

ECONOMIC GROWTH CENTER

YALE UNIVERSITY

Box 1987, Yale Station
New Haven, Connecticut 06520

CENTER DISCUSSION PAPER NO. 539

POPULATION GROWTH AND ECONOMIC DEVELOPMENT

T. N. Srinivasan

Yale University

July 1987

Note: Center Discussion Papers are preliminary materials circulated to stimulate discussion and critical comments. References in publications to Discussion Papers should be cleared with the authors to protect the tentative character of these papers.

POPULATION GROWTH AND ECONOMIC DEVELOPMENT

Much of the concern about the effect of population size and its rate of growth on economic development is based on the simple idea that first, the more the number sharing the current flow of goods and services the less there will be for each, and second, the more the number and faster its rate of growth, the less of capital (human and physical) will be accumulated and hence, smaller will be the future flow of goods and services. In this view, the process of population growth is exogenous to the processes of income generation, accumulation, technical progress and institutional change. Once it is recognized that fertility decisions are made by households who are concerned about the welfare of their progeny and who respond to the relevant market prices, opportunities for productive use of their resources and public policy signals, population growth is seen to be endogenous. Unless externalities associated with private fertility decisions are pervasive and significant, no policy intervention in those decisions will be called for. An examination of possible externalities from the point of view of resource (exhaustible and renewable) use over time, capital accumulation, distribution of income within and between generations etc. suggests that many of the alleged deleterious consequences result more from inappropriate policies and institutions than from rapid population growth. Once the appropriate institutional framework and undistorted markets are in place, there is little scope for population policy as such.

POPULATION GROWTH AND ECONOMIC DEVELOPMENT

1. INTRODUCTION

The influence of the size and rate of growth of population on the development prospects of developing countries has continued to attract the attention of economists, demographers and social scientists in general. The perceptions about this influence have varied over time from extreme pessimism to optimism and all positions in between. However, the accumulation of knowledge on the various factors that determine the fertility decisions of households and their consequences has led to a more informed view in recent years. Two influential studies are worth mentioning in this connection. The first is the World Development Report of the World Bank devoted to the population issues and published in 1984. The second is a report of the Working Group on Population Growth and Economic Development of the National Academy of Sciences (National Research Council 1986). Population and Development Review published a review symposium in September 1986 on this report to which A. C. Kelley, J. L. Simon, J. E. Potter and H. E. Daly contributed. Paul Demeny's (1986) presidential address to the Population Association of America was in part a forceful critique of the report. In addition, there have been surveys by McNicoll (1984), Kelley (1984), and Birdsall (1987). Schultz (1985, 1987), Pollak (1985) and Willis (1986) have discussed particular aspects of population growth and the approach to analysing the determinants of fertility. It is very difficult to add to these in terms of new substantive research conclusions. I will attempt only to highlight some of the issues discussed in the literature from analytical and policy perspectives. There will be very little discussion of facts, models and

econometric analyses of issues relating to population growth in the expectation that other papers in this symposium will adequately address them.

At an elementary level the concern about population size could be put very simply: the more the number sharing the current flow of goods and services the less there will be for each. Equally, more the number and faster its rate of growth, the less per head will be accumulated over time of capital and other resources and hence, smaller will be the future flow of goods and services. Thus, in this view a large population size has a purely a negative influence: it reduces the slice of a given cake that each individual will be able to enjoy and the growth in the size of the cake itself. Even at this elementary level it is easy to see that this assertion could be erroneous. First of all, the rate of growth of population is not exogenous to the process of economic development-- household's fertility decisions are influenced by the opportunities for productive use of their resources, in particular the use of time and of savings that successful development brings about. Second, the size of the cake and its rate of growth through technical change and factor accumulation are themselves likely to be influenced by the size of the population in a positive way. And indeed some writers, such as Julian Simon (1981), point to this very possibility to argue against the earlier perception of population growth as a problem.

Even if the size of population does not positively influence the process of technical change, there may still be an argument that, other things being equal, larger population itself contributes to social welfare. One strand of this argument is that from the perspective of defending a nation against its enemies, the larger population size is of some advantage. For example, Nerlove et al (1987, p. 82) quote Edgeworth

as referring to the view that larger population may be desirable, not only as an end to itself, but also for the sake of defense against competition with foreign nations, and that these considerations have perhaps the first claim on the attention of the statesmen; "being must be secured before well-being." They also generalize Edgeworth's argument by suggesting that a larger population has an advantage in providing pure public goods, of which national defense is only one example, because the per capita cost of providing a public good falls as the population becomes larger.

Even if one were to accept that the population size and its rate of growth may influence social welfare, there still remains the question whether individual households, through their own choice of fertility subject to whatever constraints that they may face, would bring about socially optimal size and rate of growth of population. If they do, then the question of the population policy does not arise. Thus, in assessing the relevance of population considerations from a social point of view, not only one has to assess the evidence for the positive or negative effects, but also whether these effects are external to the decisions of individual households. However, even if individual households are altruistic in taking into consideration the welfare of their progeny, and even if externalities are absent, still there may be room for policy intervention if for some reason it was thought that the social welfare considerations differed from individual welfare assessments, particularly with respect to the weight to be given to the welfare of the unborn future generations.

In a static world with given size of population and absence of externalities, it is well-known that at a competitive equilibrium the allocation of resources is pareto optimal. Such an allocation, however, may or may not maximize an individualistic social welfare function

(SWF).¹ Analogously, in the choice of fertility, unrestricted equilibrium may be pareto optimal, but not necessarily social welfare maximizing. However, with fertility endogenous, even the concept of inter-generational pareto optimality is problematic because the pareto criterion is not well suited for welfare comparisons of equilibria with different numbers of people. The interested reader may wish to consult Dasgupta (1985) and Nerlove et al (1987) for a discussion of the issues relating to the choice of social welfare functions and the philosophical problems underlying their choice, in the context of population growth.

In what follows the analytical and empirical knowledge relating to the impact of population size and growth on the allocation of exhaustible, renewable and accumulated resources will be reviewed. Second, the likely influence of population growth on rates of technical change, accumulation of human capital and on the distribution of income within and between generations will be examined. In the concluding section, the vexing question whether there is any argument for public intervention in household fertility decisions and the nature of such interventions will be discussed.

2. EXHAUSTIBLE RESOURCES²

In assessing the impact of population and growth on exhaustible resources, it is instructive to begin by assuming that the resource requirement per person is some fixed number. If the total available resource stock is also fixed, then it is clear the two together determine the total number of individuals that can enjoy this stock of resources. As such, changes in rate of growth of population will only affect the time pattern of the use of this resources without affecting the total number of persons that will eventually use up the stock. If this resource is vital

for human existence, the world is bound to come to an end, sooner if the population rate of growth is more rapid or later if it is less rapid. However, once we get away from this extreme assumption that the resource requirement is fixed (so that by definition nothing else can be substituted for it) and allow for potential substitutes, then the problem resource exhaustion takes on a different complexion altogether. First, as a particular resource stock gets exhausted, the relative price of that resource would go up, inducing substitution of other resources for it and ultimately affecting fertility choice itself. Second, the rising price of a resource will also induce the search for substitutes, the success of which will extend the potential population that can be sustained.

There is ample empirical evidence that resource exhaustion is not a major constraint on global economic growth, at least as yet. The material input per unit of GNP seems to be declining over the long haul. There appears to be a significant decline in real cost of resources (Simon, 1981, Appendix) at least until recently. Nordhaus (1986) reports that real oil prices in America stood in mid-1986 at almost exactly the same level as in 1900! As long as the international markets for resources function well and the access to such markets are not restricted, the fact that some countries (e.g. Japan) are not well endowed with natural resources has not constrained their growth. Nordhaus' calculations, based on a simple aggregative growth model, lead him to conclude that even for countries that import all their resource requirements, the drag on the growth rate, induced by rising real resource costs, is likely to be modest--a few hundredths of a percent per annum.

It is sometimes argued that by slowing the rate of population growth one can postpone the exhaustion of currently available resources so that more time is available for the development of substitutes. This is

not an entirely convincing argument. After all, the returns to the development of substitutes depend on their prices. To the extent these prices reach a particular level later because of slower exhaustion of existing resources, it can only postpone the development of substitutes rather than accelerate their development. On the other hand, if one is referring to the development of as yet unknown substitutes, the search for such materials is also motivated by potential returns from successful search, once again the previous argument applies. But if one is talking about exogenous technological breakthroughs, then by definition their timing is not influenced by the developments elsewhere in the economy, and as such, changes in population rates of growth cannot influence the timing. Be that as it may, the global use of exhaustible resources are primarily driven by income growth rather than by population growth. Even if the rate of growth of population is halted, with the desirable increases in the low levels of income in developing countries coming about through their economic development, their demands on resources would increase anyway.

3. RENEWABLE RESOURCES

One of the major renewable resources, whose flow is allegedly made unduly scarce by rapid population growth, particularly in developing countries, is food, or more precisely the services of arable land. A purely technical approach to this problem would be to put together an estimate of what the earth can produce in terms of food and divide that estimate by the requirement of food per person to arrive at a global carrying capacity. If this global carrying capacity exceeds any likely future global population, then by definition there is no limit to population growth arising from constraints of the availability of food. A

study along these lines was undertaken jointly by the Food and Agricultural Organization of the United Nations (FAO), United Nations Fund for Population Activities (UNFPA) and the International Institute for Applied Systems Analysis (IIASA).

The objectives of the study were "...to ascertain on the basis of land resource inventories, the potential population supporting capacities in the developing world with various levels of inputs. And, second, to compare these estimates with data on present and projected populations..." (Higgins et al, 1983, p. 5). Some of the earlier studies are reviewed in Shah et al (1984). Their estimates of population potential varied depending on variations in each of the three inputs: estimates of arable land, yield per hectare and per capita consumption needs. The range was enormous: from a low estimate of 902 million by Pearson and Harper in 1945 to 147 billion by Clark in 1967 (Shah et al, 1984, p. 5)! The FAO-UNFPA-IIASA study differs from the earlier studies in its use of a more disaggregated data base and superior methodology. Briefly stated, it uses an overlay of a climate map providing spatial information on temperature and moisture conditions on to a soil map providing spatial data on soil texture, slope and phase. This resulted in dividing the study area into grids, each covering an area of 100 square kilometers area. In all, 14 major climates during growth period were distinguished with normal (i.e. containing a humid period) length of the growing period (LGP) divided into 13 intervals and intermediate (with no humid period) LGP being divided into six intervals. Fifteen most widely grown food crops, namely, wheat, rice, maize, barley, sorghum, pearl millet, white potato, sweet potato, cassava, phaselous bean, soybean, groundnut, sugar cane, bananas/plantain and oil palm were considered. Three alternative levels of farm technology (low, intermediate and high) varying from no

change in existing cropping patterns, no use of fertilizers and pesticides and no mechanization to optimum use of plant genetic potential, along with needed fertilizers and pesticides and full mechanization are postulated.

The soil characteristic, climate, growing season length, technology and cropping pattern, together with the requirement that production be sustainable (i.e. that appropriate fallowing requirements and soil conservation measures are allowed for), determine the production potential in each of the soil-climate grids. These are then aggregated to yield production potential at the level of a country. After deduction of seed, feed and wastage one then obtains the crop-wise potential output available for human consumption. Livestock production potential was also assessed, both under the assumption that only grassland will be used to support herds, and under the assumption crop residues and by-products will be used as well (Shah et al 1984, p. 32). Given the average energy (measured in kilo calories per day) and protein (in grams per day) requirements based on the 1973 recommendations of an expert committee of FAO and World Health Organization (WHO) and the age and sex distribution of the population of a country and the production available for human consumption in terms of energy and protein, the maximum population that can be supported can be determined. The results are shown in Table 1. In this table "critical" countries are the ones that cannot meet the basic food needs of their population even if all their arable land were devoted to growing food crops, and "limited" countries are the ones that cannot meet these needs if part of their arable land has to be diverted to produce other food and non-food cash crops. Finally, "surplus" countries are the ones that meet their food as well as other non-food requirements.

It should be noted that the population carrying capacity, reported in Table 1 for "limited" countries, is the population that can be sustained

Table 1

Population Carrying Capacities (Million)

Region	<u>Level of Farming Technology</u>		
	Low	Intermediate	High
<u>I. Africa</u>			
<u>Number of Critical Countries</u>	29	12	4
<u>Limited Countries</u>	4	7	4
<u>Surplus Countries</u>	18	32	43
<u>Population Carrying Capacity of:</u>			
<u>Critical Countries</u>	209 (466)	62 (110)	9 (11)
<u>Limited Countries</u>	68 (62)	340 (258)	70 (52)
<u>Surplus Countries</u>	977 (252)	4087 (412)	12789 (717)
<u>All Countries</u>	1254 (780)	4489 (780)	12868 (780)
<u>II. Southwest Asia</u>			
<u>Number of Critical Countries</u>	14	14	11
<u>Limited Countries</u>	1	-	3
<u>Surplus Countries</u>	-	1	1
<u>Population Carrying Capacity of:</u>			
<u>Critical Countries</u>	87 (195)	116 (195)	47 (89)
<u>Limited Countries</u>	93 (69)	-	118 (106)
<u>Surplus Countries</u>	-	121 (69)	159 (69)
<u>All Countries</u>	180 (264)	237 (264)	324 (264)
<u>III. Southeast Asia</u>			
<u>Number of Critical Countries</u>	6	2	1
<u>Limited Countries</u>	4	-	1
<u>Surplus Countries</u>	6	14	14
<u>Population Carrying Capacity of:</u>			
<u>Critical Countries</u>	270 (341)	148 (156)	(3)
<u>Limited Countries</u>	1492 (1190)	-	185 (153)
<u>Surplus Countries</u>	702 (407)	4210 (1782)	6149 (1782)
<u>All Countries</u>	2464 (1938)	4358 (1938)	6334 (1938)

if all arable land was devoted to crop production and this exceeds their projected population in year 2000. However, if a third of all land is assumed to be devoted to other crops and the carrying capacity correspondingly reduced by a third, the projected population (by year 2000) of these countries will exceed the reduced carrying capacity. This is why they are listed under the category "limited." Since in many countries of the developing world population will still be growing in year 2000, Shah et al (1984) compare population carrying capacity with the hypothetical size of stationary population. In this comparison, even with a high level of technology, eleven countries cannot support the size of their stationary population, the most populous among them being Bangladesh which is expected to reach a stationary population of 430 million in year 2035. Eight countries can support their stationary population only at a high level of technology, but of the most populous among them, namely Nigeria, the balance between carrying capacity (701 million) and stationary population (623 million) is too close for comfort.

Yet another study of this nature is by Bernard Gilland (1983). By multiplying an assumed maximum yield of 5 tons of grain equivalent per hectare and an assumed (indefinitely sustainable) availability of 1.5 billion hectares of land, he obtains a maximum global output of 7.5 billion tons of grain equivalent. Gilland's assumption that "a completely satisfactory" diet including some meat will involve an average daily total intake (direct and indirect through livestock products) of 9000 kilo calories per capita of "plant energy" leads him to conclude that the earth can support 7.5 billion people. A projected stationary population of roughly 11.5 billion people can be supported at a consumption about 6000 kilo calories per capita.

What inference can one draw from such studies? It would appear that

there is technological capability and land resources to sustain a population of as high as 33 billion (or nearly 9 times the projected population of 3.6 billion in year 2000) in the five regions of the world included in the FAO-IIASA study. But this by itself is no cause for complacency since there is virtually no economic analysis underlying these projections, even though their data base and assumptions regarding technology are considerably more sophisticated and far more spatially disaggregated than any of the earlier studies of the same genre. Since farming is done by millions of individual peasants, unless it is in their private economic interest, given the prices for inputs and outputs they face and the constraints to which they are subject, they will not produce a particular set and levels of crop outputs merely because it is agro-climatically and technoloically feasible to produce it. In particular, the investments in land, capital equipment, livestock, technical skills and knowledge needed to attain the potential output will not be forthcoming unless the returns are adequate. By asking whether each country or region within a country has the potential to sustain its projected year 2000 or its stationary population, one completely ignores the economic cost of such autarkic development even if it were feasible to do so. Thus, fundamental ideas of comparative advantage and gains from trade between regions within a country and between countries are conspicuous by their absence in such analyses. At best these studies are useful in pinpointing countries where, with a technology which raises the output per unit of land to the fullest extent, even current level of population cannot be sustained relying solely on home production. This may be taken as indicating the need for out-migration of a part of its population or for investment in production for exports to pay for food imports or some combination of both.

Besides the population carrying capacity study, IIASA also engaged in a major research project on food and agriculture. This project built a system of sequential general equilibrium models (Parikh and Rabar (1981)). These included 19 individual country models and three regional models (the European Community, Eastern Europe, including USUR and a residual rest of the world. The models were linked into a global trading system, in which the world markets for the ten aggregate commodities (9 agricultural and one non-agricultural) cleared to determine the time path of equilibrium world prices. Depending on the trade policy pursued by each country, the domestic prices can differ from world prices to a greater or lesser extent. The linked system of models were intended mainly to analyze the implications of liberalized agricultural trade and to explore possible national and international policies for alleviating hunger in the developing world. In these models, the growth of population until the year 2000 was assumed to follow the medium projections of the United Nations. The simulations suggest that given the exogenously specified real income and population growth in the countries and regions of the model, the global agricultural system can meet the effective demands placed on it till 2000 without significant changes in relative prices. While there is some reduction in the proportion of the global population that is hungry by year 2000 mainly due to projected income growth, policies, such as liberalization of agricultural trade etc, that do not involve global redistribution of incomes or assets do not significantly affect the number of hungry persons.

The India model of the IIASA linked system was, however, used to simulate the effects of varying the rate of growth of India's population between 1980 and 2000. It is more elaborate than others in the system in that it distinguishes five income (more precisely, per capita real

consumption expenditure) groups among rural and urban populations with the groups numbered according to increasing affluence (i.e. group 1 is the poorest and group 5 is the richest in both rural and urban areas). Each group has its own demand function represented by a Stone-Geary linear expenditure system and the distribution of aggregate consumer expenditure among groups is assumed to be log-normal. In this model population growth is exogenously specified and influences only the demand module. Three alternative growth paths were specified: Alternative 1 corresponds to IIASA's reference projection, Alternative 2 corresponds to the standard projections for year 200 and Alternative 3 corresponds to the rapid fertility decline and standard mortality decline projection of the World Bank (1984). There is a difference of 121 million between the projections of Alternative 1 and 3 by year 2000. The model was run in a stand-alone mode with the time path of the international price vector faced by India exogenously specified to be the same as that emerging as the equilibrium path in the Linked reference run. For the reason that population influences only per capita income and demand and not the production process, the differences between the alternatives are not large (see Table 2). As is to be expected, Alternative 3 with the slowest population growth leads to a minuscule speeding up in the rate of growth of real GDP. However, the impact on energy intake and in the distribution of population among expenditure groups is more perceptible. In general, for all groups energy intake increases as population growth decreases, and the distribution of income improves as a higher proportion of the population move to richer expenditure classes, particularly in the urban areas. But the changes associated with a smaller population size are modest.

The recent famines in some parts of sub-Saharan Africa have led some

Table 2
Projections from India Model of IIASA

		Alternative 1	Alternative 2	Alternative 3
1.	Population (Millions)	1980 674 1990 843 2000 1048	672 818 995	670 788 927
2.	Rate of Growth of Population (% per year)	1971-2000 2.249 1980-2000 2.232 1990-2000 2.206	2.057 1.980 1.980	1.808 1.637 1.637
3.	Rate of Growth of Real GDP (% per year)	1971-2000 4.746 1980-2000 5.349 1990-2000 6.077	4.752 5.356 6.090	4.756 5.363 6.100
4.	Production of Wheat (Million Metric tons)	1980 33 1990 57 2000 85	33 57 84	33 57 83
5.	Production of Rice (Million Metric tons)	1980 47 1990 68 2000 92	47 68 92	47 68 92
6.	Production of Coarse Grains (Million Metric tons)	1980 26 1990 32 2000 35	26 32 34	26 32 34
7.	Production of all Grains (Million Metric tons)	1980 106 1990 157 2000 212	106 157 210	106 157 209
8.	Daily Calorie Intake			
	A. Rural Group 1	1990 1018(28)* 2000 1111(20)	1024(27) 1152(18)	1030 (26) 1183 (16)
	2	1990 1958(17) 2000 2125(16)	1959(17) 2159(16)	1961 (17) 2184 (15)
	3	1990 2584(19) 2000 2840(20)	2588(19) 2872(20)	2591 (19) 2897 (20)
	4	1990 2659(20) 2000 2927(23)	2674(20) 2937(23)	2693 (20) 2988 (23)
	5	1990 3789(17) 2000 3911(22)	3837(17) 4013(23)	3898 (18) 4174 (25)
	B. Urban group 1	1990 1170(2.1) 2000 1173(0.5)	1172(1.0) 1217(0.4)	1178 (0.9) 1261 (0.3)
	2	1990 1654(5.7) 2000 1689(3.4)	1657(5.3) 1726(2.9)	1664 (4.9) 1766 (2.3)
	3	1990 2029(17) 2000 2040(13)	2039(16) 2073(12)	2052 (15) 2115 (11)
	4	1990 2379(35) 2000 2352(34)	2396(35) 2397(33)	2419 (34) 2456 (32)
	5	1990 3102(41) 2000 3010(49)	3145(43) 3091(51)	3200 (44) 3209 (55)

Source: Same as for Table 6.

* Figures in parentheses denote the population of each class as a proportion of the relevant total population.

to point to the rapid growth in population there as one of the major contributory causes. Rapid desertification, in part due to the abandonment of the traditional methods of cultivation and livestock management, shift of cropping patterns in favour of export crops, etc. have been attributed to population pressure (Talbot (1986). However, it is becoming increasingly clear (Lele and Meyers (1986), Williams (1984)) that inappropriate government policies rather than population growth are largely responsible for the African tragedy.

Another important renewable resource is the natural environment. It is asserted that rapid population growth will accelerate the degradation of natural environment. There are two separate points to be made here. First, a number of serious environmental degradation problems arise from the production and consumption of commodities which are not only highly income elastic but also have environmental side effects. And, as in the case of exhaustible resources, the contribution of the growth of population per se to exacerbating this problem is not dominant. The second point is that almost by definition many of the environmental problems arise from externalities that are not reflected in the private production and consumption decisions. As is well-known, with an appropriately defined property rights and a suitably defined set of taxes and subsidies the externalities could be internalised. It is argued that the use of fossil fuels in developing countries exacerbates the carbon dioxide accumulation. Also, the deforestation associated with extension of food cultivation and use of firewood as fuel allegedly has led to changes in climatic conditions and soil erosion. Apart from the fact that the quantitative estimates of the extent of such degradation are extremely unreliable and their alleged negative effects, even if they are significant, questionable, once again, with a well-defined system of property rights and taxation, the negative effects could be contained. In

any case, the contribution of population growth to this phenomenon is exaggerated.

4. CAPITAL ACCUMULATION, TECHNICAL CHANGE AND INCOME DISTRIBUTION

It has been claimed that rapid population growth diverts resources away from saving and toward current consumption through several channels (Coale and Hoover (1958)). A more rapid rate of growth of population leads to a larger share of children in total population. This is viewed as inducing households to consume a larger proportion of their income than they otherwise would have done. A second channel is through public expenditure on education and health. Once again, it is argued that greater the proportion of children in the population, greater is the demand for education and health expenditures. With a given total budget these divert public resources from investment in physical capital. Yet another channel through which rapid population growth affects accumulation is through lower level of capital per worker in a steady state, thus reducing the level of steady state per capita consumption. A rough quantitative estimate of this effect can be obtained with a neo-classical growth model in which aggregate output is produced with a Cobb-Douglas production function. If capital owners do not consume and workers do not save, and if population and labor force grow at the same rate, then the elasticity of steady-state per capita consumption with respect to the rate of growth of population is $-\alpha/1-\alpha$, where α is the elasticity of output with respect to capital. With $\alpha = 0.25$, this elasticity is a modest -0.33 .

If the decision regarding childbearing is not viewed as exogenous but subject to choice, then the fact that some societies or households have more children and less of material things may simply mean that the cost of

childbearing relative to material things is lower than in others, or that their preference ordering of children and material things is different. In this view there is nothing on welfare grounds that one can infer from differences in the rates of population growth or savings across societies. Second, the fact that in low income countries children support their parents in their old age because other forms of old age security are not available can be taken to imply that as development proceeds and financial instruments for saving and insurance become available, fertility will decline. Although this argument is indeed plausible, in theory it is not clear whether the motive for having children as providers of old age security will always lead households to have more children than otherwise (Srinivasan (1985)). In the model of Becker and Barro (1985), the fertility of the altruistic household and population growth is only temporarily reduced by an expansion of social security.

The likely determinants of saving are many and dependency ratio is only one of them. It is not surprising that the empirical evidence linking savings ratios and dependency ratios is not conclusive. Although Mason (1985) finds that available evidence from an international cross section supports the proposition that a higher dependency ratio leads to lower saving, he himself suggests that the analysis on which this conclusion is based does not address a number of important issues. In particular, there are very few studies of the impact of household composition on household consumption or saving in developing countries, and most studies are based on aggregate national level data and not data from micro household surveys. Most of the studies take into account only the resource use implications of having more children and do not take into account the fact that in poor societies children also participate in labor force and generate income for the households. Taking both the resource

cost and income generation into account, whether the children are a net drag on savings is not empirically established conclusively. Mason cautiously concludes that the importance of demographic factors to national savings rates is likely to be the subject of continued debate.

The impact on public investment once again needs to be qualified. First of all it would be misleading to view expenditures on health and education as consumption only. If anything, these expenditures are mostly, if not wholly, investments in human capital which will enhance the productivity of the worker. Second, there is very little empirical evidence which suggests that the share of government spending on health and education is influenced significantly by the dependency ratio. Third, in attempting to assess the effect of dependency ratio on public expenditures, one has also to take into account that households themselves devote part of their resources to provide for the health and education of their offspring. Disentangling the effect of dependency on public and private expenditures on education and health in a world in which fertility decisions themselves are endogenous requires building and estimating sophisticated econometric models. To jump to strong policy conclusions from observed associations between public expenditures and dependency ratios would be inappropriate. In one of the more careful studies, Schultz (1987) analyzes data from a number of countries on enrollment rates and spending per student. He finds no effect of higher population growth on enrollment rates, while some negative effect on spending per student is discerned. He is cautious about placing excessive interpretation on rather weak results from a cross section.

The argument that more rapid population growth will reduce the steady state capital per worker is based on a very simple neoclassical growth model in which output is a constant return to scale function of capital

and labor. If workers do not save and capitalists do not consume, then in the steady state, per capita consumption will be at a maximum. Further, the rate of growth of output and the own rate of interest on capital will equal the rate of growth of the labor force, which in turn is equal to the rate of growth of population. It is evident in this model that a more rapid growth of population will increase the steady state rate of growth of output in the same proportion, but since the own rate of interest on capital also goes up by the same proportion, capital per worker and output per worker will be lower in the new steady state. Further, for maintaining capital stock per worker constant along the new steady state more of the output is devoted to gross investment, so that per capita consumption is lower. However, in this framework the rate of growth of population is exogenous. If the rate of growth of population is endogenous and one compared different economies which are along their steady states, it is not clear that one would observe a negative association between capital per worker and the equilibrium rate of growth of population. In any case, in the simple neoclassical models the economy is closed, not only with respect to trade and commodities, but also with respect to capital flows between countries. Once international capital flows are allowed, the analysis gets complicated (Deardorff (1985)).

The neoclassical models of growth assume that technical change, if any, is exogenous to the process of capital accumulation and population growth. It has been argued by some that the innovation process itself is influenced by demographic factors. In particular, Boserup (1981) has argued that the technology of cultivation is influenced by population density. Simon (1981) argues that the rate of technical progress would be influenced by population growth, basing themselves on the argument that a larger population implies a larger amount of knowledge creation and also

that a larger population achieves economies of scale both in the production of goods and of knowledge. He suggests that more rapid growth of population may in fact enhance the rate of growth of technical progress. Binswanger and Pingali (1984) find some empirical support for the Boserup thesis. Unfortunately, carefully conducted empirical studies of the determinants of technical progress are far too few to be able to judge the claims of Simon. The evidence he provides are suggestive but by no means conclusive.

The impact of changes in the rate of growth of population on income distribution is another matter where there has been some debate in the literature. Although there is some evidence from cross section studies that income inequality is higher in countries with more rapid rate of growth of population, there are a number of serious econometric and measurement problems that vitiate this analysis. In theory, one can of course associate greater income inequality with a more rapid rate of growth of population. For example, in the neoclassical growth model discussed earlier in which the capitalists do not consume and wage earners do not save, if one compared two economies with access to the same technology but with different rates of growth of population, both economies being on their steady state, the one with the higher rate of growth of population will have a lower wage share and a higher profit share. If wage earners are identified with the poor and the capitalists are identified with the rich, this suggests a deterioration in income distribution with increases in the rate of growth of population.

Another argument that is often advanced is that the minority of rich households in poor countries have tended to be those households with low fertility, while the majority of the poor have high fertility. Reinforcing this is the association between parental income and

expenditures on improving child quality through education and health expenditures. If the poor not only have more children but also spend less on investment in human capital on each, then the poor would get poorer and the rich will get richer over time. However, this argument is much too simplistic. A prior question is an explanation of the differential fertility between the rich and the poor. This may merely reflect differential opportunities for investment. For example, if the poor invest in children as providers of old age security only because they have no access to other investments with higher yield, while the rich, because of their access to investment opportunities, not only invest more in them and less in their children but also spend more on their children's education, then the analysis should focus on the reasons for differential access to investment opportunities and not on the fertility differentials per se since the latter are endogenous. There are several theories attempting to explain why inequality in wealth distribution is much greater than the inequality in the income distribution. Becker's (1967) hypothesizes that individuals who are more able obtain systematically higher returns to investment and tend to become wealthier. Yitzhaki (1986) suggests that if relative risk aversion is decreasing in wealth (in itself a questionable proposition), the wealthier individuals will invest in relatively risky but higher yielding portfolios and as such expected returns per unit of investment will be increasing in wealth. Finally, Arrow (1986) shows that if the cost of acquiring information about the rates of returns to alternative investment is independent of the amount invested, then the optimal amount of information purchased by an investor will be an increasing function of wealth, leading to the distribution of final wealth being more unequal than initial wealth. In all this, fertility differentials play no role.

Another version of the fertility-based argument is that when opportunities for fertility reduction become available in a poor society, the rich make use of them first. Thus, at the early stages of development the benefit of fertility reduction is concentrated among the upper strata of society and as such income inequalities would increase. Of course, once the poor also avail themselves of the opportunities for fertility reduction, this process eventually has to reverse itself. Once again, one has to ask why it is that the rich make use of the knowledge first. If this is because of their greater access to publicly-provided knowledge and publicly-subsidized means of fertility reduction, then one has to address the issue of differential access issue rather than focus on the resultant paths of fertility reduction of the two classes over time.

5. IS THERE A CASE FOR A POPULATION POLICY?

It is evident from historical data from the presently developed countries that there was a demographic transition from high to low fertility associated with their economic development. It is also clear that the time span over which the transition took place varies among countries. If a similar transition can be expected in the developing countries and if it leads to a level of fertility which is considered appropriate, and if the time span over which the transition is likely to take place is also not too long from a social perspective, then one could argue that there is no reason for changing either the post-transition fertility or the pace at which the transition takes place through public policy. Demeny (1986) for one does not believe that the premises underlying this assertion are likely to hold.

Families are the institutions whose fertility behavior determines the aggregate fertility outcome and hence the characteristics of the

transition. It is to the literature of the economics of the family that one has to turn for understanding the determinants of the transition. One very influential strand of this literature (Becker (1981)) views the household as 'producing' the goods and services that it desires using inputs purchased from the market and the time available to its members. One major conclusion emerging from this approach is that the fertility behavior is largely influenced by the trend in the cost of children relative to other activities that generate household welfare. The cost of nurturing a child and investments in its quality are both influenced by the cost of the mother's time. To the extent that rising female labor participation rates and female wages are associated with economic development, a decline in fertility can be expected. Offsetting the tendency for the cost of a child to increase because of the increasing value of mother's time is the potential contribution to the family income that a child makes in low-income economies through their participation in household production and even market activities. It is thus possible (Lindert (1980)) that before the cost of a child increases through economic development, there may be initially a fall in this cost because of increased opportunities for household production.

Attempts to quantify the effects of rising female wages on fertility have been made with historical data. For instance, Paul Schultz (1985) shows that a quarter of the decline in Swedish fertility from 1860 to 1910 could be accounted for by the rising value of female time.

The interaction between quality of children and the number of children and its impact on fertility decisions are complex. The benefits from having children and investing in their quality will accrue over a span of time in the future. Like all other investments, investment in children is also a hostage to fortune. The realization of the benefits of

such investment depends on the fulfilment of an essentially implicit contract between children and their parents. Any threat by a parent on a child (or vice versa) imposes emotional costs on the parent as well as the child. As such, the threats are unlikely to be credible enforcement mechanisms. The emphasis on implicit contracts, incentives for evasion and the consequent need for costly monitoring distinguishes the "transactions cost approach" to families. In Pollak's characterization, this approach "views marriage as a 'governance structure,' emphasizes the role of 'bargaining' within families, and draws attention to the advantages and disadvantages of family organization in terms of incentives and monitoring and to the special roles of 'altruism' and 'family loyalty'" (Pollak (1985), p. 605).

Unfortunately, in the household production model and the transactions approach a major role is played by unobserved heterogeneity in household preferences, technology, inherited traits, etc. To derive testable hypotheses about parameters of models involving only observable variables from either theory involves assumptions about structural relations and about functional forms of the distribution of latent variables. As Willis (1986) points out, "we do not have as yet a body of empirically tested quantitatively stable estimates of the major behavioral relationships suggested by the theory," although "we do have a growing capacity to generate hypotheses about both large and small questions concerning family behavior and its consequences within a theoretical framework that is a logically coherent part of the main corpus of neoclassical economic theory." Until one has a firm empirical explanations of the factors influencing fertility behavior, attempts to influence such behavior through public policy are to a considerable extent misplaced.

Demeny forcefully argues that externalities associated with

individual fertility behaviour are so pervasive that a population problem will arise in a laissez-faire equilibrium. One of his examples, that "a population problem exists when my preference for children diminishes your access to steak," seems to confuse pecuniary externalities that have only distributional implications with externalities that arise from interdependent technologies or preferences.³ In theory, in the presence of the former, the laissez-faire equilibrium is pareto optimal, and as such any socially desired redistribution can be brought about through lump sum transfers. In the presence of the latter the laissez-faire equilibrium is not pareto optimal. However, as discussed earlier, the empirical evidence for a significant presence of the externalities of the latter kind is not overwhelming and in any case, the optimal policy interventions to address them are well known, although the feasibility of implementing them is a matter of debate, particularly from the point of view of acquiring the information needed to design the optimal policy. Indeed, if the information problem is sufficiently severe, there may not be any feasible policy intervention that improves social welfare compared to a laissez-faire equilibrium, let alone maximize it.

To conclude, 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 consequence 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. But, if households are constrained in achieving their desired fertility because of lack of relevant information about means of fertility control, appropriate policy intervention to provide such information may be socially desirable. A case for publicly-supported dissemination of family planning information can be made on these grounds.

FOOTNOTES

*I thank Paul Demeny and Paul Schultz for their comments on an earlier draft.

¹Since an individualistic SWF cannot be at a maximum if the allocation is not Pareto Optimal (PO), the question then reduces to whether any arbitrary PO allocation can be sustained as a competitive equilibrium. The second welfare theorem of neo-classical welfare economics asserts that under additional restrictive assumptions, including convexity of the set of production possibilities and individual preferences, this is possible provided redistribution of individual endowments or incomes through lump sum transfers is feasible.

²This section draws on "Population and Food" in D. Gale Johnson and Ronald Lee (eds.), Population Growth and Economic Development, Washington, D.C., National Academy of Sciences (forthcoming).

³In private correspondence Paul Demeny has disputed any such confusion claiming that "uncoordinated demographic choices are likely to have an impact on income per capita over time. If the change is for the worse, lump sum transfers offer no remedy. The issue is not whether a Pareto optimum will be achieved--it may well be--nor where that optimum will lie. The issue is the size of the [Edgeworth] box: a weightier affair than mere distribution and optimal allocation." I am afraid that the problem is not one of (static) allocation versus dynamic growth. The problem is simply a pecuniary externality affecting inter-temporal choice and resource allocation. In principle, it is a distributional (across generations) issue amenable to standard remedies albeit involving intertemporal as well as contemporaneous transfers.

REFERENCES

- Arrow, K. J. (1986) "The Demand for Information and the Distribution of Income," Technical Report 494, The Economics Series, Institute for Mathematical Studies in the Social Sciences, Stanford University (processed).
- Becker, G. S. (1967) Human Capital and the Personal Distribution of Income: An Analytical Approach, Ann Arbor, University of Michigan Press.
- _____ (1981) A Treatise on the Family, Cambridge, Harvard University Press.
- _____ and R. J. Barro (1985) "A Reformulation of the Economic Theory of Fertility," University of Chicago, Economics Research Center/NORC, Discussion Paper 85-11 (processed).
- Birdsall, N. (1987) "Economic Approaches to Population Growth and Development," preliminary draft of a chapter in Hollis Chenery and T. N. Srinivasan (eds.) Handbook of Development Economics, Amsterdam, North-Holland (forthcoming).
- Binswanger, H. and P. Pingali (1984) "The Evolution of Farming Systems and Agricultural Technology in Sub-Saharan Africa," Discussion Paper ARU-23, Washington, D.C. World Bank.
- Boserup, E. (1981) Population and Technological Change: A Study of Long-Term Trends, Chicago, University of Chicago Press.

- Coale, A. and E. M. Hoover (1958) Population Growth and Economic Development, Princeton, Princeton University Press.
- Dasgupta, P. (1985) The Ethical Foundations of Population Policy, background paper prepared for the Working Group on Population and Economic Development, Committee on Population, National Research Council, National Academy of Sciences, Washington, D.C.
- Deardorff, A. (1985) Trade and Capital Mobility in a World of Diverging Populations, background paper prepared for the Working Group on Population and Economic Development, Committee on Population, National Research Council, National Academy of Sciences, Washington, D.C.
- Demeny, P. (1986) "Population and the Invisible Hand," Demography 23 (4).
- Gilland, B. (1983) "Considerations on World Population and Food Supply," Population and Development Review, 9 (2), 203-211.
- Higgins, G. M., A. H. Kassam, L. Naiken, G. Fischer and M. M. Shah (1983) Potential Population Supporting Capacities of Lands in the Developing World, Technical Report FPA/INT/513 of Project Land Resources for Population of the Future, FAO, Rome.
- Kelley, A. (1984) "The Population Debate: A Status Report and Revisionist Interpretation," Department of Economics, Duke University, processed.
- Lele, U. and L. R. Meyers (1980) "Growth and Structural Change in East Africa: Domestic Policies, Agricultural Performance and World Bank Assistance, 1963-1986," Research Report No. 1, Managing Agricultural Development in Africa, Washington D.C., World Bank (processed).

Lindert, P. (1980) "Child Costs and Economic Development," in Richard Easterlin (ed.), Population and Economic Change in Developing Countries, Chicago, University of Chicago Press, 5-79.

Mason, A. (1985) "National Savings Rates and Population Growth: A New Model and New Evidence," background paper prepared for the Working Group on Population and Economic Development, Committee on Population, National Research Council, National Academy of Sciences, Washington, D.C.

McNicoll, G. (1984) "Consequences of Rapid Population Growth: An Overview and Assessment," Population and Development Review, 10, 177-240.

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

Nerlove, M., A. Razin and E. Sadka (1987) Household and Economy: Welfare Economics of Endogenous Fertility, New York, Academic Press.

Nordhaus, W. (1986) "Resources, Technology and Development: Will the Table be Bare When Poor Countries Get There?," Indian Economic Review, XXI (2), 81-94.

Pollak, R. A. (1985) "A Transaction Cost Approach to Families and Households," Journal of Economic Literature, XXIII (2), 581-608.

Schultz, T. P. (1985) "Changing World Prices, Women's Wages, and the Fertility Transition: Sweden, 1860-1910," Journal of Political Economy, 93 (December), 1126-1149.

_____ (1987), "Education Investments and Returns in Economic Development," preliminary draft of a chapter in Hollis Chenery and T. N. Srinivasan (eds.), Handbook of Development Economics, Amsterdam, North-Holland (forthcoming).

Shah, M. M., G. Fischer, G. M. Higgins, A. H. Kassam and L. Naiken (1984), "People, Land and Food Production--Potentials in the Developing World," International Institute for Applied Systems Analysis, Luxenburg, Austria (mimeographed).

Simon, J. (1981), The Ultimate Resource, Princeton, Princeton University Press.

Srinivasan, T.N. (1985) "Children as Providers of Old Age Security and Parental Fertility Decisions," Yale University, Economic Growth Center, processed.

Talbot, L. M. (1986), "Demographic Factors in Resource Depletion and Environmental Degradation in East African Rangeland," Population and Development Review 12(3), 441-451.

Williams, M. J. (1984), as quoted in The New York Times, December 2.

Willis, R. J. (1986), "What Have We Learned from the Economics of the Family?," University of Chicago, Economics Research Center--NORC, Discussion Paper 87-1.

World Bank (1984), World Development Report, New York, Oxford University Press.

Yitzaki, S. (1986), "On the Relation Between Return and Income," Quarterly Journal of Economics (forthcoming).