On Population and Resources: A Comment

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IN A RECENT ARTICLE in this journal Partha Dasgupta concludes: "Judging by level of analysis, most of those who have been investigating economic growth, poverty, environmental stress, and fertility behavior have not read widely beyond their particular fields of interest" (2000: 644–645). Unfortunately, Dasgupta has not referenced widely even in areas that one might assume were in his fields of interest.

Let me note one example. Dasgupta mentions (p. 648) only two of the many statistical estimates of the relationships between population and economic growth that were made following the 1986 report of the US National Academy of Sciences on population and economic growth. While these two studies showed a negative relationship, other studies found a variety of outcomes: no statistically significant effect of population growth on economic growth, occasionally a positive effect, and also occasionally a negative effect (Levine and Renelt 1992; Kelley and Schmidt 1996; Barro 1997; Burkett, Humblet, and Putterman 1999; Johnson 1994). The regression analyses have not produced the uniform result Dasgupta implies.

I am among those whose analyses of the interrelationships between population and resources Dasgupta criticizes for being overly optimistic. My presidential address to the American Economic Association, "Population, food and knowledge" (Johnson 2000), and my role in the 1986 NAS report for which I served as co-chair were both noted critically. Thus I have been motivated to respond to some of his inferences and conclusions.

Is disinvestment common?

An important element in the relationship between population and economic growth is the rate of investment. The usual measures of investment in na-

tional accounts do not take into consideration depletion of natural resources or additions to human capital in the form of education. Dasgupta refers to Hamilton and Clemens's (1999) estimates of "genuine investment and capital deepening" for many countries. Dasgupta summarizes these estimates for five countries—Bangladesh, India, Nepal, Pakistan, and China—and for sub-Saharan Africa. He notes that two of the countries and sub-Saharan Africa had negative rates of "genuine investment" for the period 1970 to 1993. But comparisons of this nature can be misleading. The total population of developing countries with negative investment rates, shown in his Table 4, was 777 million in 1998, while the developing countries with positive investment rates had a combined population of 2,350 million, or three times as many. Moreover, the data in Hamilton and Clemens (1999) do not indicate that sub-Saharan Africa, with a population of 628 million, had a negative rate of investment—they show a small positive rate for the period.[1] After making the assumption that the growth of per capita wealth was proportional to the growth of per capita GNP, Dasgupta states that per capita wealth declined in four of the five countries and in sub-Saharan Africa. From the data in his Table 4, however, this conclusion is in error—in all five Asian countries per capita wealth increased, although it did decline in sub-Saharan Africa.[2]

While the effort to provide a fuller estimate of investment than the usual national income accounts data is laudable, an estimate that ignores a major change that has occurred over the past half-century in developing countries may be misleading as well. It seems odd that an effort to measure "what really happened" neglects a major form of capital accumulation in developing countries—namely, the increase in human capital attributable to the increase in life expectancy. This gain is over and above the increase in education as a measure of human capital formation. For most developing countries, the 1970–93 period saw significant increases in both life expectancy and years of education attained. For example, the increase in life expectancy in 28 low-income countries between 1960 and 1996 was 20 years: from 44 to 64 (World Bank 1984: 262; 1998: 12–14, 104–107).[3] The percentage of time that people spent in their productive years increased significantly; the percentage of children in the population declined; and the percentage who were elderly had not yet increased significantly. Should this not be included in the measurement of capital if one wants to measure the productive capacity or wealth of a country? The measure of human capital Hamilton and Clemens used was the annual expenditure on education, probably only by governments. The measure does not include the time input of students and thus is an underestimate of the actual investment in education, although probably not much of an underestimate since years of education in most developing countries are limited.

Increased life expectancy and population growth

Of course, the gain in life expectancy that occurred in the developing countries increased the population, which Dasgupta apparently considers to be a negative factor in the development of nations. Would he argue that, had life expectancy in the developing countries remained constant at the level of 1965 or 1970, well-being would have been improved? I hope not. The population growth of the last half-century was caused by mortality decline, not by increased fertility. The rapid population growth in the developing countries occurred because while fertility fell, mortality declined even more rapidly. In sub-Saharan Africa, where there has been little real per capita income growth and modest improvement in the education of females, the fertility rate, according Dasgupta's Table 3, declined from an average of 6.6 in 1980 to 5.4 in 1998. This is a substantial change in less than two decades.

Limited female education and fertility

I find it odd that Dasgupta gives so much attention to a few countries in Africa where females with limited years of primary schooling have higher fertility than females who have no schooling. The argument seems to be that we cannot be sure of the causality between schooling and fertility. Achieving one to four years of primary schooling adds little to the human capital of individuals; many in this group may not be functionally literate. If we wish to pull people out of poverty, the case can be made that one of the most appropriate ways is to increase the level of education, which is in fact happening in sub-Saharan Africa (Sender 1999: 94).[4]

The relationship between primary education and fertility may have already changed. Data for 13 sub-Saharan countries for 1990–94 give fertility rates for women with no schooling and primary and secondary schooling (Kremer and Chen 2000). In only two of these countries was fertility higher for women who had primary education than for those who had none. This does not directly contradict the earlier data that found that in some countries the fertility rate for women with one to four years of schooling was greater than for women with no schooling. What these data show is that in 1990–94 in 11 out of the 13 countries women with any level of primary schooling had lower fertility than women with no education. The two countries where women with primary education had higher fertility than women with no education had a combined population of 17 million, a small percentage of the more than 600 million total population for the region. As noted by Dasgupta, the total fertility rate in sub-Saharan Africa declined by 18 percent between 1980 and 1998. Thus even if in some countries women with one to four years of primary education have more chil-

dren than women with no education, this phenomenon has not halted a significant decline in the total fertility rate.

Why recent history is relevant

Dasgupta faults those of us who have optimistic views of the future for relying on the experience of only two centuries of growth, following at least 5,000 years when growth was modest at best. We are in agreement that up to 1750 there had been little improvement in the conditions of life in Europe and Asia. But in making this point, Dasgupta undermines his case that population growth works against the reduction of poverty. By today's standards nearly all of the world's population in 1750 lived in poverty. Most of the people now classified as poor have a much higher level of living than the average individual who lived in Europe in 1750. Life expectancy in the 28 low-income countries in 1996 was 64 years, as noted earlier, roughly double what prevailed in Europe in 1750 and nearly three times what it was in India at the beginning of the twentieth century (Bogue 1969: 572). This great improvement occurred while the world's population increased sevenfold.

Dasgupta faults those who believe that population size has no adverse effect on economic well-being: such optimists assume instead that future innovations will "make no more than a finite additional demand on the natural-resource base" (p. 645). What he apparently has in mind is how the demand for natural resources will change as further economic growth occurs and new products emerge. Obviously we do not know what new products will emerge or we would invent them now. But we do know that in many ways the natural-resource intensity of today's output is significantly less than it was a century ago and far less than it was five centuries ago. I grant that, because total output has increased so much, the fact that the natural-resource intensity has declined does not tell us what change has occurred in the total demand for natural resources. But if we should run short of coal, oil, and natural gas or need to reduce their use to reduce global warming, we have a source of energy—nuclear—that requires no significant amount of natural resources.

We know as well that with an approximate doubling of the world's population and increased per capita consumption of agricultural products, the total land cultivated for crops in the world has not increased since 1967 and over that period of time the real price of grains in international markets has fallen by 40 percent. Such a development could not have been imagined when Ricardo and Malthus wrote, when natural-resource constraints were a major factor limiting national output; in fact, it could hardly have been imagined as recently as 50 years ago. For example, agricultural land in the United States now contributes less than 0.5 percent of GDP.

Even adding in the cost of all fertilizers and pesticides as natural-resource inputs, the share of natural resources used in agriculture remains at less than one percent of the national GDP.

Why can one have a high degree of confidence that economic growth can continue with increased population? I believe the reason is knowledge—the world has shown an amazing capacity to advance knowledge over the past two centuries compared to all previous time. There are two reasons for this. First, there are more people and thus there are more people who can contribute to the creation of new knowledge (Kremer 1993). Second, we now have people who specialize in the creation of knowledge—we have research institutes and universities, institutions that hardly existed more than a century and a half ago (Johnson 2000). A single American state university now has more faculty members than all colleges and universities in Germany, then the world's center for graduate study and research, had in 1900 (Johnson 2000). As the world's population and income have grown rapidly over the past two centuries, the economic gains from new knowledge have increased and the number of persons engaged in advancing knowledge has increased in response.

Knowledge increased dramatically in the twentieth century. Is there any reason to doubt whether the rate of flow of knowledge will be maintained? In fact, it is highly probable that knowledge will grow at a faster rate in the future as the share of the world's resources devoted to the creation of knowledge continues to increase as a consequence both of the efforts of developing countries to establish and expand their own research universities and institutes and of the continued growth of population, until population stabilizes before the end of the twenty-first century.

We also have the record of the past century of a relative decline in the resource-intensive sectors—agriculture, mining, and manufacturing—and a sharp increase in services that rely far less on natural resources. More significant than anything else, we have seen a decline in the real prices of resource-intensive products, such as oil and steel.

Some other points

Let me briefly note a few other points Dasgupta makes that I do not think the evidence supports. On page 663 he argues that "...[i]ncreased population size implies greater crowding...." Then he argues that crowded centers of population "provide a fertile ground for the spread of pathogens...." The implication is that in developing countries cities are less healthy than rural areas, but this seems not to be the case. Brockerhoff and Brennan (1998) show that infant mortality rates were lower in large cities in the 1990s than in rural areas (p. 91). And there is evidence, both current and past, that population density has a positive effect on the level of per capita income

(Burkett, Humblet, and Putterman 1999). Dasgupta presents no evidence to support either of his propositions. A striking contradiction of these two presumed facts is found in China, where (a) the highest-income area is the most densely populated (the coastal region) and the lowest-income area is the least densely populated (the western region) and (b) life expectancy is greater in urban than in rural areas.

Dasgupta emphasizes the possible relationship between fertility and the fact that parents do not bear the full cost of rearing their children, either because society pays a significant part of the cost (free public education, subsidized health care) or other family members do. While these considerations may influence fertility decisions, it remains true that as society has borne larger shares of the costs of children, fertility has fallen. In part, this is because education, especially secondary education, has direct effects on reducing fertility. But it may also be that as real per capita incomes increase, society bears an increasing share of the costs of rearing children while there are offsetting effects of higher incomes on the number of children desired. In any case, there is no direct evidence that this kind of externality has had a positive effect on fertility; a theory can be created that says this, but a theory could also be constructed to show a contrary effect. All that is required is the appropriate assumptions in the model. Any such model needs to be tested against actual experience, and this Dasgupta does not do.

I find it difficult to accept the extreme pessimism that is displayed in Dasgupta's section "Household labor needs and the local commons" (pp. 671–674). He argues that there may be communities in which there is no way out of poverty because circumstances associated with poverty induce either higher fertility or an increase in the number of children as infant mortality declines: "[A]long this pathway poverty, household size, and environmental degradation would reinforce one another in an escalating spiral" (p. 674). Here, as elsewhere throughout his article, there is no indication of how common such communities are: are they isolated examples or do they represent the majority of poor communities in the world? If it were true that the majority of the communities now in poverty were as poor as or poorer than such communities were 50 years ago, then the arguments presented might warrant great concern. But this is not the case. If one considers the poorest countries in the world, numerous measures of well-being have improved over the past half-century—life expectancy, infant mortality, per capita food supply, percent of the population malnourished, availability of education, and decline in the percent illiterate. Even in sub-Saharan Africa, where measured per capita incomes have fallen in many countries since the 1970s, life expectancy, education, and literacy have improved. Consequently, if some communities have either seen no improvement or have declined in welfare as a result of population growth, they must have been a significant minority of the total population. Do such communities exist? Are there areas in India with life expectancy of 23 years as

was the case in 1900, or 32 years as in the 1940s (Bogue 1969: 572)? Dasgupta provides no evidence that such communities exist.

Concluding comments

There is much one can readily agree with in Dasgupta's analysis of factors that have reduced fertility and will continue to do so. While there may be a small number of countries where women's attainment of a very limited amount of education does not reduce their fertility, no evidence contradicts the conclusion that education beyond the primary level for women is associated with lower fertility. The reasons for this are several and are not in doubt: education through the secondary level delays marriage and the age at which the first child is born; education increases the value of a woman's time and the cost of a child; and education is generally associated with the degree of autonomy accorded to a woman. Dasgupta's Table 7 reports that fertility declines as women's share in paid employment increases; this relationship is similar to what would have been obtained had the share of the population in urban areas been the variable.

Dasgupta notes the effects of property rights and institutional changes on fertility, and properly so. In some, probably a majority, of the villages in China, government policy has reallocated the rights to use farm land in response to demographic change. Thus while an explicit policy restricted population growth, another policy that favored large families existed as well. But all such policies need to be evaluated in the context of the totality of factors that affect fertility. And we know that for developing countries over the past several decades, the totality of factors have resulted in declines in fertility, not in a few instances but everywhere at the national level.[5]

Notes

1   In Table 4 Dasgupta presents estimates of the ratio of investment to GNP for five developing countries and sub-Saharan Africa. He says the data were derived from Table 3 in Hamilton and Clemens (1999) but there is no summary for sub-Saharan Africa in Table 3; the data for that region apparently came from their Table 2. I had difficulty duplicating the estimates that he presents of the ratio of genuine investment to GNP for 1970–93. The differences for the five countries are small –his estimate for China is 10.0 percent while from the same data I derive an estimate of 11.3 percent. But for sub-Saharan Africa he states that the investment ratio is a negative 2.8 percent. The raw data in the source are as follows:

1970–79, +7.3; 1980–89, –3.2; 1990, –3.8; 1991, –1.2; 1992, –0.6; and 1993, –1.1. I am assuming that he arrived at his figure by averaging the data for the 24 years. When I average these estimates, the mean is +1.4 percent, not –2.8 percent. This positive rate is very low, but it does not imply disinvestment. Note that if the period 1970–79 included growth for nine rather than ten years, the average investment rate is reduced to 1.2, but is still positive.

2   Table 4 includes estimates of the average annual percentage rate of change in per capita GNP (fourth column). Dasgupta does not have an estimate of per capita wealth but estimates its growth by assuming an output–wealth ratio of 0.25—wealth

per capita is four times GNP per capita. This assumption means that per capita wealth would increase at the same annual rate as per capita GNP: If the output-to-wealth ratio is constant, there can be no other result. Since the annual rate of growth of per capita GNP is positive for the five countries in the table, the annual rate of growth of per capita wealth must also be positive if his assumption about the relationship between output and wealth is accepted. In sub-Saharan Africa the rate of GNP growth is negative and if one accepts his assumption about the relationship between income and wealth, the growth of per capita wealth would also have declined by 0.2 percent annually. It is difficult to understand how he obtained his result that per capita wealth declined in each of the countries except for China.

3   Two adjustments were made to the 1960 data. First, the World Bank listed 34 countries as low income; however, data were not available for six countries in 1996 and these countries were deleted from the list These countries accounted for only 2.8 percent of the population of the 34 countries listed as low income. Second, the life expectancy for China for 1960 was given as 41. This

life expectancy was low as a consequence of the famine for the period 1959–61. The life expectancy used for China to derive the average life expectancy for 1960 was 47.

4   Sender (1999) presents data on the increase in female enrollment in primary schools for 16 sub-Saharan African countries between 1960 and 1990–94. The unweighted average of the percent of females enrolled in primary school increased from 28 percent in 1960 to 78 percent in 1990–94. The increase in gross enrollment in secondary school ranged from 2 percent to 17.5 percent for approximately the same period of time. These data indicate that the percent of females who receive only one to four years of primary schooling decreased significantly.

5   According to World Bank estimates of fertility (2000: 286–287), every country out of more than 100 that had a fertility rate in excess of the replacement rate in 1980 experienced a decline in fertility between 1980 and 1998. Consequently, of all the factors that affect fertility, both positively and negatively, those that had a negative effect dominated.

References

Barro, R. J. 1997. "Determinants of economic growth: A cross-country empirical study," Cambridge, MA: Harvard Institute for International Development, Discussion Paper No. 579.

Bogue, D. J. 1969. *Principles of Demography*. New York: Wiley.

Brockerhoff, M. and E. Brennan. 1998. "The poverty of cities in developing regions," *Population and Development Review* 24(1): 75–114.

Burkett, J. P., C. Humblet, and L. Putterman. 1999. "Preindustrial and postwar economic development: Is there a link?" *Economic Development and Cultural Change* 47(3): 471–495.

Dasgupta, P. 2000. "Population and resources: An exploration of reproductive and environmental externalities," *Population and Development Review* 26(4): 643–689.

Food and Agriculture Organization. Various issues. *Production Yearbook*. Rome: FAO.

Hamilton, K. and M. Clemens. 1999. "Genuine savings rates in developing countries," *World Bank Economic Review* 13(2): 333–356.

Johnson, D. G. 1994. "Effects of institutions and policies on rural population growth with application to China," *Population and Development Review* 20(3): 503–531.

————. 2000 "Population, food, and knowledge," *American Economic Review* 90(1): 1–14.

Kelley, Allen C. and Robert M. Schmidt. 1996. "Toward a cure for the myopia and tunnel vision of the population debate: A dose of historical perspective," in Dennis A. Ahlburg, Allen C. Kelley, and Karen Oppenheim Mason (eds.), *The Impact of Population Growth on Well-being in Developing Countries*. Berlin: Springer-Verlag, pp. 11–35.

Kremer, M. 1993. "Population growth and technological change: One million B.C. to 1990,"
    Quarterly Journal of Economics 108(3): 681–716.

Kremer, M. and D. Chen. 2000. "Income distribution dynamics with endogenous fertility,"
    NBER Working Paper 7530. Cambridge, MA: National Bureau of Economic Research.

Levine, R. and D. Renelt. 1992. "A sensitivity analysis of cross-country growth regressions,"
    American Economic Review 82(4): 942–963.

National Research Council. 1986. *Population Growth and Economic Development: Policy Ques-
    tions*. Washington, DC: National Academy Press.

Sender, J. 1999. "Africa's economic performance: Limitations of the current consensus,"
    The Journal of Economic Perspectives 13(3): 89–114.

World Bank. 1984. *World Development Report*. New York: Oxford University Press.

———. 1998. *World Development Indicators 1998*. New York: Oxford University Press.

———. 2000. *World Development Report 2000/2001*. New York: Oxford University Press.