–65.

Bauer, P. T. 1985. Untitled chapter in B. Wattenberg and K. Zinsmeister, eds. *Are World Population Trends a Problem?* Washington, D.C.: American Enterprise Institute for Public Policy Research.

Becker, G. S. 1981. *A Treatise on the Family*. Cambridge, Mass.: Harvard University Press.

Becker, G. S., and H. G. Lewis. 1973. "Interaction between Quantity and Quality in Children." *Journal of Political Economy* 81: S279–88.

Behrman, J. R., and N. Birdsall. 1988. "The Reward for Choosing Well the Timing of One's Birth: Cohort Effects and Earnings Functions for Brazilian Males." *Review of Economics and Statistics* 70, no. 1: 129–35.

Bilsborrow, R. E. 1973. "Dependency Rates and Aggregate Savings Rate: Corrections and Further Analyses." University of North Carolina.

Binswanger, H. P., and V. W. Ruttan. 1978. *Induced Innovation, Technology Institutions and Development*. Baltimore, Md.: Johns Hopkins University Press.

Birdsall, N. 1988. "Economic Approaches to Population Growth." In H. Chenery and T. N. Srinivasan, eds. *Handbook of Development Economics*. Amsterdam: North-Holland.

———. 1980a. "A Cost of Siblings: Child Schooling in Urban Colombia." In J. Simon and J. DaVanzo, eds. *Research in Population Economics*, vol. 2. Greenwich, Conn.: JAI Press.

———. 1980b. "Population Growth and Poverty in the Developing World." *Population Bulletin* 35, no. 5.

———. 1977. "Analytical Approaches to the Relationship of Population Growth and Development." *Population and Development Review* 3, no. 1–2:63–102.

Birdsall, N., and C. C. Griffin. 1988. "Fertility and Poverty in Developing Countries." *Journal of Policy Modeling* 10, no. 1:29–55.

Birdsall, N., and O. Meesook. 1986. "Children's Education and the Intergenerational Transmission of Inequality: A Simulation." *Economics of Education Review* 5, no. 3:239–56.

Birdsall, N., and others. 1979. "Demography and Development in the 1980s." In P. Hauser, ed. *World Population and Development- Challenges and Prospects*. Syracuse, N.Y.: Syracuse University Press.

Blake, J. 1983. "Family Size and the Quality of Children." *Demography* 18, no. 4:421–42.

Boserup, E. 1981. *Population Growth and Technological Change: A Study of Long-Term Trends*. Chicago: University of Chicago Press.

———. 1965. *The Conditions of Agricultural Growth*. London: Allen and Unwin.

Boulier, B. L. 1977. "Population Policy and Income Distribution." In C. R. Frank and R. C. Webb, eds. *Income Distribution and Growth in the Less Developed Countries*. Washington, D.C.: Brookings Institution.

Cain, M. T. 1983. "Fertility as an Adjustment to Risk." *Population and Development Review* 9, no. 4:688–702.

Cassen, R. H. 1978. *India: Population, Economy and Society*. New York: Holmes and Meir.

Chenery, H. 1960. "Patterns of Industrial Growth." *American Economic Review* 50:624–54.

Chomitz, K. M., and N. Birdsall. 1987. "Incentives for Reducing Fertility: Concepts and Issues." World Bank, Population, Health and Nutrition Department, Washington, D.C.

Coale, A. J., and E. M. Hoover. 1958. *Population Growth and Economic Development in Low-Income Countries*. Princeton, N.J.: Princeton University Press.

Demeny, P. 1986. "Population and the Invisible Hand." *Demography* 23, no. 4:473–87.

Enke, S. 1966. "The Economic Aspects of Slowing Population Growth." *Economic Journal* 76: no. 301:44–56.

Fei, J.C.H., and Ranis, G. 1964. *Development of the Labor Surplus Economy: Theory and Practice*. Homewood, Ill.: R.D. Irwin.

Glover, D. R., and J. Simon. 1975. "The Effect of Population Density on Infrastructure: The Case of Road Building." *Economic Development and Cultural Change* 23, no. 3:453–68.

Hammer, Jeffery. 1986. "Population Growth and Savings in LDCs: A Survey Article." *World Development* 14:579–91.

Hansen, A. H. 1939. "Economic Progress and Declining Population Growth." *American Economic Review* 29:1–15.

Hardin, G. 1968. "The Tragedy of the Commons." *Science* 162:1243–48.

Hirschman, A. O. 1958. *The Strategy of Economic Development*. New Haven, Conn.: Yale University Press.

Kelley, A. C. 1980. "Interactions of Economic and Demographic Household Behavior." In R. A. Easterlin, ed. *Population and Economic Change in Developing Countries*. Chicago: University of Chicago Press.

Kelley, A. C., and J. Williamson. 1974. *Lessons from Japanese Development: An Analytical Economic History*. Chicago: University of Chicago Press.

King, T., and A. C. Kelley. 1985. *The New Population Debate: Two Views on Population Growth and Economic Development*. Public Trends and Public Policy Series 7. Washington, D.C.: Population Reference Bureau.

Kuznets, Simon. 1966. *Modern Economic Growth*. New Haven, Conn.: Yale University Press.

———. 1976. "Demographic Aspects of the Size Distribution of Income: An Exploratory Essay." *Economic Development and Cultural Change* 25: 1–94.

Lam, D. 1985. "Distribution Issues in the Relationship between Population Growth and Economic Development." Background paper for the Working Group on Population Growth and Economic Development, Committee on Population, National Research Council, Washington, D.C.

Lee, R. D. 1988. "Evaluating Externalities to Childbearing in Developing Countries: The Case of India." Paper prepared for United Nation's Expert Group Meeting on Consequences of Rapid Population Growth in Developing Countries, New York.

———. 1980. "An Historical Perspective on Economic Aspects of the Population Explosion: The Case of Pre-Industrial England." In R. A. Easterlin, ed. *Population and Economic Change in Developing Countries*. Chicago: University of Chicago Press.

Leff, N. 1969. "Dependency Rates and Savings Rates." *American Economic Review* 59, no. 5:886–96.

Leibenstein, H. 1974. "An Interpretation of the Economic Theory of Fertility: Promising Path or Blind Alley?" *Journal of Economic Literature* 12, no. 2:457–79.

———. 1967. "The Impact of Population Growth on 'Non-Economic' Determinants of Economic Growth." In *Proceedings of the World Population Conference*, vol. 4, pp. 8–11. Belgrade, 1965.

———. 1954. *A Theory of Economic-Demographic Development*. Princeton, N.J.: Princeton University Press.

Lewis, W. A. 1954. "Economic Development with Unlimited Supplies of Labour." *Manchester School* 22:139–91.

Maine, D., and R. McNamara. 1985. *Birth Spacing and Child Survival*. New York: Columbia University Press.

Mason, A. 1985. "National Savings Rates and Population Growth: A New Model and New Evidence." Background paper for the Working Group on Population Growth and Economic Development, Committee on Population, National Research Council, Washington, D.C.

Meade, J. E. 1964. *Efficiency, Equality and Ownership of Property*. London: Allen and Unwin.

Meadows, D. H., and others. 1972. *The Limits to Growth*. New York: University Books.

McNicoll, G. 1984. *Consequences of Rapid Population Growth: An Overview*. World Bank Staff Working Paper 691. Washington, D.C. See also *Population and Development Review* 10, no. 2:177–240.

National Academy of Sciences. 1971. *Rapid Population Growth: Consequences and Policy Implications*. Baltimore, Md.: Johns Hopkins University Press.

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

Nelson, R. 1956. "A Theory of the Low-level Equilibrium Trap in Underdeveloped Economies." *American Economic Review* 46, no. 5:894–908.

Nerlove, Marc, Assaf Razin, and Efraim Sadka. 1987. *Household and Economy: Welfare Economics of Endogenous Fertility*. New York: Academic Press.

Repetto, R. 1979. *Economic Equality and Fertility in Developing Countries*. Baltimore, Md.: Johns Hopkins University Press for Resources for the Future.

Robinson, Warren, and Wayne Schutjer. 1984. "Agricultural Development and Demographic Change: A Generalization of the Boserup Model." *Economic Development and Cultural Change* 32, no. 2:355–66.

Rodgers, G. 1984. *Poverty and Population: Approaches and Evidence*. Geneva: International Labour Organisation.

Rosenzweig, M. R., and Wolpin, K. 1980. "Testing the Quantity-Quality Fertility Model: The Use of Twins as a Natural Experiment." *Econometrica* 48, no. 1:227–40.

Samuelson, P. 1958. "An Exact Consumption-Loan Model of Interest with or without the Social Contrivance of Money." *Journal of Political Economy* 66, no. 6:467–82.

Sanderson, W. 1980. *Economic-Demographic Simulation Models: A Review of Their Usefulness for Policy Analysis*. Laxenberg, Austria: International Institute for Applied Systems Analysis.

Schultz, T. P. 1985. "School Expenditures and Enrollment, 1960–1980: The Effects of Income, Prices and Population Growth." Background paper for the Working Group on Population and Economic Development, Committee on Population, National Research Council, Washington, D.C.

Schultz, T. W., ed. 1974. *Economics of the Family: Marriage, Children and Human Capital*. Chicago: University of Chicago Press for the National Bureau of Economic Research.

Sen, A. 1975. *Employment Technology and Development*. Oxford: Clarendon Press.

Simon, J. L. 1981. *The Ultimate Resource*. Princeton, N.J.: Princeton University Press.

———. 1977. *The Economics of Population Growth*. Princeton, N.J.: Princeton University Press.

Simon, J. L., and A. M. Pilarski. 1979. "The Effect of Population Growth Upon the Quantity of Education Children Receive." *Review of Economics and Statistics* 61, no. 4:572–84.

Solow, R. M. 1956. "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Economics* 70:65–94.

Srinivasan, T. N. 1988. "Population Growth and Economic Development." *Journal of Policy Modeling* 10, no. 1:7–26.

United Nations. 1973. *The Determinants and Consequences of Population Trends*, vol. 1. New York.

Wattenberg, B., and K. Zinsmeister, eds. 1985. *Are World Population Trends a Problem?* Washington, D.C.: American Enterprise Institute for Public Policy Research.

Wheeler, D. 1985. "Female Education, Family Planning, Income and Population: A Long-Run Econometric Simulation Model." In N. Birdsall, ed. *The Effects of Family Planning Programs on Fertility in the Developing World*. World Bank Staff Working Paper 677. Washington, D.C.

Williamson, J. G., and P. H. Lindert. 1980. *American Inequality: A Macroeconomic History*. New York: Academic Press.

World Bank. 1986a. *Population Growth and Policies in Sub-Saharan Africa*. Washington, D.C.

———. 1986b. *World Bank Atlas*. Washington, D.C.

———. 1984. *World Development Report 1984*. New York: Oxford University Press. Also available as *Population Change and Economic Development*, Oxford University Press, 1985.