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Economic Consequences of Population Change in the Third World

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WE ARE LIVING in an unusual era in demographic history. For thousands of years, world population grew at a snail's pace, so slowly, in fact, that it took over 1 million years for population to reach 1 billion—and that was 200 years ago. But the pace quickened, and in a relatively short span of 120 years the population doubled to 2 billion. The third billion took only 35 years to arrive, and the fourth, 15. Presently world population exceeds 5 billion, and demographers do not forecast a leveling until the end of the next century at somewhat over 10 billion.

Most of this population increase in modern times has taken place in the Third World. The present article reviews the literature that assesses some of the consequences of this population growth on the economic development of these countries.

This is a difficult topic to address because of the one-sided coverage in the popular press which has emphasized the strong adverse consequences of the "population explosion." Any rendering of the scholarly literature, which is by no means as conclusive on the importance of the various positive and negative effects of population growth, must confront this difficulty in communication. Representative of the more alarmist judgments is that of Robert S. McNamara in 1973, then president of the World Bank, who compared population growth with nuclear war:

> . . . the greatest single obstacle to the economic and social advancement of the majority of peoples in the underdeveloped world is rampant population growth. . . . The threat of unmanageable population pressures is much like the threat of nuclear war. . . . Both threats can and will have catastrophic consequences unless they are dealt with rapidly and rationally. (1973, pp. 31, 45–46)

McNamara's view is shared by many political leaders and a goodly number of scholars as well. For example, a 1971 National Academy of Sciences report entitled *Rapid Population Growth: Consequences and Policy Implications* found little good in population growth, and identified 17 reasons why smaller populations would bene-

fit the less developed countries (LDCs).

It may therefore come as a surprise that research over the last decade has provided the basis for a modified and moderated appraisal of the consequences of population growth. This "revisionist interpretation," guarded in tone and assessment, is best represented by a new National Academy of Sciences report in 1986 entitled *Population Growth and Economic Development: Policy Questions,* which (1) recognizes that population growth and size can have positive as well as negative effects, (2) examines both direct and indirect linkages between population and development, (3) acknowledges that several problems previously attributed to population are due largely to other causes, and (4) holds that the role of population is sometimes to exacerbate more fundamental problems and to reveal their symptoms sooner and/or more dramatically. The revisionist interpretation still concludes that economic development in most Third World countries would be faster with slower rates of population growth, although such a judgment must be qualified because the net impact of population varies from country to country and over time. In some countries population growth may on balance contribute to economic development; in many others, it will deter development; and in still others, the net impact will be negligible.

The extensive empirical research that has given rise to this interpretation can be characterized as a response to the sobering challenge posed by Simon Kuznets in 1960 in which he observed:

> . . . we have not tested, or even approximated, empirical coefficients with which to weight the various positive and negative aspects of population growth. While we may be able to distinguish the advantages and disadvantages, we rarely know the character of the function that relates them to different magnitudes of population growth. (1960, p. 339)

Happily, progress has been made in economic-demographic research since then, and the time is opportune to summarize and appraise the intervening literature.

Framing the Question. Ideally, a literature survey would provide a rough quantitative answer to the questions: What has been the net impact of rapid population growth on the pace and structure of economic development in the Third World over recent decades, and how concretely has demographic change interacted with the economy to provide such an outcome? This is basically an historical "population-counterfactual" (or "what if") question, the answer to which requires a formal model that reveals and measures the economic outcomes of alternative population scenarios. Unfortunately, the problems of constructing such a model are formidable.[1] First, the model must extend over a period of at least one life cycle (around 60 years). During such an interval, institutions and government policies that condition the operation of the economy change, sometimes significantly, and probably in response to demographic change as well as other causes. These institutional changes are not easily modeled, nor are they well understood. Second, the model must be complex and embody general-equilibrium feedbacks because the direct and indirect impacts of population change are likely to be important and pervasive. Third, it is difficult to specify meaningful population-growth scenarios because fertility and mortality rates are themselves influenced by economic change. And finally, the lack of available data limits our ability to specify and validate such a model. Clearly, providing a *quantitative, net-economic-impact* answer to the population-counterfactual question is at best a remote possibility.

Instead, the present survey will employ a general-equilibrium perspective to exam-

[1] Geoffrey McNicoll is skeptical because such modeling deals with "inherently unverifiable, contrary-to-fact conditionals" (1984, p. 212). See also W. Brian Arthur and McNicoll (1975) and Peter D. McClelland (1975).

ine those consequences of population change that have been highlighted in the literature on economic demography, and which appear to bear significantly on the population-counterfactual question. This orientation helps to delimit the approach and choice of topics. The general-equilibrium perspective dictates an evaluation of more than those direct effects of population stressed during the 1960s and 1970s; induced feedbacks, a feature of recent economic/demographic research, merit attention.[2] Focusing on areas emphasized in the literature results in a consideration of the most familiar sources of economic growth. And the counterfactual (or "what if") perspective directs attention away from studies that examine whether countries have been successful in "accommodating" rapid population growth, and toward those that suggest whether development would have been much different in an environment of slower population growth.

Delimiting the Survey. The economic-demography literature is vast, and thus further constraints must be placed on the scope of the present survey. First, matters relating to the location and movement of population—internal and international migration, city growth, and urbanization—will be deemphasized. These topics merit separate reviews (see Mark R. Rosenzweig 1988; Jeffrey G. Williamson 1988). Second, the paper will focus on the *consequences*, as distinct from the *determinants* of demographic change. The rich literature on the microeconomics of fertility and mortality, as well as the numerous macroeconomic/historical studies of the Demographic Transition, also merit separate reviews. The endogeneity of population growth to economic development will therefore be treated as a qualifying theme.

Third, only the *economic* consequences of population growth will be emphasized, even though selected social and political implications may be as important as some of the economic factors considered. A fourth limitation relates to the clear error of appraising the impact of population on the "Third World" when in fact there is no such homogeneous entity. The Third World represents over 100 nation states, disparate in cultures, agroclimatic zones, political systems, historical traditions, and resource bases. Almost any general statement about the Third World is subject to notable exceptions. To dwell on such exceptions would reduce this review to a compilation of lists and vignettes. But to focus exclusively on the general to the exclusion of the particular would fail to do justice to the research and information base. My compromise strategy is to dwell primarily on the "Third World," and to provide examples of deviations from "typical" patterns and relationships.

A fifth limitation relates to the criteria used to assess the effects of population change. Decisions must be made about (1) the sources of the demographic effects to be considered; (2) the length of the period over which the effects are assessed; and (3) the elements of economic life that are affected. My emphasis will be on (1) the effects stemming from the growth rate and the age distribution of the population, with some attention to its size, density, and other qualitative attributes; (2) the effects over several decades, but including shorter-run effects (around one decade) where they appear to be particularly relevant; and (3) the effects on per capita output growth, with some evaluation of impacts on income levels and distribution, and individual/family welfare. These choices constitute those areas where empirical and analytical research has been concentrated and,

[2] The general-equilibrium perspective of the recent National Academy of Sciences report on population substantially explains its somewhat guarded assessment of the consequences of population change. The authors highlight "the key mediating role that human behavior and human institutions play in the relation between population growth and economic processes" (National Research Council 1986, p. 4).

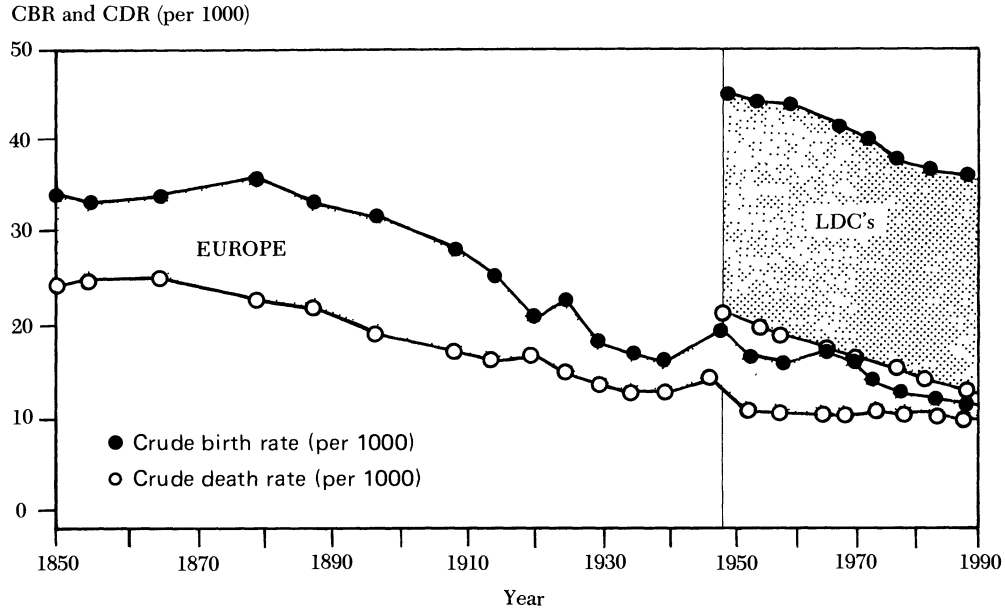

Figure 1. Crude Birth and Death Rates, 13 West European and 106 LDCs (Unweighted)

as a result, merit principal emphasis in a survey article.

Organization. Section I provides an empirical point of reference by summarizing some of the salient demographic trends in the Third World. Section II takes up analytical perspectives useful to assessing the impacts of population on development. A preliminary empirical appraisal of the relationship between population and economic growth is provided in Section III, followed in Sections IV–VI by an examination of the effects of demographic change on the scale of production, the rate of saving and the composition of investment, and the rate and form of technical change in agriculture. Section VII concludes with a summary assessment and some qualifications relating to government policies, ecology, and values.

I. *Demographic Change: Past, Present, and Future*

A. *The Past*

To place current demographic trends in perspective, it is useful to review some features of the European "Demographic Transition," that 150–200 year period during which population growth rates rose from low to high and then returned to low rates again, but then on a considerably enlarged population base.

Beginning in the eighteenth century with low population growth rates of about .5 percent per year, the transition began with a gradual reduction in death rates, accompanied by persistently high birth rates. Although there was considerable country-specific variation in the patterns and levels of vital rates, the trends in Figure 1 are representative.[3] An important feature of most (but not all) of the individual country transitions was a delayed de-

[3] Following Kuznets (1966, pp. 52–53), this transition is represented as unweighted country averages, thereby emphasizing country-specific socioeconomic-cultural factors important to explaining vital rate trends. Thirteen countries are included: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom (England and Wales). Data from 1850–1950 are from H. J. Habakkuk and M. Postan (1965, pp. 68–69), and from 1950 to the present from United Nations (1986) (medium variant).

cline in the birth rate, often lagging mortality reduction by decades, which resulted in a period of rapid population growth of about 1.5 percent per year. This period was accompanied by sustained and substantial economic prosperity, urbanization, and structural transformation—all factors that eventually brought about reduced birth rates and low rates of natural population increase. Indeed, the transition was generally restricted to those countries that had entered into Modern Economic Growth.

B. *The Present*

For comparison and reference, Figure 1 shows vital rate trends since 1950 in the LDCs, whose demographic transition lags behind that of Europe by about 100 years. While the LDCs have similarities with the experience of Europe—an early reduction in mortality, followed by high, and then declining birth rates associated with a period of economic prosperity, urbanization, and structural change—there are also striking differences. In particular, LDC birth rates are on average considerably higher than those at the peak of the European transition. (Given data constraints, the earlier portion of the Demographic Transition in the Third World is not presented in Figure 1.) When combined with a particularly rapid decline in mortality rates, reaching low levels early in the transition, the result has been an exceptionally rapid pace of population change.

Table 1 documents the variation in the demographic experience by region. Given China's atypical demographic record and impact on the results, the Asian and total LDC aggregates have been computed with and without China. The text will refer to the series excluding China, unless otherwise noted.

Five rough generalizations are illustrated by this table.

The pace of population growth in the LDCs is exceptionally high. Currently expanding at an annual rate exceeding 2.25 percent (excluding China), this pace is well above that experienced in Europe during its period of rapid population growth. At this rate, the doubling time of the LDC population is 28 years. There is considerable variation by region, and even more by country. The current pace of population change is highest in Africa at about 3.0 percent, with individual countries, including such large ones as Nigeria and Kenya, growing at 3.5 and 4.2 percent, respectively. This region is followed by Latin America and South Asia with growth rates ranging between 2.0 and 2.2 percent, and East Asia at 1.9 percent. The slower pace of population change in Asia is shared by several countries, including Korea and Indonesia (1.7 percent). However, even these rates are high by historic standards. Regionally, the Demographic Transition is most advanced in East Asia, followed by Latin America and South Asia; it is least advanced in Africa.

Large reductions in death rates have contributed overwhelmingly to the increase in total population growth. The current death rate of 11/1000 has been cut in half since 1950–55, and by more than two-thirds (from around 37/1000) since 1937 (Samuel H. Preston 1980). This sizable reduction to a rate approaching that of industrial countries is largely responsible for the acceleration of total population growth in recent decades. The speed of this reduction has been four to five times as fast as that experienced in Europe in the nineteenth century (Kuznets 1980). But unlike Europe, where the decline can be attributed largely to gradual improvements in living standards and modernization, much of the mortality reduction in the LDCs has occurred without significant economic or institutional change. Instead, it has been related to a greatly enhanced capability to cope with infectious diseases, as well as improved communications and transportation which have brought about a wide diffusion of upgraded public health practices (Kuznets 1980).

While impressive, such progress re-

TABLE 1

MEASURES OF DEMOGRAPHIC CHANGE, 1950–1990, BY REGION

Regions	Africa	Latin America	Asia[a]	Except China	LDCs	Except China	More Dev. Countries[b]	World
Population in millions								
1950	224	165	1,292	737	1,684	1,129	832	2,516
1985	555	405	2,697	1,637	3,663	2,603	1,174	4,837
Percent Annual Popul. Growth								
1950–55	2.12	2.73	1.96	2.04	2.04	2.13	1.28	1.79
1985–90	3.02	2.16	1.67	2.00	1.94	2.25	0.60	1.63
Crude Birth Rate per 1000								
1950–55	48.3	42.5	44.2	44.6	44.4	44.7	22.7	37.3
1985–90	45.2	29.7	26.0	31.1	29.4	33.9	15.1	26.0
Total Fertility Rate								
1950–55	6.47	5.86	6.07	6.04	6.12	6.12	2.80	4.94
1985–90	6.22	3.73	3.26	4.03	3.69	4.33	1.97	3.28
Crude Death Rate per 1000								
1950–55	27.1	15.4	24.8	24.6	24.2	23.8	10.1	19.6
1985–90	15.1	7.6	9.3	11.1	10.0	11.4	9.5	9.6
Life Expectancy at Birth								
1950–55	37.8	51.1	40.2	39.9	41.1	41.2	65.8	46.0
1985–90	51.3	65.7	62.0	57.1	59.1	54.9	74.0	61.1
Infant Mortality Rate/1000								
1950–55	191	125	186	180	180	173	56	156
1985–90	101	56	68	92	79	98	14	71
Percent Urban Population								
1950	15.7	41.0	13.9	16.1	17.0	20.4	53.8	29.2
1985	29.7	68.9	24.9	27.7	31.2	35.5	71.5	41.0
Percent Dependency Under 15								
1950	42.4	40.5	36.7	39.1	37.9	40.0	27.8	34.5
1985	45.1	37.9	35.2	38.8	36.9	39.9	22 2	33.4
Over 65								
1950	3.6	3.3	4.3	3.7	3.9	3.6	7.6	5.1
1985	3.1	4.5	4.7	3.9	4.2	3.8	11.2	5.9

Source: United Nations (1986), medium variant projections.

[a] Asia excludes Japan.

[b] "More Developed Countries" include: North America, Japan, Europe, Australia–New Zealand, and USSR.

quires qualification because the average crude death rate does not itself account for age-specific incidence of mortality which is better measured by life expectancy at birth. Here the record is slightly less dramatic but still notable, with life expectancy rising from 41.2 to 54.9 years since 1950–55 with much of this improvement due to a reduction of the infant mortality rate from 173/1000 to 98/1000.[4] Nev-

[4] High infant mortality rates were experienced in Europe at the onset of the transition. Around 1800, these rates in Sweden and Germany were 250/1000 and 300/1000, respectively (World Bank 1984, p. 58). In Sweden, life expectancy for men in 1750 was only 34.2 years (World Resources Institute and Interna-

ertheless, future improvements in life expectancy will be more difficult to achieve because mortality reductions must increasingly come from gains at older ages; they will also have less impact on future rates of population growth. For example, extending the life of women over 50 has little impact on future births, whereas reducing the mortality of children who will in turn raise a family contributes substantially to future population numbers.

Fertility rates, peaking in the mid-1960s, have begun to decline in most countries, although they remain high by historic standards and are still increasing or have not begun to decline in some countries. The average crude birth rate has declined from about 45/1000 to about 34/1000 since 1950. Even so, current rates are high by historic standards, roughly corresponding to those in many European countries during the peak of the Demographic Transition. Moreover, there is some indication that birth rate reductions in several Third World countries (e.g., Costa Rica, India, Korea, and Sri Lanka) may have stalled. Whether this is a temporary pause is an unanswered question (World Bank 1984, p. 71).

There is considerable variation in fertility by region and country, with the crude birth rate ranging from around 25/1000 in East Asia to around 45/1000 in Africa; Latin America and South Asia are in between at 30/1000. The record of specific countries widens this spread, with crude birth rates in Nigeria and Kenya exceeding 50/1000 and Argentina and Chile approaching 20/1000. Most countries have shown some reduction in fertility rates in recent decades, but in some (mainly Africa) these changes have been small, and in a few, the rates are still rising.

High fertility has resulted in a relatively young age structure. The proportion of the LDC population under 15 is currently about 40.0 percent, almost twice that in the industrialized world. While the proportion of the elderly is small (3.8 percent), the share of the population of "working age" upon whom the young and elderly are dependent (1.3 workers per dependent) is still considerably smaller than that in the industrialized world (2 workers per dependent);[5] however, this situation is changing. On the one hand, declining birth rates are beginning to age the LDC populations, and a more economically favorable age structure will emerge in the future. Moreover, issues associated with accommodating an aging population are already beginning to emerge as a demographic concern for the twenty-first century. On the other hand, the present and upcoming decades will be dominated by the legacy of past rapid population growth, manifesting itself in a bulge of young people seeking jobs, forming households, bearing children, and raising a family.

Expansion in the share of the population in urban areas has been moderate, but the growth of very large cities has proceeded at a rapid pace. In analyzing urban trends, one must distinguish between the pace of urbanization (the share of the total population living in urban areas), and city growth. Consider each of these measures in turn.

Presently 35.5 percent of the LDC population lives in urban areas, up from 20.4 percent in 1950.[6] Latin America is the most urbanized region (68.9 percent). Even though the *absolute* size of urban populations has expanded notably in recent decades, this increase has occurred largely

tional Institute for Environment and Development 1986, p. 16), a level exceeded by almost every Third World country today. The pace of infant mortality reduction in the LDCs has declined in recent years (Julie DaVanzo et al. 1985).

[5] An adjustment in the usual definition of "working age" (15–65) to account for the relatively longer working span in the LDCs would narrow the dependency burden comparisons noted in the text.

[6] A lower population boundary of 2,500–5,000 encompasses most country definitions of "urban areas" (United Nations 1980, pp. 121–24).

because urban growth has been taking place on an already sizable population base. The pace of structural transformation—changes in the urban *share*—is broadly consistent with the historical experience of Europe at roughly comparable stages of development.[7] The primary explanation of urbanization trends is *not* the overall (rapid) rate of population growth but rather the course of underlying *economic* processes. Rural-to-urban migration, which has figured prominently in urbanization, has been primarily motivated by migrants responding to the economic opportunities of urban areas (Preston 1979; Allen C. Kelley and Jeffrey G. Williamson 1984; Williamson 1988).

It is the pace of city growth, especially the emergence of exceptionally large cities, that most distinguishes Third World urban trends.[8] This reflects the significantly faster rate of population growth in recent times. Indeed, internal migration has accounted for a much smaller portion of Third World city growth than it did in Europe during its urban transition.

C. *The Future*

In the year 2000, 20 of the 25 cities in the world with populations of over 10 million are projected to be in the LDCs. These include Mexico City and São Paulo, each having projected populations exceeding 25 million. Such large concentrations are without precedent and the economic implications of managing and providing public services for them are unknown.

Including China, LDC population growth peaked at 2.5 percent in 1965–70. This rate is expected to decline to 1.1 percent in 2025, when Third World population is projected to be 6.8 billion (United Nations 1986, medium variant). Thus, it is expected that over the 75-year period from 1950 to 2025, Third World population will have increased by 5.1 billion. While these numbers are large by any standard, it is notable that even in the year 2025, the majority of Third World countries will record population growth rates approximating those experienced in Europe at the peak of its Demographic Transition. The momentum of population change will be maintained throughout much of the twenty-first century, with projected world population stabilizing in about the year 2100 at about 10–11 billion.

How much confidence can be placed in these long-term projections? Paul Demeny (1984) aptly describes them as "speculative exercises rather than forecasts" (p. 108). They are fraught with uncertainty arising from difficulties in predicting fertility trends and the fact that forecasting errors cumulate over time.[9] This is illustrated by examining revisions in the UN projections compiled in 1974 which underestimated the pace of fertility decline in which the

[7] Early accounts by Bert Hoselitz (1957) emphasized "overurbanization" in the Third World, but recent analyses have documented a relatively conventional pattern. For example, the urban share in the presently developed countries increased from 17.2 percent to 26.1 percent in the period 1875 to 1900, a change closely approximating the experience of the Third World from 1950 to 1975 (Preston 1979, p. 196).

[8] While city growth between 1875 and 1900 in the presently developed countries increased by about 100 percent, the pace in the Third World during the period 1950–75 was 188 percent. "Cities" represent urban areas with populations exceeding 100,000 (United Nations 1980, p. 40).

[9] Projections are made by modifying a base-year population by assumed mortality, fertility, and net migration. In terms of fertility, UN projections assume (1) a specific date (about the years 2005 and 2025 for medium- and high-variant projections, respectively) when the total fertility rate (TFR) is 2.0, (2) a linear decline in the TFR to that date, and (3) a replacement level of fertility thereafter. (The total fertility rate is the average number of children born to a group of women over their childbearing years if they experienced no mortality.) In terms of mortality, UN projections assume a quinquennial gain of 2.5 years in the expectation of life at birth until life expectancy reaches 62.5 years, followed by a slowdown in the gain thereafter. Adjustments are made for some developing countries (United Nations 1986, pp. 9–10). For a discussion of early projections, see Thomas Frejka (1973, 1981a); for an explication of World Bank projections, see Demeny (1984).

total fertility rate of 4.5 children in 1970–75 dropped to 3.5 children in 1980–85 (United Nations 1986, p. 33). The 1974 projections (medium variant) placed world population in the years 2000 and 2100 at 6.4 and 12.3 billion, respectively; the revised UN estimates available in 1981 placed world population at 6.1 and 10.4 billion, respectively (United Nations 1975; Rafael M. Salas 1982). While the projections differed by only .3 billion in the year 2000, this difference widened to 1.9 billion by the year 2100.[10] Clearly, the sensitivity of long-term projections to the highly uncertain course of fertility justifies caution in using such figures.[11]

How, then, can one select among the various projections for the year 2100? Tomas Frejka (1981b) offers guidelines concerning his own projections. He pretty much rules out his high projection of 13.4 billion (with replacement fertility in the years 2040–45) because it assumes a rate of fertility decline that is considerably lower than the one experienced in the past 10 or 15 years, and is similar to that experienced in Europe during the Demographic Transition.[12] He also rejects his low projection of 8.5 billion (with a replacement level in the years 2000–2005) because it assumes the total fertility rate (TFR) will continue to decline at the pace experienced in the last 10 to 15 years. This is improbable because conditions for sustained high fertility still prevail in most of Africa and in many countries of Asia. His median projection uses a replacement rate stabilizing in 2020–25 with a resulting population of 10.6 billion, a figure bracketed by the projections of the United Nations of 10.2 billion and the World Bank of 11.2 billion.

[10] Based on comparisons of past projections with subsequent experience, Nathan Keyfitz (1981) questions the usefulness of population forecasts that extend much beyond 20 years.

[11] For example, the choice of dates when individual countries reach replacement fertility is based on the judgment of demographers, and descriptions of their procedures are vague. The United Nations (1986) fertility projections are based on "past and current fertility trends, . . . placed within the social, economic, and political context of the country. Trends and anticipated changes in the socio-economic structure and cultural values of the society as well as policies and programs directed towards family planning are considered . . ." (pp. 9–10). The World Bank (1984) projections "vary from country to country, depending on current fertility levels, recent trends, and family planning efforts" (p. 74).

[12] Dudley Kirk's (1971) study of the Demographic Transition suggests that the pace of fertility decline is faster the higher the level from which it was initiated.

II. *Analytical Perspectives*

A. *Models of Growth and Development*

1. *The One-Sector Models.* The aggregate production function represents the most widely used framework for identifying the impacts of population growth on the economy.

If the production function exhibits constant returns to scale, and if, for simplicity, we assume that labor is a constant proportion of population, then its productivity depends on the availability of complementary factors (e.g., land, resources, and human and physical capital) and on technology. An increase in population growth will reduce the growth of average productivity through diminishing returns—a "resource-shallowing" effect—if such a population increase does not also affect the growth of complementary factors and/or technology. If population growth diminishes the growth of the other factors and/or technology, labor productivity growth is reduced by even more; if it stimulates the growth of the other factors and/or technology (a "resource-augmenting" effect), labor productivity growth is increased or decreased, depending on the relative importance of the negative resource-diluting versus the positive resource-augmenting effects. (An empirical assessment of these effects is provided in Section V.)

In the standard growth model, where savings rates are exogenous to population growth, and where technical change is ex-

ogenous, an increase in population growth lowers the *level* but not the long-run *growth rate* of output per capita. This is because the capital-shallowing effect of an increase in population growth eventually drives down the long-run level of capital per worker enough so that it can be sustained by the (fixed) ratio of savings to output. As a result, increases in labor productivity are determined by changes in the rate of technological progress (Robert M. Solow 1956; Edmund S. Phelps 1968).[13] The impacts of increasing or decreasing returns to scale and changes in the rate of advance of technology can substantially alter these relationships.

Scale. If production is subject to increasing or decreasing returns to scale, population growth can itself directly increase or decrease the growth rate of output per capita. Negative scale effects would be unusual in the aggregate except possibly in countries that are already densely populated, and positive ones have been considered important to the growth of some presently developed countries. (A discussion of the nature and empirical relevance of scale effects is found in Sections IV and VI.)

Technology. Consider three alternative formulations of technical change. First, if technological advance takes place *independently* of factor supply growth, then the previous finding that population growth has a negative impact on the level of per capita income (and a neutral impact on long-run per capita growth) remains unaltered.

Second, if technical change is all or partially *embodied* in, say, new human or physical capital, a vintage specification is appropriate whereby new capital is relatively more productive than old (Solow 1960; Richard R. Nelson 1964). The average age of the capital stock, itself a determinant of labor productivity, is lowered (i.e., capital becomes more productive) when an increase in population growth causes total output and capital stock to expand more rapidly. Rapid population growth then quickens the pace at which new technology can be incorporated into production, and thereby has a positive impact on per capita output growth;[14] however, this impact takes place only during the transition between equilibrium age distributions of the capital stock. During such transitions the declining age of the capital stock acts as some offset to the decline in the stock of capital per worker.

Finally, population growth can directly affect the rate of technical change and/or its form (factor bias).[15] For example, Kenneth J. Arrow (1962) has hypothesized that learning-by-doing is quickened in an environment of rapid employment growth—a rate-of-change effect. Alternatively, relative price changes resulting from rapid population growth may stimulate the adoption of technologies more consistent with changing factor proportions, although the impact of this on total factor productivity is uncertain. (An empirical assessment of these possibilities is considered in Section VI.)

[13] For a review of this growth-theoretic literature as it applies to population, see John Pitchford (1974) and McNicoll (1975).

[14] Edward F. Denison (1964, 1967) places limited importance on embodiment in the U.S. and Western Europe; however, he notes that embodiment will be more important in situations where the capital stock is older, where its age distribution is distorted, and where capital markets are not functioning well (because of, say, lack of competition or government regulations)—presumably conditions that are relatively prevalent in the Third World. P. J. Verdoorn (1949) identified a significant positive association between output and labor productivity growth, based on aggregate interwar data for 15 developed countries, and on individual sector data for 4 countries. While the sources of this relationship have been subject to debate, Bryan L. Boulier (1984) demonstrates that, based on Verdoorn's formulation, it is not possible to distinguish between competing explanations: positive impacts of population growth through scale effects, embodied technical change, or labor-supply limitations.

[15] These various models are surveyed and extended in Julian L. Simon (1986). See also Peter J. Lloyd (1969) and Gunter Steinmann and Simon (1980).

Saving. While the growth-theoretic literature assumes a constant saving rate that is unrelated to demography (for an exception, see James Tobin 1967), the economic-demographic literature considers several population-sensitive saving specifications. For example, in the life-cycle model, saving is influenced by the need to finance the maintenance of children (the child-dependency effect), and retirement. And in the income-distribution model, population growth can increase saving if the effect of a lower capital-labor ratio is to shift income toward recipients of nonlabor income, who are assumed to save more on average. (This effect reduces but does not erase the impact of population growth on capital dilution, and depends on the elasticity of capital-labor substitution.) It should be noted that in the age-specific formulations (like those with vintage capital above), the impact of aging in the very long run will be on the level as distinct from the rate of growth of income per capita. (An empirical assessment of the impact of population growth on saving is taken up in Section V.)

Summary of One-Sector Models. The long-run impact of population growth and size on per capita output growth in the one-sector models is theoretically ambiguous. Population growth and size have a negative impact through diminishing returns, diseconomies of scale, and perhaps savings; and it has a positive impact through induced technical change, economies of scale, and perhaps savings. In the short run, the net impact is more likely to be negative as a result of resource-shallowing effects, which are immediate and take time to overcome; however, changing demographic age structures can stimulate or depress saving rates, depending on the saving model and its parameters. They can also stimulate or depress the rate of technical change, depending on the extent to which technology is embodied in capital and other factors. Having said this, we observe that most economists conclude that the negative resource-shallowing impacts of population growth dominate the countervailing induced feedbacks, even in the long run. As a result, unless scale effects associated with population are present and sufficient to offset substantially the adverse effects of resource shallowing, induced feedbacks take on the role of reducing, but not necessarily overturning, the negative impacts of population growth.

2. *The Dualistic Models.* Models of economic dualism fall into two categories: labor-surplus formulations where labor is paid more than its marginal product in some occupations, and neoclassical formulations where labor is paid its marginal product.

Labor-Surplus Model. The labor-surplus model highlights the transfer of labor from a relatively unproductive sector such as traditional agriculture to a more productive sector such as modern industry.[16] Population growth exerts a negative impact on development because labor fails to pay its way in the traditional sector, adds to the pool of unemployed or underemployed labor, and reduces the surplus needed to fuel modern-sector growth. The period of time when both sectors become "modern"—when all labor is paid its marginal product—is therefore postponed.

Neoclassical Model. In the two-sector neoclassical model, labor receives its marginal product, and population growth exerts a smaller negative impact than in the labor-surplus paradigm (Dale W. Jorgenson 1961; Avinash K. Dixit 1973; Ryuzo Sato and Yoshio Niho 1971; Kelley, Williamson, and Russell J. Cheetham 1972). This negative impact is reduced somewhat in the Kelley, Williamson, and Cheetham (1972) formulation since population growth

[16] Theoretically, this model also admits "traditional" industrial and "modern" agricultural enterprises. The pioneering formulation by W. Arthur Lewis (1954) was subsequently formalized and elaborated by John C. H. Fei and Gustav Ranis (1964).

contributes to the overall rate of capital accumulation by increasing the economy-wide share of (nonlabor) income going to the relatively high savers. This specification is of methodological interest because it illustrates a role for feedbacks in modifying the first-order direct effects of population growth highlighted in most economic-demographic models.[17] This general-equilibrium perspective whereby initial impacts of population growth are dampened (but seldom overturned) by induced impacts explains in part the moderated and less pessimistic "revisionist" assessments of the consequences of population growth (see Footnote 2 above).

3. *The Multisector Models.* Given the problem of increasing analytical intractability as one moves beyond simple dualistic models, and the desire of government agencies to formulate population policies and provide quantitative assessments on the role of population, multisector simulation models have emerged as a major activity in economic-demographic research. Although the resulting literature is large, it has been reviewed by others so the present summary can be brief.[18]

Multisector models have primarily added complexity in the form of accounting detail. Population is broken down by age, sex, labor force participation, education, and location; production is divided into sectors, sometimes location-specific; factor inputs are disaggregated, usually highlighting demographic and skill attributes of the labor force; and demand is specified by commodity.

Three general observations are relevant to appraising the insights of these models into the impact of population. First, the analytical contributions have been modest. The models have been grounded almost entirely on the fundamental theoretical relationships highlighted in the one- and two-sector frameworks reviewed above. In fact, in most multisector models, the key qualitative predictions derive neither from the accounting detail nor from the empirical parameters, but follow directly from one or two analytical specifications. These typically emphasize areas in which population manifests a negative impact (e.g., diminishing returns) with limited or nonexistent countervailing influences. The numerical analysis serves mainly to illustrate the underlying analytic structures.[19]

Second, the empirical contributions of the multisector models have been limited. This is unfortunate because the raison

[17] The nature and strength of this relationship depend critically on the elasticity of capital-labor substitution. In a simulation of the model parameterized to correspond to the experience of Meiji Japan, a tripling of the Japanese population growth rate over a 28-year period reduced aggregate output per capita, industrial output, and urban levels by 7.7, 3.7, and 4.4 percent, respectively (Kelley and Williamson 1974, pp. 132–33).

[18] The major review is by Warren C. Sanderson (1980), who evaluates Kelley, Williamson, and Cheetham (1972), Kelley and Williamson (1974), Food and Agricultural Organization (FAO) (1976), Simon (1976), and Irma Adelman and Sherman Robinson (1978). Arthur and McNicoll (1975) review Ansley J. Coale and Edgar M. Hoover (1958), Stephen Enke (1960), U.S. Census Bureau models as summarized in Joseph E. Quinn (1975), Purdue Development Model as summarized in T. Kelley White et al. (1975), and BACHUE as summarized in René Wéry, Gerry B. Rodgers, and Michael J. D. Hopkins (1974). Simon and Herman Kahn (1984) review Council on Environmental Quality and U.S. Department of State (1980). Solow (1973) reviews Donella H. Meadows et al. (1972). Dennis A. Ahlburg (1987) reviews Robin Barlow and Gordon W. Davies (1974), Richard Anker and James C. Knowles (1983), Robert M. Schmidt (1983), and David Wheeler (1984). See also David E. Horlacher (1981) and Kelley (1974).

[19] Referring to the TEMPO models that feature Cobb-Douglas production functions, Arthur and McNicoll (1975) observe: "This central assumption has the robust property that the derivative of per capita output with respect to labor is always negative. An increase in population can therefore never pay its way" (1975, p. 257). Referring to the BACHUE-2 ILO model, Arthur and McNicoll conclude: "Demographic effects on consumption would have to be extraordinarily large to run counter to the trivial theorem determining the fertility issue: slices of the economic pie (growing virtually independently of population) would get smaller the more people to divide it" (1975, p. 258). See also Rodgers, Wéry, and Hopkins (1976).

d'être of such models is quantitative assessment; however, the paucity of Third World data required to accommodate the extensive demands for parameters and initial conditions has proved constraining. And given the size of the models, the use of sensitivity analysis to overcome data limitations has proven to be cumbersome and of limited generalizing value.

Third, a key purpose of such models—to account for the indirect effects of changes in economic and/or demographic structures—has seldom been fulfilled either analytically or empirically. While analytically a framework with considerable price endogeneity is required, the accounting detail of most models has resulted in data constraints that preclude a meaningful general-equilibrium specification.

4. *The Net Impact of Population in Models of Growth and Development.* It appears that neither formal growth theory nor the simulation models have provided a basis for making conclusive statements about the net impact of population on development although, as noted above, most economists conclude that the negative resource-shallowing impacts will dominate induced feedbacks and thus positive scale effects are required to overturn a net-negative impact assessment. Thus, as an alternative tack, it pays to return to basics: an empirical assessment of the key building blocks in the theoretical structures—for example, the impacts of population that derive from diminishing returns and scale, accumulation and saving, and technical change. We will return to these linkages below, but first we will apply the theoretical perspectives just reviewed to the evolution of population ideas over time.

B. *Overview of Ideas and Debates*

Few topics in economics have a longer tradition of controversy than the analysis of the impact of population on economic growth and development (for an early review, see Edward P. Hutchinson, 1967). The debate rose to prominence in 1798 with the publication of *An Essay on the Principle of Population*, the famous pamphlet in which the Reverend Thomas Malthus argued that food production could not keep pace with population's natural proclivity to grow in an unchecked fashion. In the absence of prudential checks, the result would be starvation, vice, and misery, and a tendency for economies to stagnate at a subsistence level of income. In one of the most famous passages in all of economics, Malthus concluded:

> Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio. A slight acquaintance with numbers will show the immensity of the first power in comparison of the second. (1798, p. 14)

His pessimistic speculations caused the discipline of economics to be dubbed the "dismal science." This label and the Malthusian perspective on population have persisted to this day despite the fact that his predictions failed to materialize for the countries he studied.[20] Contrary to expectations, agricultural productivity rose steadily and population growth slowed in those countries that entered the process of Modern Economic Growth. Food surpluses, not food shortages, turned out to be agriculture's nemesis over time. The "Malthusian Devil" of recurrent famines resulting from the unyielding influence of diminishing returns was exorcised by an expansion of the land frontier, capital intensification of agriculture, and improvements in farming technology. In the industrializing countries, concern about the adverse consequences of rapid population

[20] Although his earlier publications were more widely cited, Malthus' empirical assessments were modified in later writings (Coale 1978). Studies by economic historians have also confirmed the relevance of some Malthusian predictions on rents, wages, food prices, fertility, and mortality in England between the fourteenth and eighteenth centuries (Ronald D. Lee 1980b; World Bank 1984, p. 57).

growth subsided under the weight of these trends.[21]

Indeed, an about-face occurred in the 1930s when economists pinpointed *slow* population growth as one factor explaining the insufficient expansion of aggregate demand, and contributing to the prolongation of the Depression (John Maynard Keynes 1937; Alvin H. Hansen 1939; William B. Reddaway 1939). John R. Hicks (1939) provided one of the bolder assessments:

> One cannot repress the thought that perhaps the whole Industrial Revolution of the last two hundred years has been nothing else but a vast secular boom, largely induced by the unparalleled rise in population. (1939, p. 302n)

Apparently the negative "supply-side" effects of population emphasized by Malthus were being challenged by the positive "demand-side" effects stressed by Hanson and other "stagnationists." This challenge was short-lived.[22]

The 1960s and 1970s saw the pendulum of opinion swing decisively back to an emphasis on the negative supply-side impacts of population. This reorientation was spurred by several developments: the unprecedented rates of population growth in the Third World; the judgment that a deficiency of aggregate demand was not important in accounting for development trends in the LDCs; and the promotion and implementation of birth-control policies and programs by governmental agencies, notably the U.S. Agency for International Development, and the United Nations Fund for Population Activities. There was also a substantial broadening and strengthening of the intellectual foundations of the pessimistic evaluation of the impacts of population growth with the appearance of two quite separate strands of thinking.

The first strand not only revived the Malthusian notion of diminishing returns resulting from scarce farmland but also applied this framework to a host of renewable and nonrenewable resources. Representative of this literature were the studies by Jay Forrester (1971) in *World Dynamics*, and Meadows et al. (1972) in *The Limits to Growth*, which predicted that the world had only about 100 years remaining before economies and/or biosystems collapsed. Central to this scenario were the adverse consequences of population growth pressing against the land, natural resources, energy, and the environment (see also Council on Environmental Quality and U.S. Department of State 1980). Even though economists severely criticized these studies for failing to model market- and politically induced feedbacks realistically, never since the early nineteenth century have Malthusian concerns exercised greater popularity (Simon and Kahn 1984).[23] Seldom have the consequences of a powerful economic idea—the law of diminishing returns—been applied more broadly and embraced with greater conviction.

The second strand of thinking related to an assessment of population's impact on the pace and composition of saving and investment. This emphasis coincided with the prominence attributed to capital in development models and the popularity of the neoclassical paradigm. The pioneering for-

[21] A history and appraisal of Malthus' contributions are provided by Joseph J. Spengler (1945a, 1945b), Keyfitz (1972), and Coale (1978).

[22] Stagnationist arguments have recently been applied to the current situation of slow population growth rates in the developed countries (Ben J. Wattenberg 1987).

[23] Referring to the Forrester-Meadows model, Solow (1973) points out that ". . . the characteristic conclusion . . . is very near the surface. The basic assumptions are that stocks . . . are finite, that the world economy tends to consume the stock at an increasing rate, . . . and that there are no built-in mechanisms by which approaching exhaustion tends to turn off consumption gradually and in advance. You hardly need a giant computer to tell you that a system with those behavior rules is going to bounce off its ceiling and collapse" (1973, p. 43).

mulation was by Coale and Hoover (1958) in *Population Growth and Economic Development in Low Income Countries*, which identified three adverse effects of population growth:

> *Capital-Shallowing Effect.* Rapid population growth lowers the ratio of capital to labor because there is nothing about population growth per se that increases the rate of saving.
>
> *Age-Dependency Effect.* Rapid population growth results in high "youth-dependency," which increases requirements for household consumption at the expense of saving, and lowers the saving rate.
>
> *Investment-Diversion Effect.* Rapid population growth shifts (mainly) government spending into areas such as health and education at the expense of more productive, growth-oriented investments.

These hypotheses had a strong impact on the analysis of economic-demographic relationships and even U.S. population policy. Indeed, political scientist and policy analyst Phyllis T. Piotrow (1973) observed that the Coale-Hoover thesis ". . . eventually provided the justification for birth control as a part of U.S. foreign policy" (1973, p. 15). Moreover, many of the early simulation models relied upon the Coale-Hoover ideas as the primary linkages between population growth and the economy (Barlow 1967; Enke 1971; William E. McFarland, James P. Bennett, and Richard A. Brown 1973; Frank T. Denton and Byron G. Spencer 1973, 1976; and Barlow and Davies 1974).

It is important to recognize that while these ideas, which stressed the adverse consequences of population growth, dominated academic writing and served as the intellectual foundations of the debates about the effects of population in the 1960s and 1970s, some scholars were offering a somewhat more guarded assessment.[24] A large body of empirical research was also accumulating during this period. Some economists cautioned that the *strength* of the conclusions concerning the negative consequences of population growth were not buttressed by the evidence (especially that relating to saving and investment). They added that some possible positive impacts (notably increasing returns to scale and induced technical change in agriculture, at least in some settings) were being overlooked or downplayed. But this literature attracted relatively little attention. (An examination of the conditions under which such scale and technological benefits of population may be realized is taken up in Sections IV and VI.)

The 1980s saw the population-assessment pendulum swing again, this time toward the more eclectic, and somewhat less pessimistic revisionist interpretation adumbrated in the introduction to this article. Several developments contributed to this reorientation. The first was the accumulation of a large volume of empirical research that suggested (1) the possibility that population-induced technical change (largely in agriculture) could reduce or offset the effects of diminishing returns; (2) the capacity of individuals and firms to respond quite flexibly to resource scarcity and changing factor supplies; and (3) the apparent unimportance of some of the hypothesized Coale-Hoover effects. The second development was a changed political climate—a return to traditionalist views about the family, and challenges to government's family-planning policies, especially those relating to abortion—which was more conducive to an evaluation and airing

[24] Albert O. Hirschman (1958), Kuznets (1960, 1967), Ester Boserup (1965, 1981), Colin Clark (1967), Richard A. Easterlin (1967), Harvey Leibenstein (1971, 1976), Kelley (1974), Robert H. Cassen (1976, 1978), Simon (1977), and Peter T. Bauer (1981) all pointed out potentially important positive as well as negative impacts of population growth.

of the accumulating research that roughly quantified a wide range of linkages between population and the economy.

The third event was the publication of Julian L. Simon's book, *The Ultimate Resource* (1981), which advanced the controversial conclusion that population growth in the long run could actually enhance the pace of economic growth in the Third World. While virtually alone in its optimism, Simon's book, written for a general audience,[25] generated heated debate. It was considered by some to represent a threat to by now well-established and intellectually grounded family-planning policies, and further stimulated empirical research on the consequences of population growth.

The timing of the present review may be opportune because the pendulum of scholarly opinion has swung toward a more centrist (or possibly a less pessimistic) position than at any other time in recent decades.[26] This environment facilitates a balanced review of a wide literature and affords an opportunity to point out some gaps in knowledge at a time when the research agendas are being formulated for the next round in the debate.

III. *The Evidence: A First Pass*

While several models predict a negative net impact of population growth on economic development, it is intriguing that the empirical evidence documenting this outcome is weak or nonexistent. The typical empirical study examines correlations between per capita output growth and population growth, sometimes measuring the sensitivity of the results to various data samplings over time and/or space (for example, Easterlin 1967; Kuznets 1967; Anthony Thirlwall 1972; John Isbister 1975; Tim Hazeldine and R. Scott Moreland 1977; Simon 1977; Mark Browning 1982). Figure 2 provides a representative set of results.

On the one hand, there has been a tendency to discount these reduced-form, bivariate correlations as simplistic and difficult to interpret. It is argued that causation is not revealed, and institutional variations among countries may mask the relationships. On the other hand, it has also been argued that few if any statistical associations establish causation; the cross-country results are consistent with the few studies using time-series data; a zero correlation in the face of strong (negative) priors merits attention; and the positive and negative effects of population growth may offset each other.

A more important difficulty in interpreting Figure 2 is the presence of simultaneous equation bias because population growth is influenced by income growth. This relationship is widely discussed in the historical literature on the Demographic Transition. Lee (1983) has discounted the importance of this reverse-causation bias by suggesting that, as a first approximation, one would expect population growth to be more related to the level than to the rate of growth of income. His hypothesis seems quite reasonable with respect to explaining birth rate changes, and Preston (1980, 1986) finds that only 30 percent of the reductions in death rates over the period 1930 to 1970 are associated with improvements in income per capita and economic development, although these factors increased in importance in the 1970s. Preston observes that because mortality reductions have affected about equally the

[25] The book was based on his extensive technical writings (e.g., Simon 1977).

[26] This position is best represented by a recent report of the National Research Council (1986) which makes no quantitative statements on the magnitude of population's net impact on development. The report (1) notes that the impact is likely negative in most cases, (2) highlights several positive impacts, and (3) provides some documentation suggesting the importance of market-induced feedbacks that have weakened the strength of previously hypothesized negative linkages between rapid population growth and the economy.

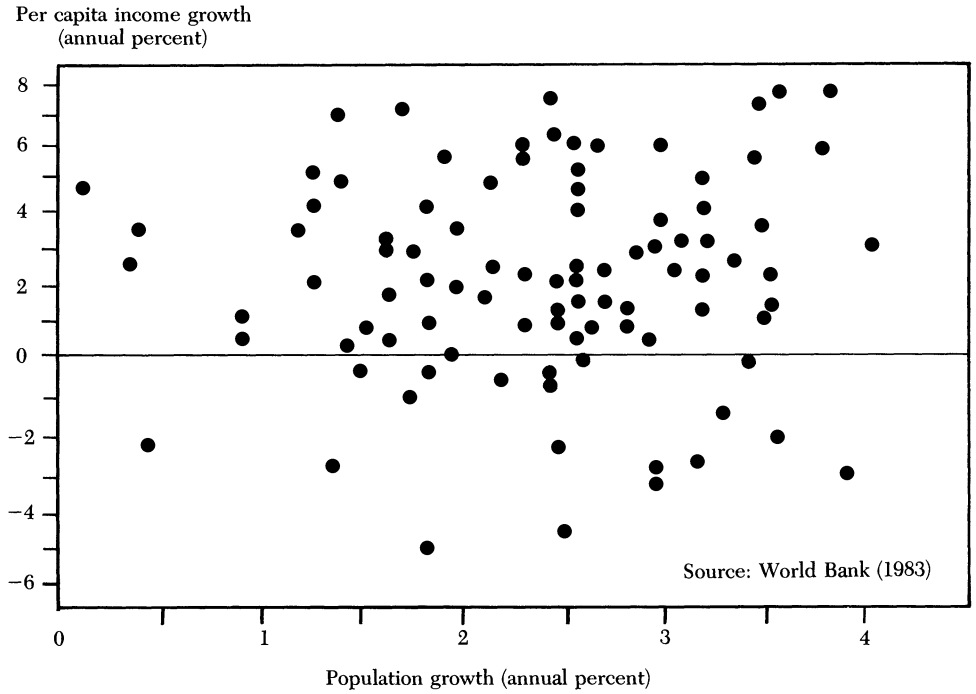

Figure 2. Income per Capita Growth and Population Growth, Developing Countries, 1970–81

growth rates of the working and nonworking populations, whose impacts on income per capita growth are in opposite directions, a lack of correlation between income per capita and population growth in the aggregate is not surprising. At any rate, Lee's summary evaluation of this literature is instructive and provocative:

> . . . these cross-national studies have not provided what we might hope for: a rough and stylized depiction of the consequences of rapid population growth: unless, indeed, the absence of significant results is itself the result. (1983, p. 54)

My own judgment, confirmed by the wide-ranging nature of the debate, is that these statistical correlations provide little prima facie information about the size or nature of the net impact of population growth on economic growth; however, they have attracted considerable notice and, as such, merit attention. They have also encouraged empirical studies that attempt to isolate and measure population-development linkages, a literature to which I now turn.

IV. *Economies of Scale*

An evaluation of scale effects of population size is complex because these effects originate from different sources and are exceptionally difficult to quantify. The narrowest point of reference focuses on *within*-firm variations in productivity when all factors of production change proportionally. It is usually acknowledged that with the exception of a few industries, most technical economies are exhausted by firms of moderate size (E. A. G. Robinson 1960). In a broader framework, scale economies emanate from indivisibilities in lumpy investments, including roads, communications, research and development, and markets. These economies can be quite

important, especially in agriculture (Boserup 1981). In a still broader framework, scale economies derive from increased specialization and diversification *between* firms.[27] According to George J. Stigler (1961):

> The large economy can practice specialization in innumerable ways not open to the small (closed) economy. The labor force can specialize in more sharply defined functions. . . . The business sector can have enterprises specializing in . . . repairing old machinery, in printing calendars. . . . The transport system can be large enough to allow innumerable specialized forms of transport. . . . (1961, p. 61)

A critical qualification in Stigler's analysis is the assumption of a *closed* economy because many of the benefits of specialization in tradeables can be obtained through international trade. Moreover, even in a closed economy, market size is only partially and sometimes indirectly influenced by population size. For example, market size can be expanded by linking regional centers with improved transport, although the economic viability of investments in transport may itself be related to population size and density.[28] And some of the advantages of scale can be obtained by population concentrations as distinct from larger national populations.

[27] For an alternative classification, see Allyn A. Young (1928).

[28] Donald R. Glover and Simon (1975) use cross-national data for 113 countries for 1968, and time-series data for 64 countries for the period 1957–68, to compute a strong elasticity of roads per area with respect to population density after controlling for per capita income. The results are invariant to level of development as measured by countries grouped by per capita income, and by type of road (paved or unpaved), although the estimated elasticities are higher for paved roads. Possible problems of interpretation arising from population moving to areas well served by roads are considered minimal given the relative unimportance of international migration. While data on roads are fraught with measurement problems, there appears to be no reason to believe that these errors are correlated with the population-density variable.

Most analyses of scale economies have been directed to currently developed economies, where the positive effects of scale are often highlighted.[29] In a discussion of U.S. economic growth over the period 1869–1953, Moses Abramovitz notes:

> "the division of labor is limited by the extent of the market." If there is anything to the notion that when raw materials are plentiful, resources and output will be connected according to the law of increasing returns to scale, then the great expansion of total resources must have contributed substantially to the increase in productivity. (1956, p. 12)

And Denison (1962) offers a quantitative speculation:

> Economies of scale two or three times enough to offset the 'drag' of land should not strike economists as unreasonable. (1962, p. 175)

These studies, referring to a sparsely populated area with resource abundance, stressed that the ability to capture scale effects is related to the capability of utilizing scale-dependent modern technologies, and to the availability of capital and a favorable institutional environment. Such qualifications are critical to assessing the relevance of the historical experience of the developed countries to the Third World where such preconditions are in general less favorable.

Have Third World nations benefited from scale effects of larger populations? The answer depends on the source of the effect. With respect to within-firm scale economies, the National Research Council (1986) concludes that the advantages of population size do not appear to be especially large in Third World manufacturing—or at least not as large as in the agri-

[29] In a cross-sectional study of manufacturing which controls for per capita income, Hollis B. Chenery (1960) estimates the partial elasticity of output with respect to population to be .20. See also Chenery and Moises Syrquin (1975).

cultural sector, because "localized" scale economies are more sensitive to the concentration than to the size of the population (J. Vernon Henderson 1987 and Jeffrey James 1987).[30]

Other reasons for discounting the importance of scale economies in the Third World have been advanced. First, economies in infrastructure are judged to be substantially exhausted in cities of moderate size. Second, as noted above, specialization through international trade provides a means of garnering some or many of the benefits of size. And third, scale effects are most prevalent in industries with relatively high capital/labor ratios and such industries are inappropriate to the factor proportions of developing countries. Having said this, it is important to recognize that inward-looking, import-substitution trade strategies are common in the Third World (Anne O. Krueger 1978, 1983). As a result, *given* these policies, an expanded national market and population are conducive to capturing economies of scale, albeit at some cost (Tibor Scitovsky 1960). This development, if it occurs, conveys benefits through reducing the adverse consequences of a harmful trade policy.[31]

It is in agriculture where the positive benefits of population size have been most discussed. Higher population densities can decrease per unit costs and increase the efficiency of transportation, irrigation, extension services, markets, and communications (Simon 1975; Glover and Simon 1975; Boserup 1981).[32] These economies may be substantial where modern agricultural technologies require large infrastructural investments (Boserup 1981, ch. 16; Prabhu L. Pingali and Hans P. Binswanger 1984; Hayami and Ruttan 1985). Moreover, because the adaptation of new technologies may be specific to small agroclimatic areas, economies are realized by spreading research costs over larger outputs.[33]

The real issue, then, is not the existence of scale economies, but rather their quantitative importance over varying ranges of population sizes, as well as the conditions under which they may occur. On the one hand, while scale economies deriving from high population densities may have accounted for a portion of expanded agricultural output in recent decades, in several important Asian countries these densities were sufficiently high decades ago to justify the investments associated with the new technologies. In such cases, one must be cautious in attributing positive scale effects largely to increased population numbers. On the other hand, in some countries increased population numbers may well have made investments associated with the new technologies economically attractive. Unfortunately, empirical studies that provide quantitative precision to the interactions between population size and scale are unavailable.

Boserup (1981) appears less sanguine about the benefits of population size in the intermediate future because densities appropriate to modern technologies in Asia are three to four times the average for Africa and Latin America. She notes that:

> . . . except for areas with much more than average density, establishment of efficient extension networks would require large and probably uneconomic investments in rural roads. (1981, p. 204)

[30] Limited empirical evidence suggests that the rate of technical change in manufacturing (measured by industrial labor productivity growth) may be uninfluenced by population density and growth (James 1987).

[31] This point is consistent with the World Bank (1984) report on population that observes ". . . countries such as India and China can seem to benefit from the sheer size of their domestic markets" (p. 79).

[32] Robert E. Evenson (1984a) finds some negative effects.

[33] Compare Evenson (1984b) and Binswanger and Pingali (1984) for contrasting views.

(Of course, roads serve many important functions in rural production in addition to their interactions with extension activities.) Moreover, even in areas where densities are not limiting, it is frequently found that institutional conditions—such as land ownership patterns, poorly developed capital markets, and government policies—restrict the exploitation of technologies embodying positive scale effects. It is probably the differences between institutional conditions that most differentiate the putative favorable historical experience with scale effects in some developed countries with the apparently less favorable experience in many Third World nations.

Summary assessments of scale effects attributable to population size can only be impressionistic. I am inclined to attribute a qualified role to these effects in accounting for Third World development. First, the performance in Asian agriculture, the source of employment for the majority of the Third World labor force, has been impressive. "Green Revolution" technologies would not have conveyed the same advantages in sparsely settled regions; however, only a part of these scale-economy benefits can be attributed to larger population numbers. Second, the lower densities in many non-Asian countries reduce the potential for taking advantage of similar scale-dependent technologies in the intermediate future. (This situation will change in the long run when larger population sizes may convey some benefits.) Third, scale economies of the type Stigler describes, while never quantified, cannot but help to contribute positively to growth. While these division-of-labor/specialization effects may now be substantially exhausted in the larger and more densely populated Third World countries, in the future, as these countries continue to develop, additional advanced, scale-dependent technologies may be open to them; however, the benefits to the smaller and more sparsely populated countries may still lie in the future and take the form of minimizing the adverse consequences of inward-looking trade policies currently popular in the Third World.

V. *Saving and Capital Formation*

In the postwar period the evaluation of the impacts of population growth on the pace and form of saving and capital formation has centered on capital shallowing, age dependency, and investment diversion (Coale and Hoover 1958).[34] This section examines the theoretical basis of these linkages and their empirical importance in the Third World.

A. *Capital Shallowing*

As noted in Section II.A, in the simple neoclassical model population growth exerts no impact on per capita output growth in the long run, although in the short to intermediate run (which may be decades) the impact through capital shallowing is negative, and in the long run, the level of per capita output is adversely affected.

While the quantitative importance of these impacts is difficult to assess, a rough approximation can be obtained by using the simple neoclassical growth model. For example, the National Research Council's (1986) illustrative calculation reveals an increase in the long-run level of per capita output of only 13 percent as a result of a reduction of population growth from 3 to 1 percent.[35] Several of the sources-of-

[34] An early analysis of these relationships is found in Demeny (1965, 1967). See also Kelley (1973, 1988) and Jeffrey S. Hammer (1984).

[35] The calculation assumes labor-augmenting technological progress at 2 percent annually, depreciation at 3 percent annually, and a constant-return-to-scale Cobb-Douglas production function with a capital coefficient of .3 and a labor coefficient of .7. The economy takes 15 years to adjust halfway to the new steady-state capital/labor ratio. A variant with saving adjusting optimally (i.e., to maximize consumption) en route to steady state would mitigate the adverse effects of rapid population growth. See also Michael C. Keeley (1976) and Srinivasan (1988b).

growth studies also suggest a relatively modest role for capital, although the results are sensitive both to the measurement of capital and to the period of evaluation. Thus, while in Denison's (1974) calculations for the U.S. from 1948 to 1969, capital accounts for 20 percent of the growth in national income per person employed, the estimate by Barbara M. Fraumeni and Jorgenson (1981) places the figure at 42 percent. The higher estimate is based on the use of gross versus net weights, plus an adjustment for capital "quality" (especially the relative growth of short-lived capital in the U.S.).[36]

In general, although the capital-shallowing effects of population growth are unfavorable, their quantitative importance appears to be modest unless the output elasticity with respect to capital is considerably higher than that typically assumed in simple applications with growth-theoretic models, or estimated in many sources-of-growth studies, although there is considerable variance around these estimates; however, the latter apply to developed countries, and capital may be more important in the Third World, thereby aggravating the capital-shallowing impacts of population growth.

B. *Saving*

1. *Age-Dependency Formulation.* The literature on population/saving rate linkages has focused almost exclusively on the household sector.[37] In its usual form, the age-dependency linkage (a narrow version of the life-cycle model) recognizes that an additional child has an incremental claim on household consumption, and asserts that this claim is a drain on household saving. Empirical representations of this thesis have typically specified an "adult equivalency" measure whereby each child's consumption is taken as a *fixed* proportion of an adult's. The problem with this formulation is that it is too narrow. Families may be so poor that they accumulate little or nothing; the options for financing additional children are therefore severely constrained—children must be financed out of household consumption. Moreover, the impact of children on the household can be quite complex because children may (1) substitute for other forms of consumption (which may adversely affect labor productivity), (2) contribute directly to household market and nonmarket income, (3) encourage parents to work more (or less), (4) stimulate the amassing (or reduction) of estates, and (5) encourage (or discourage) the accumulation of certain types of assets (e.g., education, or farm implements). The impact of expanded family size on household saving can therefore be negative, negligible, or positive; the issue is an empirical one. Unfortunately, there are few microeconomic studies that explore these relationships using data from developing countries.[38]

2. *Life-Cycle Formulation.* The life-cycle model broadens the analysis of household budgeting beyond the narrow age-dependency formulations, concerned with the costs of raising a family, to the need to save for retirement (Franco Modigliani and Richard Brumberg 1954; Modigliani and Albert K. Ando 1957; Tobin 1967; Ar-

[36] If one considers a longer period from 1929 to 1969, Denison's calculations show a capital contribution to per capita income of 11 percent; however, this low figure, cited by the National Research Council (1986, p. 41) appears atypical because over the period 1929–48, the growth of capital per person employed was estimated to be negative.

[37] Hypotheses relating to the impact of demographic factors on government saving are found in Nathaniel H. Leff (1969), and on business saving in Richard E. Bilsborrow (1979, 1980).

[38] One study using Kenyan data appears to show children as having a negligible impact on household saving when the induced impact of children on all sources of household income is taken into account (Kelley 1980). A study of U.S. nineteenth-century laborers in the iron, steel, glass, and textile industries suggests similar results (Kelley 1976a).

thur and McNicoll 1978).[39] At the aggregate level there are two separate effects of population growth on saving: a positive "rate-of-growth effect" resulting from a higher proportion of young workers (savers) to retirees (dissavers), and a negative "dependency effect" resulting from the need to support an increasing number of children. The net impact depends on which effect dominates, and this is an empirical matter about which there is little direct evidence.[40]

The relevance of the life-cycle formulation to the low-income setting has been challenged on the ground that credit markets may not be well equipped to facilitate the smoothing of consumption across time. However, such an institutional constraint may affect more the form of life-cycle planning than its relevance. In particular, resource transfers through the extended family may play a role in retirement planning (Laurence Kotlikoff and Avia Spivak 1981), and children may represent a form of "investment" for retirement. One should recognize, however, that while to the *household* children may represent an investment, in *society* they compete with other forms of retirement assets that could augment capital per worker. Children as pension assets are partially a consequence of financial-market failure, and as such, may dampen per capita output growth.[41]

3. *Distribution-of-Income Formulation.* The impact of population growth on the distribution of income and thus on saving represents a potentially important linkage. Several development models have hypothesized, and empirical studies confirmed, that saving rates vary by level of income, and possibly by income source.[42] Because rapid population growth raises the level of population, vis-à-vis complementary factors, ceteris paribus, and thus the relative return to nonwage income (whose recipients may on average have higher overall income and correspondingly higher saving rates), it can also exert a positive impact on saving. (Of course, this effect must be qualified by the impact of population growth on the average level of income.)

4. *Empirical Analyses of Economy-Wide Saving.* Theory alone cannot predict even the direction of the impact of population growth on saving; the final arbiter must rest in the data. Indirect linkages of population growth with business and government saving complicate the analysis further, primarily because it is generally agreed that there is considerable substitution between

[39] The life-cycle model has been extended and evaluated by Andrew Mason (1981, 1987) to take account of systematic impacts of children on household income; and by Lee (1980a) to account for differing family types and income-earnings profiles.

[40] Frank D. Lewis (1983) concludes that about one-quarter of the increase in nineteenth century U.S. saving was due to age-distributional changes. In another study using LDC data, Kelley (1973) combines estimates of differential savings impacts by cohort with information on changing cohort size associated with alternative population growth rates. Because in this study the dissaving impact of the aged cohort (through retirement) exceeds that of youth cohort (through child maintenance), a reduction in population growth that shifts the composition of the dependent population toward the aged reduces aggregate saving. These results must be qualified by the fact that some of the financing of youth dependency is done through nonmarket allocations within the family, and does not enter into national accounts that measure the impacts of age on saving.

[41] The role of children as pension assets has been emphasized by Mead Cain (1983), Peter H. Lindert (1983), Jeffrey Nugent, K. Kan, and R. J. Walther (1983), and Srinivasan (1988a). In an interesting historical application, Williamson (1985) observes that nineteenth century English emigration increased the "default risk" of children as pension assets, which had a dampening impact on household fertility.

[42] The W. Arthur Lewis (1954), Fei and Ranis (1964), and Kelley, Williamson, and Cheetham (1972) formulations represent examples. In practice, income-source distinctions can be blurred in the Third World setting, and particularly in peasant agriculture. Empirical studies of saving rates by income source include Kelley and Williamson (1968), Williamson (1968), and Surjit Bhalla (1978). Studies showing saving rates rising with income include Luis Landau (1971) and Bhalla (1980), and those linking increased income inequality with rapid population growth include Kuznets (1976, 1980) and C. R. Winegarden (1978). For a general survey of saving, see Raymond F. Mikesell and James E. Zinser (1973).

forms of saving for the economy as a whole. This provides some justification for focusing on aggregate saving in the empirical analysis.[43]

Empirical studies typically use cross-country data to isolate age-dependency effects on economy-wide saving. The most popular model explains the domestic saving rate by (1) income per capita (in U.S. dollars using exchange rates for conversions), (2) growth of real income per capita (as one proxy for life-cycle influences), and (3) the dependency rate (the share of the dependent population—youth, aged, or both—to the total).

The pioneering study by Leff (1969), which found that youth, aged, and total dependency exerted a negative impact on saving, generated considerable debate centering largely on econometric and methodological issues (Nassau A. Adams 1971; Leff 1971, 1973, 1980; Arthur Goldberger 1973; Bilsborrow 1979, 1980). Numerous replications of the Leff model using alternative country samples, years, data definitions, data aggregations, and econometric procedures have generally failed to uncover notable dependency effects. Statistically significant results (positive or negative), when found, are often weak.[44] In short, the evidence does not support the hypothesis of a quantitatively important negative impact of population growth (through age-dependency effects) on saving.

This conclusion, now widely held, merits qualification.[45] First, the empirical evidence is not particularly strong, resting as it does on international cross-country data. The results are sensitive to country selection, year of study, data aggregation, functional form, treatment of statistical issues such as heteroscedasticity, and official exchange-rate conversions.[46] Second, the financial saving variable omits in-kind saving/investments in agriculture which may be influenced by population pressures.[47] Third, if foreign capital inflows are responsive either to domestic interest rates or to demographic change, then an expanded model taking such impacts into account is required.

Finally, if the concept of saving is broadened to include the financing of investments in human as well as in physical capital, age-dependency impacts of rapid population growth may emerge. For example, Ram and Theodore W. Schultz (1979) have pointed out that a reduction in infant

[43] Studies of the interdependency of savings by source include Modigliani (1970), Paul David and John Scadding (1974), and Sateesh K. Singh (1975).

[44] These results are reviewed by Jeffrey S. Hammer (1984). See Adams (1971), Kanhaya Gupta (1971, 1975), Singh (1975), Leff and Kazuo Sato (1975), Philip Musgrove (1978), Bilsborrow (1979, 1980), Rati Ram (1982), and Kelley (1988).

[45] With respect to the age-dependency effect, the *World Development Report* concludes: "Recent empirical studies find only minor support for this view" (World Bank 1984, p. 82). Timothy King (1985) concurs: "In the litany of antinatalist argument, however, this one bears little weight. . . . most modern theories suggest that the proportion of children in the population is not very important" (1985, p. 4). Hammer's review of the literature (1984) concludes: "While there is much evidence to indicate that these two aspects of development [population and saving] are intertwined in many ways, no simple generalizations are justified" (1984, p. 3). See also McNicoll (1984), Kelley (1985), National Research Council (1986), and Nancy Birdsall (1988).

[46] Robert Summers and Alan Heston (1984) discuss the difficulties in using official exchange rates in making comparisons of income across countries. Investment, and thus saving which is computed as a residual, may also be poorly measured by internal price deflators. (Gross domestic saving is computed as the difference between gross capital formation and current account deficits.) The real value of investment is understated because producer durables are relatively expensive in the price structure of the typical low-income country. According to Irving B. Kravis (1986), this measurement bias implies that "developing countries spend a relatively large part of their incomes on producer durables, but do not get as much as appears for what they spend" (p. 15).

[47] Based on a sample of 48 countries for 1965, Simon (1975) finds that cross-country variations in the proportion of cultivated land that is irrigated is strongly related to population density, after controlling for the level of per capita income. Possible problems of interpretation arising from population moving to irrigated areas are considered minimal given the unimportance of international migration.

and child mortality rates increases the return on investing in human capital. Because expenditures on human capital bulk high in a broad measurement of asset accumulation, increased population growth, which in part results from mortality reduction, could increase total (but not necessarily per capita) savings/investments; however, Preston (1980) has used a series of hypothetical examples to illustrate the hypothesis that mortality reductions of the type experienced in the Third World exert a relatively small impact on the present value of human capital investments. At any rate, given the likely importance of children as a form of savings/investment in the Third World, additional evidence will be required to gauge the impacts of family size on the allocation of household accumulation of human and physical capital. At an economy-wide level, this analysis has taken the form of assessing the impact of population growth on the composition of investment.[48]

C. *Composition of Investment*

In several economic-demographic models rapid population growth is assumed to shift (mainly governmental) spending away from growth-enhancing forms such as physical-capital investment, and toward allegedly less- or nonproductive forms such as schooling.[49] This "investment-diversion" hypothesis has been challenged by an accumulating empirical literature.

The most detailed study of government spending on schooling is by T. Paul Schultz (1987), who examines the experience of 89 countries over the period 1969–80. He presents a puzzle. On the one hand, Third World countries have not only kept pace in providing educational services to increasing numbers of youths, but substantial human-capital deepening has taken place. Among the low-income countries in Schultz' sample, enrollment rates and average years of schooling completed per pupil have about doubled; and among the middle-income countries, these statistics rose significantly as well. On the other hand, this accomplishment was accompanied by a significant reduction in per pupil costs in the low-income countries, although in the middle-income countries, these costs increased. Surprisingly, demographic change appeared to be relatively unimportant in explaining enrollment rates, although Schultz emphasizes that expenditures per pupil are negatively related to enlarged school-age cohorts. Additionally, the relative size of the school-age population exerted no independent effect on the shares of GNP expended on education, causing Schultz to observe:

> This finding challenges the working assumption of Coale and Hoover (1958) that linked population growth to the share of income allocated by poor countries to "less productive" expenditures on education and social welfare programs. (1987, pp. 458–59)

Instead, increases in enrollment rates were financed by rising incomes per capita and, to an important extent (in the group of low-income countries), by a reduction in costs per pupil. These cost reductions were due partly to small increases in student-to-teacher ratios, but mainly to a relative decline in teachers' salaries, especially in cities. While a reduction in the quality of schooling probably occurred, the magnitude of this impact is qualified. Schultz speculates that the downward pressure on

[48] Studies using U.S. data suggest that saving is influenced more by the timing of children than by their age and/or number (Thomas J. Espenshade 1975; James Smith and Michael Ward 1980), and that the relationship in family size may be nonlinear and, in particular, that a negative impact on saving is found mainly for smaller families (W. Eizenga 1961).

[49] In most models, spending on education is classified as consumption (Coale and Hoover 1958; McFarland, Bennett, and Brown 1973; Rodgers, Hopkins, and Wéry 1978; Anker and Knowles 1983). The *World Development Report 1984* presents a variant of the investment-diversion hypothesis, speculating that the schooling requirements of an expanding population (capital widening) diverts resources from quality improvements (capital deepening) in education (World Bank 1984, p. 85). See also Gavin W. Jones (1971, 1975, 1976).

teachers' salaries may have been influenced by compensating amenities of urban areas that teachers valued, including the availability of part-time employment, by an expansion of the supply of teachers, and possibly by a deterioration in teacher quality.[50] Moreover, among middle-income countries, costs per pupil actually increased on average.

While these results are consistent with the findings of other studies, they should still be considered as preliminary (as Schultz cautions).[51] The various empirical studies are few in number and are based on international cross-country data subject to many of the difficulties discussed above (in Section V.B.4). Moreover, pupil outputs (e.g., achievement) are approximated by inputs (e.g., enrollments), and the data fail to account adequately for state and local, and especially private, spending on education. Finally, the explanation of changes in costs per pupil, and how these relate to the quality of education, requires additional elaboration.

Where does this leave us? Unfortunately with an inconclusive assessment which, in an area dominated by strong opinions, may itself represent an interesting finding. While the investment-diversion formulation has not been confirmed empirically, the challenge to this interpretation must still be considered as suggestive. Surely some investment diversion took place, but such a mechanism for financing schooling in response to population pressures has been neither the exclusive nor even the most important response. Governments, like households, face many alternatives in adjusting to demographic change.

The results showing substantial improvements in enrollment rates and average years completed per pupil also raise a fundamental issue concerning the impact of demographic change on capital formation. In particular, the classification of spending on items such as schooling as "unproductive" and spending on physical capital as "productive" is inappropriate because it downplays the value of literacy, numeracy, and other school-acquired skills as determinants of income growth. Both the relative and the absolute returns to investing in human capital are likely to be modified by rapid population growth. For example, schooling is relatively labor intensive in production; moreover, the economy-wide average teacher salary is likely to be influenced by the rate of turnover of the teacher workforce. These types of impacts are seldom explored; however, the evidence presented above suggests that rapid population growth sets in motion forces that can modify the findings of simple models highlighting investment diversion.

D. *Summary*

The capital-shallowing impacts of population growth have adversely influenced the pace of economic development in the Third World. While difficult to quantify, these impacts are considered by some researchers to be modest in size. The hypothesis of an adverse impact of age dependency on saving rates has not been generally supported in empirical studies, although one cannot be overly confident of the results because they rely primarily

[50] Such a reduction in relative teacher salary rates may also be due to the rapid infusion of less-expensive and -experienced teachers. Manuel Zymelman (1982, 1985) found this impact to be important in 15 developing countries in the 1970s.

[51] Three additional studies downplay the importance of population pressures in explaining shifts in the composition of spending on education. In a study of 40 LDCs for 1970, Simon and Adam M. Pilarski (1979) provide results suggesting that the proportion of school-age children in the population, as well as the fertility rate, had no independent effect on primary enrollment rates or expenditures per child, although secondary enrollment rates were adversely affected. In a cross-country study of 1977 government expenditure patterns, Alan A. Tait and Peter S. Heller (1982) uncovered no statistically significant impacts of youth dependency on the composition of government spending (excepting defense, but including education). In a cross-country study of 1961–63 data, Kelley's (1976b) findings suggest that aggregate government spending shares are relatively insensitive to the youth dependency rate. See also Bilsborrow (1978), Hiroshi Miyashita et al. (1982), and T. J. Meeks (1982).

on cross-country data. A similar qualification applies to studies suggesting that population growth has been relatively unimportant in shifting spending away from physical-capital investments and toward expenditures on, say, education. Here, however, the record of human capital deepening has been impressive.

VI. *Diminishing Returns and Technology in Agriculture*

The linkages between population size and growth, and labor productivity in agriculture, are particularly important because the substantial majority of the labor force in the Third World, especially in Africa, India, and China, derives its living from the land.

The basic theoretical relationships are straightforward. Diminishing returns to labor due to a limited supply of land reduces labor productivity. While this reduction can be offset by altering technology, expanding the amount and/or quality of land or other factors, and realizing economies of scale internal, and still more important, external to the farm (e.g., economies in transportation), the key issue is whether and by how much such offsets respond to population size and growth (Boserup 1965, 1981; Simon 1975; J. Dirck Stryker 1976; William A. Darity, Jr. 1980; Simon and Steinmann 1981; Frederic L. Pryor and Stephen B. Maurer 1982; Lee 1984; Warren Robinson and Wayne Schutjer 1984; Vernon W. Ruttan and Yujiro Hayami 1984; and Hayami and Ruttan 1985, 1987). The theoretical relationships are diverse, and consequently the net impact of population change on agricultural productivity can be determined only empirically.

A. *Trends in Food Production and Consumption*

Worldwide, over long spans of time, and over recent decades, diminishing returns have been more than offset by countervailing forces.[52] Per capita food production has risen fairly steadily, although there is considerable variation by region. As seen in Table 2, over the 1970s per capita production rose by a modest 0.4 percent per year, expanding most rapidly in the middle-income developing countries (0.9 percent) and in Southeast Asia (1.4 percent), and actually declining for a sizable group of relatively low-income countries (−.3 percent per year), especially in sub-Saharan Africa. The overall production situation appears to have been mildly positive; sub-Saharan Africa represents an important exception.

The food consumption situation is more difficult to evaluate. On the one hand, the price per calorie of foodgrains has declined, and *improvements* in consumption per capita have surpassed those in production (Johnson 1985). This is because world trade in foodgrains has increased greatly with food moving from the agricultural-surplus developed nations to the agricultural-deficit developing nations.[53] On the other hand, the *levels* of per capita consumption are inadequate for large numbers of people, affecting their well-being and productivity.[54] The causes of malnutrition are varied, although food impoverishment

[52] For an historical review, see Lee (1980b). For the Third World, see FAO (1981, 1983), John W. Mellor and Bruce F. Johnston (1984), and D. Gale Johnson (1985).

[53] Staple food imports, constituting 1.5 percent of Third World consumption in the mid-1950s, rose to 5 percent in the mid-1970s, and have been projected to be 8.5 percent in the year 2000 (Mellor and Johnston 1984, pp. 536–38). These projections may be modified by countries striving for food self-sufficiency. Wendy L. Wall notes that ". . . global grain trade . . . is down 16% thus far in the 1980s. . . . many experts now are calling the grain-trade boom of the 1970s a fluke" (1987, p. 1).

[54] Estimates of malnutrition vary widely. An upper-range estimate indicates that in 1980 730 million people consumed "insufficient calories for an active working life," and of these, some 340 million consumed "insufficient calories to prevent stunted growth and severe health risks" (World Resources Institute and International Institute for Environment and Development 1986, p. 45). Thomas Poleman (1982) and Srinivasan (1982) have identified methodological and empirical difficulties in estimating numbers of malnourished persons.

TABLE 2
GROWTH RATES OF FOOD OUTPUT BY REGION, 1960–1980
(AVERAGE ANNUAL PERCENTAGE CHANGE)

Region or Country Group	Total		Per Capita	
	1960–70	1970–80	1960–70	1970–80
Developing Countries	2.9	2.8	0.4	0.4
Low-income	2.6	2.2	0.2	−0.3
Middle-income	3.2	3.3	0.7	0.9
Africa	2.6	1.6	0.1	−1.1
Middle East	2.6	2.9	0.1	0.2
Latin America	3.6	3.3	0.1	0.6
Southeast Asia[a]	2.8	3.8	0.3	1.4
South Asia	2.6	2.2	0.1	0.0
Industrial Market Economies	2.3	2.0	1.3	1.1
World	2.7	2.3	0.8	0.5

Source: World Bank (1984, p. 90).
Note: Production data are weighted by world export unit prices. Growth rates for decades are based on midpoints of five-year averages except that 1970 is the average for 1969–71.
[a] Excludes China. Each country is alternatively classified by income level and region.

is often not the result of insufficient aggregate production, but is due to the way in which food and income are distributed.[55] The linkages between population and food thus involve primarily the impacts of demographic change on the productivity of agriculture, and on the distribution of the outputs of agriculture. Because the distributional issues have already been reviewed by Mellor and Johnston (1984), my attention will focus on ways in which population relates to agricultural production.

[55] Amartya K. Sen (1981) presents evidence suggesting that famines have been largely the result of groups of people not having an "entitlement" (income and/or government-determined claims) to food, and have sometimes occurred in the regions where there was excess production. Johnson (1984) summarizes the evidence as follows: "Most of the famines that have occurred during the past quarter-century have resulted from wars, civil strife or refusal of governments to act in time to provide famine relief. Unavailability of food is no longer an important source of famine; the famines that do occur result primarily from man's inhumanity to man, not from a hostile nature" (1984, p. 77).

B. *Sources of Expanding Agricultural Output*

1. *Expansion of the Land Frontier.* Until the middle of the twentieth century, the expansion of the land frontier constituted an important source of increased agricultural output. In recent decades output expansion has been due more to increased agricultural yields and land intensification—a rising overall resource-land ratio, often resulting in multiple cropping (Johnson 1974; Mellor and Johnston 1984). The most conspicuous example is the "Green Revolution" (Hayami and Ruttan 1984).

This switch toward land intensification is *not* the result of insufficient land worldwide, or even in the Third World. Only about half of the world's 4 billion hectares of cultivable land is in use.[56] Rather, land

[56] "Cultivable land" excludes that which is ". . . too cold, too dry, too steep, or otherwise unsuitable . . ." for agricultural production. Most unused cultivable land is presently in pasture, meadowland, or

intensification results from the fact that the bulk of the population resides in East and South Asia, where land is relatively scarce. This has encouraged the development of land-saving, labor-using technologies. Moreover, in those areas of Africa and Latin America where land is still relatively abundant, the costs of bringing land under cultivation are rising. For example, large areas are infested with insects carrying river blindness, sleeping sickness, and malaria (World Bank 1982). As a result, increasing attention is being directed toward ways of improving acreage yields because, even in many areas where there is still much unused land, such a strategy represents the most economical way of increasing agricultural output.

2. *Land Intensification and Technical Change.* Land intensification, stimulated by rising population/land ratios, has evolved slowly over long spans of time and through several stages: gathering, forest-fallow, bush-fallow, short-fallow, annual cropping, and multicropping. During most of the period preceding the Industrial Revolution when agricultural systems were evolving, population grew slowly. Because improvements in indigenous technology induced by rising population density have typically only slowed the rate of decline in labor productivity as a result of diminishing returns (Hayami and Ruttan 1987, p. 92), an increase in the use of complementary inputs and/or longer working hours has been required to raise output per worker (Boserup 1965, 1981; Lee 1980b, 1984; Pingali and Binswanger 1984, 1986, 1987). The same types of responses are occurring throughout the Third World today.[57]

Several factors have combined to alter the situation countries now face. First, the stock of remaining cultivable land is increasingly expensive to bring under production.[58] Second, population is growing much faster than in the past. Finally, rising income and population densities have encouraged the use of "packages of inputs"—improved seeds, fertilizers, pesticides, water control and irrigation, and capital—which have greatly expanded the productivity of land and labor.

As a short digression, it may be instructive to speculate on whether technological responses will be sufficient to keep pace with, or ahead of, increased population numbers in the Third World in the coming decades, and especially in sub-Saharan Africa. Studies that have focused *solely* on land, water, soil type, and technology as constraints on agricultural output suggest that Third World countries as a group have substantial capacity to increase production using "high inputs" (e.g., mechanization, modern fertilizers and seeds). Even with "moderate inputs," food surpluses would be available into the intermediate future.[59] (These estimates actually understate future agricultural potential because technologies

forest (World Resources Institute and International Institute for Environment and Development 1986, p. 44). For alternative measurements, see World Bank (1982, p. 59), and R. Dudal et al. (1982, p. 5).

[57] In a study of some 52 villages in ten countries of sub-Saharan Africa and India, Pingali and Binswanger (1984, 1986, 1987) find that farmers are moving from midslope areas into valleys, more intensive production techniques are being implemented, and increased mechanization is taking place.

[58] While marginal lands are typically of reduced quality, this has not been uniformly the case. Good land remains but is uneconomical to settle given low densities and high costs of transport and reclamation. A detailed analysis of the costs of reclaiming land in Africa and India is provided by Binswanger and Pingali (1984), Pingali and Binswanger (1984, 1986, 1987), and Subrata Ghatak and Ken Ingersent (1984).

[59] With high inputs, the Third World could feed several times its population, and selected countries like India and Zaire could produce substantial surpluses. To estimate Population Carrying Capacity (PCC), a climate map with information on temperature and moisture is superimposed on a soil map with information on texture, slope, and phase. A series of grids, each 100 kilometers square, with information on 14 climates and 15 food crops, are then examined: Kirit S. Parikh and Frans Rabar (1981), FAO (1981, 1983), G. M. Higgins et al. (1983), M. M. Shah et al. (1984), and J. W. Kincher et al. (1985). For a critical evaluation of the PCC calculations and methodology, see Srinivasan (1987). For alternative methodologies for estimating food-producing capacities, see Roger Revelle (1975) and Carl Eicher (1984).

tend to improve over time.) However, the situation varies enormously for individual countries. While most should be able to meet their minimum food requirements in the year 2000 assuming moderate uses of better technology and inputs, others (especially in sub-Saharan Africa) will not be so fortunate and will require outside assistance (World Bank 1984, p. 91). Such assessments typically assume no international trade in foods. Many countries listed as "critical" on food self-sufficiency lists (e.g., oil-producing nations) can generate enough foreign exchange to acquire food in trade; however, dependence on trade for a commodity necessary to life evokes some caution in moving to a position of excessive specialization.

One must be cautious in using estimates of food self-sufficiency because they fail to take into account the most important factors explaining actual output—the availability of resources required to adopt the improved technologies, and government policies and institutions that affect farmers' incentives to produce. Additionally, the goals of "self-sufficiency" and "minimum food requirements" in these various models beg the central issue of the present paper—the impact of rapid population growth on economic prosperity. At any rate, these studies do suggest that the availability of land and technology do not appear to represent notable constraints on food production in the aggregate.[60]

C. *Empirical Considerations*

In terms of the empirical record, the more interesting issues relate not to the *potential* for land intensification, but rather to the *actual* response of agricultural production to population pressures, and the resulting impact on labor productivity. Here the picture is varied. In much of Asia (India [Punjab], Indonesia [Java], Philippines, South Korea, Taiwan, and Thailand), the response has been positive and substantial (Pingali and Binswanger 1984; Hayami and Ruttan 1987). The Green Revolution has spread rapidly. Within a decade, about one-half of the Third World's wheat acreage and one-third of its paddy fields have been converted to new high-yielding, semi-dwarf varieties. With good conditions, acreage yields can double or triple. From being the world's second largest cereal importer in the mid-sixties, India became self-sufficient in the late 1970s (World Bank 1982, pp. 68–71). In other areas such as Bangladesh, real agricultural wages have declined over time (A. R. Khan 1984), and landlessness has grown, creating pressures for, and constraints on, the institutional changes required to accommodate population growth (Arthur and McNicoll 1978). In still other areas (parts of Kenya, Sudan, and Tanzania), intensification has resulted in some degradation of the resource base (P. Gourou 1980).[61]

Given this varied experience, it is difficult to generalize about the net impacts of population-induced changes in technology. For most of Asia, population pressures have encouraged the movement toward adopting new agricultural technologies that are exceptionally productive by historical standards. But there are conspicuous examples where the new technologies have not taken hold. Thus, while the overall impact of the technology revolution may be favorable, important exceptions cloud the picture.

A major factor explaining variations in

[60] In a study of 38 African countries, Nikos Alexandratos (1986) finds that ". . . a country's capacity to feed its growing population . . . depends only weakly on its land endowments per se and more on other factors" (1986, p. 19). Johnson (1984) is unequivocal on this point: ". . . there is not the slightest shred of evidence that continued poor performance of food and agriculture in most of Africa is in any way related to resource restraint" (1984, p. 76).

[61] For a description of resource-degradation problems in Bolivia, Chile, Ecuador, Peru, and Nepal, see Lester R. Brown (1981) and Brown et al. (1985, p. 39); for Africa, see World Resources Institute and International Institute for Environment and Development (1986, ch. 4). See also Pierre R. Crosson (1982, 1983, 1984).

country-specific experience has been differences in institutions such as markets, land-tenure arrangements, and government policies. Boserup (1981) observes:

> The Indian experience shows that rural infrastructure is a precondition for the use of industrial and scientific inputs in agriculture. (1981, p. 203)[62]

Hayami and Ruttan (1987) place particular emphasis on institutional factors:

> The gains from the new technology can be fully realized only if land tenure, water management, and credit institutions perform effectively. Markets for inputs that embody new technology—seeds, fertilizer, pesticides—must perform efficiently. Product markets in which prices are distorted against either producers or consumers fail to generate the potential gains from the new technology. (1987, p. 94)

In general, where institutional factors are favorable, the potential of the new and highly productive technologies, in part induced by population size and growth, is amplified; where they are not favorable, the costs of population growth are raised. Moreover, even under favorable conditions, the impact of population varies with its size. In much of densely populated Asia, the scale of production associated with the new technologies was sufficiently large some decades ago to justify major agricultural investments. Increased population numbers in the intervening period plausibly contributed only moderate benefits through scale. Indeed, the largest scale effects associated with population numbers may well lie in the sparsely settled regions of Africa and Latin America where it may be some time before the heavy investments in social overhead capital required by the new technologies are justified.[63] In the interim, the picture is not especially promising. Fragmentary evidence suggests that land intensification may not be sufficient to fully offset diminishing returns to labor in some countries, although there are important exceptions and relevant empirical studies are few in number.[64]

A critical component in untangling the relationships between technology and demographic change is the impact of population pressures on institutions (land tenure arrangements, government policies, and the like), especially because the new technologies flourish mainly where institutional conditions are favorable. Regrettably, no generalization is possible here.[65] While, as Hayami and Ruttan (1987) note,

> . . . the potential gains from the new technology have generated an effective demand for institutional reform (1987, p. 48),

[62] She observes that purchased inputs, including chemical fertilizers, are bulky and must be transported and stored. Fueling and repair services are required for mechanical equipment. Extension networks must be established. Large-scale irrigation must be provided, or service facilities for tube wells or other types of small-scale irrigation.

[63] Agroclimatic conditions in Africa are not as advantageous to known technologies. Soils are deficient in key minerals; the hotter climate reduces the efficiency of fertilizer use; a higher clay content reduces water absorption capacity; and closer proximity to the sun results in a reduced area over which a given technology package is appropriate. These factors increase the cost of research and development, and the cost of inputs appropriate to Africa. See Gourou (1980), and World Resources Institute and International Institute for Environment and Development (1986, pp. 55–57). There are some examples of quite successful land intensification in tropical areas (H. Breman and C. T. de Wit 1983).

[64] For Africa, see Pingali and Binswanger (1987); for India, see Evenson (1984b); and for pre-industrial England, see Lee (1980b). It is important to recognize that there are diminishing returns to the nonlabor inputs of the new technologies. For fertilizers, see Brown et al. (1985); for problems of waterlogging and salinity resulting from irrigation, see Hayami and Ruttan (1984).

[65] Rosenzweig, Binswanger, and John McIntyre (1984) suggest that output, land, labor, and especially rural credit markets develop in response to higher population densities. This results from the role these markets play in hedging against risk and in transmitting information. Robert Bates (1983), a political scientist, observes ". . . population density promotes the formation of political systems by generating a demand for the vesting of property rights over scarce resources" (Bates 1983, p. 35).

Srinivasan's (1987) judgment seems germane:

> . . . it is difficult to assess even qualitatively whether such change [in agricultural systems] will be orderly or whether the burdens of adjustment will be distributed in proportion to the capacity to bear them. . . . it is difficult to say whether an easing of demographic pressures will merely postpone the day of political reckoning, or will provide an extended period during which institutions can respond positively. (1987, p. 24)

It is crucial to determine, for example, whether population pressures result in land fragmentation or in land reform. There is as yet no general basis for such judgments.[66]

VII. *The Bottom Line*

Based on the above review and three recent surveys of the literature, a bottom-line assessment of the impact of population growth and size on the rate of economic growth in the Third World can be offered. (These surveys include McNicoll 1984; World Bank 1984; and National Research Council 1986. Other surveys include Birdsall 1988; Kelley 1985; King 1985; and Srinivasan 1988b.)

A. *The Bottom Line*

Economic growth (as measured by per capita output) in many developing countries would have been more rapid in an environment of slower population growth, although in a number of countries the impact of population was probably negligible, and in some it may have been positive. Population's adverse impact has most likely occurred where arable land and water are particularly scarce or costly to acquire, where property rights to land and natural resources are poorly defined, and where government policies are biased against the most abundant factor of production—labor. Population's positive impact most likely occurred where natural resources are abundant, where the possibilities for scale economies are substantial, and where markets and other institutions (especially government) allocate resources in a reasonably efficient way over time and space. Because there is no believable and generally accepted quantitative estimate of population's impact on development, only a qualitative (a direction-of-impact) assessment can be made. This assessment, positive or negative, varies from country to country, over time, and possibly with the rate of population growth. What is clear is that an assessment of the impact of population growth on economic development is highly complex, that problems like unemployment, famine, and malnutrition are caused by *many* factors (including rapid population growth), and that an emphasis on policies of slowing population growth without simultaneously confronting the other fundamental causes of such problems may well lead to disappointing results.

While it is difficult to formulate a "consensus assessment" of the impact of population growth on economic growth based on economic-demographic research, the statement above is broadly consistent with three recent evaluations.

1. The National Academy of Sciences Working Group on Population Growth and Economic Development provides a somewhat moderate view:

> On balance, we reach the qualitative conclusion that slower population growth would be beneficial to economic development of developing countries. (National Research Council 1986, p. 90)[67]

[66] For a case study of land fragmentation in Bangladesh, see Arthur and McNicoll (1978); for a case study of two rural Indonesian villages with contrasting patterns of institutional change in response to rising population densities, see Hayami and Masao Kikuchi (1981); for a speculative description of government policy change in African agriculture in response to food shortages, see Wall (1987).

[67] The working group was composed of D. Gale Johnson (co-chair), Ronald D. Lee (co-chair), Nancy Birdsall, Rodolfo A. Bulatao, Eva Mueller, Samuel H. Preston, T. Paul Schultz, T. N. Srinivasan, and Anne D. Williams.

Examining this carefully worded statement in detail is instructive because it exemplifies central elements of the "revisionist perspective" concerning the consequences of population growth in the Third World: (1) there are both important positive and negative impacts of population growth (thus, "on balance"); (2) the actual size of the net impact—and even whether it is strong or weak—cannot be determined given current evidence (thus, "qualitative"); (3) only the direction of the impact from high current growth rates can be discerned (thus, "slower," and not "slow"); and (4) the net impact varies from country to country—in most cases it will be negative, in some it will be positive, and in others it will have little impact one way or the other (thus, "most developing countries").

2. The World Bank (1984) in its *World Development Report 1984* (hereafter *Report*) provides a more specific assessment: ". . . population growth—at rates above 2 percent . . . —acts as a brake on development" (p. 79). The *Report* qualifies this observation by noting that at rates of less than 2 percent, population growth can be accommodated; that is, living standards can continue to rise, albeit at a lower pace. And under certain conditions (e.g., in Europe and some developing countries) "moderate population growth" (the rate is unspecified) can convey positive benefits in the form of a continuous upgrading of the labor force with better educated workers; demand stimulation; economies of scale in transport, communications, social services, and production; technological innovation and reduced investment risks; and economic and military power. The World Bank is guarded in its evaluation, and, like the National Academy of Sciences, provides only a qualitative (direction-of-impact) assessment. The *Report* observes: "The conclusion that rapid population growth has slowed development is by no means straightforward or clearcut" (p. 79). Moreover, some of the negative impacts of population on development widely posited in the literature are downplayed (e.g., there is apparently a "weak link between savings and dependency burdens"; p. 82), and others are elevated in importance (e.g., there may be adverse impacts of dependency on educational expenditures; pp. 84–86).

3. McNicoll (1984) of the Population Council provides an assessment that is more difficult to interpret. His evaluation, like the others, identifies both positive and negative influences of population. On the one hand, he concludes that ". . . rapid population growth is a serious burden on efforts to generate sustained increase in per capita product" (p. 212), but discounts the significance of many traditional economic concerns. For example, based on his view of both the analytical and the empirical literatures, he observes: "What then can be said about the net savings or investment impact of rapid population growth? The answer appears to be very little" (1984, p. 207). He also finds a modest role for scale economies in the long run and is impressed by the positive impacts of population in stimulating innovation, a force that has reduced diminishing returns in agriculture. His negative assessment is probably influenced by the weight he places on noneconomic factors. For example, he emphasizes that kinship structures as well as international relations suffer as a result of rapid demographic change.

Will the current qualified and moderate evaluations of the economic impacts of population be sustained over time? Probably not, if the history of the "population debate" can be taken as a guide. Substantial gaps in knowledge remain to be closed by additional research. I conclude by considering three qualifications.

B. *Qualifications*

1. *Government Policies.* Government policies condition both the form and the size of population impacts on the economy,

and these policies likely respond, in turn, to demographic change.[68] Unfortunately, very little can be said about how government policies react to rapid population growth because a theory of government behavior that commands substantial empirical support is not available. Economists have therefore tended to take the policy-making process to be exogenous in analyses of demographic change, a defendable approach so long as it does not result in downplaying the important role of government policies as conditioning variables.

In many Third World countries, government policies have been incompatible with the promotion of economic growth in an environment of rapid population change. Consider three examples. First, policies toward the labor-intensive agricultural sector (especially in Africa) have taken the form of low investments in rural social overhead capital, high taxation of farm outputs (export taxes, and marketing boards that buy output at suppressed prices), taxation and high costs of farm household purchases, and exchange rates that encourage primary product imports and discourage exports.[69] Such policies deter productivity-enhancing investments that counter the effects of diminishing returns. (A conspicuous exception is the Green Revolution in parts of Asia where governments have invested in roads, irrigation, communications, research and development, and markets, and have implemented pricing policies that have encouraged farmers to innovate and invest.)

Second, inward-oriented international trade policies, including exchange rates that favor low-cost imports, have stimulated capital-intensive production in some industries with a corresponding underutilization of abundant supplies of labor (Krueger 1982; World Bank 1982, 1983).

Finally, policies that favor the location of populations in urban areas (e.g., relatively heavy commitments to education, health care, and transport services, as well as food subsidies for urban dwellers) have encouraged in-migration and city building that is both capital intensive and expensive.[70]

In general, those countries where government policies have encouraged production patterns at variance with comparative advantage by underutilizing abundant supplies of labor have likely experienced greater costs and fewer benefits of rapid population growth (Uma L. Lele and L. R. Meyers 1980; Sen 1981; Bates 1983; Johnson 1984). The revisionists have drawn attention to these policy-making issues by observing that many of the adverse consequences attributed to rapid population growth (e.g., food shortages, urban squa-

[68] Such an assessment can be extended beyond government to include institutions such as markets, property rights, land tenure arrangements, and the like. See Douglass C. North and Robert P. Thomas (1973), Arthur and McNicoll (1978), Lee (1980b, 1984), Hayami and Kikuchi (1981), Bates (1983), McNicoll (1984), and Rosenzweig, Binswanger, and McIntyre (1984).

[69] In the late 1970s in Brazil, Malawi, Upper Volta, and Yemen, the farm price of cotton was 70 percent of the world price; a similar picture emerges for rice in Bangladesh, Pakistan, the Philippines, and Senegal (World Bank 1982, p. 48). In Ghana, Ivory Coast, Kenya, Nigeria (southern), Senegal, Sudan, Tanzania, and Zambia, farmers often receive less than two-thirds the potential sales realization from export crops; in many cases they receive less than one-half (Bates 1986). See also Bates (1983), Boserup (1981, ch. 16), World Bank (1986, chs. 4-6), Malcolm D. Bale and Ernst Lutz (1981), FAO (1981, pp. 95–96), Krueger (1982), Bale and Ronald C. Duncan (1983), and Hayami and Ruttan (1985, ch. 12).

[70] The National Research Council (1986, p. 68) study concludes that rural-urban migration is motivated primarily by economic opportunity in cities, including access to public services and educational facilities. See also Michael J. Greenwood (1969, 1971, 1978), Howard N. Barnum and Richard H. Sabot (1977), Lorene Y. L. Yap (1977), Henry Rempel (1981), Michael P. Todaro and J. Stilkind (1981), Johannes F. Linn (1983), and Dipak Mazumdar (1983, 1985). Simulation studies of developing countries suggest that urbanization (not necessarily large-city growth) has been substantially due to the growth of industry and modern sector services, while overall population growth has played a relatively small role (Preston 1979; Kelley and Williamson 1984; and Rakesh Mohan 1984).

lor, unemployment) are largely the result of unsuitable government economic policies. A major impact of population growth has been to reveal the consequences of such policies sooner and more dramatically; as such, population growth "exacerbates" some problems, but may not be their most important cause. It may therefore represent misplaced emphasis to confront such problems with population policy because without a change in economic policies, slower population growth may simply postpone the day of reckoning when the adverse consequences of the economic policies are tallied.

This is a reasonable set of propositions *if* the argument is one of redressing a misplaced emphasis on population policies in those cases where population growth is relatively unimportant; however, one difficulty with the debates has been their polarization toward either-or choices. It is more appropriate to recognize that *both* population and economic policies exert independent as well as interacting effects on the economy, and that a combination of policy changes may be in order. Two recent statements on the need to develop a balanced perspective that considers population/economic policy interactions are instructive. On redressing a possible misplaced emphasis on population policy for solving the short- to intermediate-run problem of starvation, Srinivasan (1987) observes:

> The cause of eliminating starvation . . . will be ill-served if, instead of analyzing avoidable policy failure, policy makers turn their attention to attempts at changing an admittedly slow-acting process such as the interaction between population growth and the food economy. This is not to deny the modest improvements . . . resulting from an exogenous reduction in the rate of population growth; rather it is to point out that the pay-off to the correction of policy failures is likely to be more rapid and perhaps greater. (1987, p. 25)

The World Bank (1984) generalizes this point with a somewhat stronger emphasis on population policy, and also highlights the need to distinguish between short- and long-run impacts of policies.

> In short, policies to reduce population growth can make an important contribution to development (especially in the long run), but their beneficial effects will be greatly diminished if they are not supported by the right macroeconomic and sectoral policies. At the same time, failure to address the population problem will itself reduce the set of macroeconomic and sectoral policies that are possible, and permanently foreclose some long-run development options. (1984, p. 105)

2. *Ecology.* Many writers have expressed concerns over the advvrse ecological/biological impacts of rapid population growth. (Examples include desertification, overfishing, and declining rain forests.) Surveys and appraisals of this literature are provided by World Resources Institute and International Institute for Environment and Development (1986), National Research Council (1986, ch. 3), and Simon and Kahn (1984). These are important matters because institutional mechanisms (enforced government regulations and private property rights) are sometimes unavailable or insufficient to assure an appropriate use of resources over time.[71] Thus population growth, while often not the primary cause of natural resource and environmental degradation, can certainly exacerbate problems of resource overutilization countenanced by market failures. Because the costs of market failure have been difficult to measure, the importance of environmental considerations has been subject to wide-ranging debate. (For example, some of the most serious ecological problems

[71] Rising population densities against land and other resources can spur a definition of property rights. Bates (1983) notes: "The greater the number of claimants for land and the greater its relative scarcity, then the greater the extent to which one person's use of this resource precludes another's. There is thus an incentive to render land a well-defined commodity: one that is amenable to compensation for its utilization" (p. 34).

arise more from living standards associated with high incomes than from population size per se.) In particular, it has been argued that the costs of ultimately reversing an inappropriate intertemporal utilization of ecological resources can be high, if not prohibitive, and therefore a conservative posture of environmental preservation appears prudent.

Herman E. Daly (1986) goes a step further and faults economics as being methodologically incapable of confronting environmental matters because neoclassical theory

> suffers from a total failure to distinguish the problem of optimal allocation of resources from the problem of optimal scale of the entire economy relative to the ecosystem in which the economy is physically embedded as a fully dependent system. (1986, p. 582)

His criticism merits attention on two grounds. First, most studies of population have indeed been scale neutral because useful estimates of scale effects are unavailable. Second, economists have generally downplayed issues of optimal population size because ecological notions of "carrying capacity" are analytically vague and empirically imprecise, and because substantial difficulties are encountered in assigning a value to the environment for future generations. At any rate, considerations relating to environmental consequences of population should supplement the economic factors surveyed in this paper.

3. *Values.* Economic analyses of demographic change have typically focused on the growth and distribution of per capita output. Such studies could well benefit from a broader "welfare perspective" in which parents value both the numbers and the welfare of their children (Yew-Kwang Ng 1986). These values not only influence parents' decisions concerning family size, but also how much time and money they allocate to their children. Parental commitments to their children can be substantial. The National Research Council (1986) speculates that ". . . most parents are willing to make many of the *sacrifices* required to raise a child through its dependency period, so that some of the most important economic adjustments to population growth are not only automatic but even considered part of a *desirable* process by those who undertake them" [emphases mine] (1986, p. 4). Using the jargon of the "new home economics," children are consumer (and possibly producer) durables conveying utility (and possibly future income) to their parents. "Desirable sacrifices," say in the form of foregone consumption, may be represented as welfare-augmenting decision making by parents. (This assumes that parents possess some ability to control family size.)[72]

When children are part of the parents' utility function, determination of the impacts of population growth on "welfare" (by contrast to "economic growth") is still more complex (Partha Dasgupta 1987). Normative issues relating to the specification of the social welfare function enter conspicuously into the analysis. Classical economists in the tradition of J. S. Mill emphasized per capita utility, while utilitarians in the tradition of Jeremy Bentham emphasized "the greatest good for the greatest number," or total utility, so that total population numbers enter in a more prominent way. Because parents do indeed value children, and, moreover, children serve parents' economic needs in the Third World, then positive issues relating to population growth and size must reckon with normative issues relating to the specification of the social welfare function. For example, Marc Nerlove, Assaf Razin, and Efraim Sadka (1987) entertain the theoretical pos-

[72] For an introduction to the extensive economics literature on the determinants of family size (known as the "new home economics"), consult Theodore W. Schultz (1974). For an extension of this framework, which highlights biological and fertility-control considerations, see Easterlin, Robert A. Pollak, and Michael L. Wachter (1980).

sibility that under certain conditions the rate of per capita economic growth—seemingly a positive criterion for evaluating rapid population growth—depends critically on how children enter their parents utility function. This arises because the rate of capital accumulation and its composition depend on whether parents view children as capital or consumer goods.

Externalities muddy the issue further. Children convey benefits and costs not only to their parents but to others as well. Demeny (1986) emphasizes this issue when he writes:

> The essence of the population problem—if there is a problem—is that individual decisions with respect to demographic acts do not add up to the recognized common good; that choices at the individual level are not congruent with the collective interest. (1986, p. 473)

He speculates that for many developing economies the external costs of children exceed their external benefits, and this results in overpopulation because governments are unwilling to take sufficient corrective action.[73] Referring to western/capitalist societies, he observes that "micro-level sovereignty concerning fertility decisions was explicitly elevated to the rank of a fundamental human right, protected from social control by the state" (1986, p. 484). His controversial proposal of "demographic constitutions," with all its political, ethical, and moral implications, illustrates both the wide-ranging scope of the welfare approach to assessing the consequences of population, and simultaneously the narrower (but more nearly operational) scope represented by most economic analyses of this topic.

Both Demeny and Simon have emphasized the need for a broader perspective. Demeny (1986) observes:

> . . . we should ask and try to answer more daring questions than neoclassical economics inspires us to. What kind of society would we like to be a part of? and what kind of arrangements should that society have concerning demographic matters? (1986, p. 487)

Simon (1981), after providing some 20 chapters devoted to analyzing various economic consequences of population growth and size, delivers a similar imperative in a concluding chapter entitled "Ultimately, What Are Your Values?" He observes:

> Science alone does not, and cannot, tell us whether any population size is too large or too small, or whether the growth rate is too fast or too slow. . . . Social and personal decisions about childbearing, immigration, and death inevitably hinge upon values as well as probable economic consequences. And there is necessarily a moral dimension to these decisions over and beyond whatever insights science may yield. (1981, p. 344)

While Demeny and Simon take issue on matters of science and employ different values to weigh the various consequences of population growth, they join in their admonition to economists and others that values must enter prominently in the "population debate." Economic and scientific analyses, while indispensable elements in providing bottom-line assessments, must be seen in appropriate perspective.

[73] Srinivasan (1988b) points out that some of Demeny's examples confuse pecuniary externalities that have only distributional implications with externalities that arise from interdependent technologies or preferences. Srinivasan concludes that ". . . most of the arguments for a policy intervention in private household fertility decisions appear to be based either on an inappropriate association of undesirable social consequences due to other distortions in the society with individual fertility choices, or on associations that cannot be ruled out in theory but are empirically weak, if not exaggerated" (p. 23). See also Ng (1986).

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