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Population Change and Aggregate Output

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1. Introduction

FOR the modern period, that is, since the end of the 18th century, the available statistical records reveal no cases in which the prevalent substantial rises in population were accompanied by secular declines in per capita product. To be sure, there were sharp drops in total and per capita output—occasioned in the underdeveloped countries by crop failures and in the developed countries by cyclical recessions. In the underdeveloped countries population increase, occurring under conditions of pre-modern agriculture and primitive transportation and industry, can be viewed as a factor in the persistence of a low per capita standard of living, and hence in the catastrophic impact of famines. Yet the long-term statistical records, error-prone as they are for such countries as India and Egypt over the first half of the 20th century, give no clear indication of a long-term decline, although they do show failure of the low per capita income to rise. The evidence thus suggests that in modern times secular rises in population have been accompanied by secular rises in aggregate output—for many countries so large that there was also a marked secular rise in per capita product.[1]

It appears that population growth, despite pressure on the limited stock of natural resources and man-made capital, has permitted substantial rises in product per capita, particularly in countries with a social framework attuned to modern technology. However, the empirical evidence, at least in its present state, is insufficient for a detailed analysis of the impact of population growth on the growth of aggregate output. While it reveals marked contrasts among countries with respect to growth of income per capita, it does not suggest that differences in the rate of population increase are an important variable in accounting for these contrasts. In the discussion that follows, we must, therefore, resort to speculation.

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[1] In Table 1 of my paper "Quantitative Aspects of the Economic Growth of Nations: I," *Economic Development and Cultural Change*, Vol. v, no. 1, October, 1956, p. 10, eighteen countries that show secular growth of population show also a substantial rise in per capita product. Ireland, in the nineteenth century, shows a decline in population and a rise in per capita income.

The theme is a broad one—the impact of secular growth of population on per capita output. I speak of growth rather than decline because it has been, and is likely to be, far the more prevalent pattern; and I focus on per capita output, because any conclusion concerning the contribution of population growth to the rise in per capita output leads to obvious inferences for aggregate output. Finally, a word about the drift of the speculations that follow. My impression is that recent professional (and popular) literature has emphasized the disadvantages and dangers of population growth—the drain upon irreproducible resources, upon capital accumulation, upon the organizing capacity of societies, and so on. Little can be added to these arguments. But as a matter of balance, I propose to dwell upon the positive contributions of population growth —admitting that they must eventually be weighed against the negative effects.

2. *Population as Producers*

An increase in population means, other conditions being equal, an increase in the labor force. The precise contribution to the labor force will differ depending upon whether population growth is caused by a decline in the death rate, by net immigration, or by an increase in the birth rate. The differences are of great importance, since reduction in the death rate of the working population or net immigration (usually of persons in the prime working years of life) minimizes the cost of investment in bringing infants to the age of effective participation in the labor force. We recognize these important differences but prefer not to complicate the discussion by treating them separately.

Let us assume that the labor force increases at the same rate as total population (or somewhat less if there is an increase in the birth rate). This increased labor force will be able to turn out as much or more product per worker (and hence per capita of total population) if it is equipped with the same amount of capital as, or greater amount than, was previously available per worker; and if the reproducible capital-output ratio remains the same or decreases. The latter "if" takes account of the possible effect of pressure upon the limited supply of irreproducible resources: if such pressure develops, there may be need for more man-made capital per unit of output, or for some chain of substitution and technological innovation.

I shall deal with the supply of capital in the section below. Here, the point to be stressed is that capital investment must include not only material goods, but the even more important input into education and

training of the population—a factor of particular relevance if population growth stems from the birth rate rather than from the death and immigration rates. Obviously, the productive contribution of these additional numbers is as dependent upon their education and skills as upon the material capital equipment with which they are provided.

Let us assume further that capital investment, thus broadly conceived to include the raising and training of the new generations, is at least as large per capita for the additions to the labor force (B) as for the already existing labor force (A). What are the reasons for assuming that the per worker productivity of $A + B$ would be greater than that of A and, that, therefore, under the conditions given (constant proportions of labor force to population), per capita income would also be higher? Three somewhat different reasons can be advanced.

The first is connected with the distinctive assumption that there exists in the country a variety of unexploited natural resources and that additions to the labor force would permit greater utilization of these resources. This utilization, combined with a more specialized division of labor would, in all probability, lead to a greater product per worker. The crux of this argument lies in two points: (a) an increasing density of population spreading to formerly uninhabited parts of the country brings into use resources previously inaccessible, and the wider base of natural resources warrants the expectation of a higher per worker productivity; (b) a larger labor force permits a more intensive division of labor with whatever higher productivity benefits attach thereto. This is certainly a special case, but it should be kept in mind in view of the experience of several countries in the Western hemisphere. For example, the history of Brazil and even of Canada suggests that the diverting of most of the available immigration from Europe to the United States deprived these countries of an influx of immigrants before World War I (and perhaps even after) that could have contributed to a greater rise not only in aggregate output but even in output per capita. There may be countries in the world today in which a more intelligent and liberal immigration policy would mean an impetus to the growth of both aggregate and per capita product.

Second, there is the argument concerning the greater mobility of a growing than of a stagnant labor force, advanced by J. M. Keynes when the specter of stagnant or declining population haunted the advanced Western economies.[2] It is the younger groups in the labor force who are most mobile—in space and within the productive system—since, unlike

[2] See his "Some Economic Consequences of a Declining Population," *The Eugenics Review*, Vol. xxix, no. 1, April, 1937, pp. 13-17.

older workers, they are not committed to family and housing or to established positions. This greater mobility is particularly true of new entrants into the labor force, who naturally veer toward those sectors that are likely to spearhead the country's economic growth, and who are oriented toward these sectors even in their training within the educational system.

There is an important related aspect. Population growth may be due either to immigration, or to a substantial rate of natural increase (or to both). In the latter case, there are likely to be sizable differences among various social groups and various parts of the country (for example, between the lower and upper income groups, and between the countryside and the cities) in the rates of their natural increase. Such differences are usually negatively correlated with differences in economic growth opportunities: while the transition to industrialization is occurring, the countryside and smaller cities with their lesser economic growth opportunities are likely to have higher rates of natural increase than the larger cities with their greater growth potentials; similarly, the rates of natural increase of low income groups are likely to be higher than those of high income groups with their greater economic opportunities. It follows that the realization of economic growth potentials is contingent upon a vast internal migration—movement of people from the country to the cities, and within the cities from places of lesser to those of greater economic promise. A substantial rate of population growth means, then, either a greater rate of immigration from abroad or a greater rate of internal migration, or both. This migration may be supplementary to the special mobility propensities of the young entrants into the labor force.

The importance of mobility in the distribution of human resources in response to the differential growth possibilities in the economy can easily be underestimated. Modern economic growth is characterized by rapid structural changes, shifts in importance among industries, and in their location within the country's economy. Stickiness in the response of the labor force to such potential changes can be a serious obstacle to economic growth and greater per capita product. If insufficient labor flows to rising economic opportunities, the relative cost of labor and the relative price of the product remain too high to permit expansion of output to the full potential. Conversely, if the labor force in relatively deteriorating economic opportunities remains attached to them, the national level of product per worker and per capita is not likely to rise. A young or otherwise mobile group within the labor force is therefore strategically important. Moreover, a migrant who has severed familial and other

noneconomic ties is a more adaptable economic agent than a person who, like a stationary stone, is overgrown with the moss of his habitual patterns of life. It follows that population growth, in contrast to population stability, may, because of the greater mobility and adjustability of human resources, be conducive to higher per worker (and hence per capita) levels of output; and this may be true, within limits, of greater vs. lesser population increase.

The third argument is perhaps the most far-reaching. The greatest factor in growth of output per capita is, of course, the increasing stock of tested, useful knowledge. The producers of this stock are the scientists, inventors, engineers, managers, and explorers of various description—all members of that population whose growth we are considering. Assume now that, judged by native capacities (and they do differ), 0.05 per cent of a given population are geniuses, another 2.0 per cent are possessors of gifts that may be described as talent, and another 10.0 per cent have distinctly higher than average capacity for fruitful search for facts, principles, and inventions. (The grades of native ability and percentages are, of course, purely illustrative, and would probably be changed by an expert in this field.) Since we have assumed the education, training, and other capital investment necessary to assure that the additions to the population will be at least as well equipped as the population already existing, the proportion of mute Miltons and unfulfilled Newtons will be no higher than previously. Population growth, under the assumptions stated, would, therefore, produce an absolutely larger number of geniuses, talented men, and generally gifted contributors to new knowledge— whose native ability would be permitted to mature to effective levels when they join the labor force.

We now face the question whether an increase in the absolute number of these contributors to new knowledge is likely to produce increasing, constant, or diminishing returns per head. Returns in this case mean potentially useful knowledge in the form in which it can have major effects on economic production—as has been the case in the modern period. My answer inclines strongly toward increasing returns—for two reasons. The first lies in the interdependence of knowledge of the various parts of the universe in which we human beings operate—in the sense that greater knowledge of chemistry contributes to greater knowledge of physics, and progress in both of these contributes to greater knowledge of physiological and biological functions. In the same sense, discoveries and inventions in the field of tensile strength of metals contribute to discoveries and inventions in the field of electric currents; and even new devices in

social engineering in one field (for example, corporate organization) facilitate new organizational devices in other fields (for example, credit instruments). A greater supply of people who can contribute to new knowledge may therefore mean a better coverage of a variety of inter-related fields, and where discoveries so complement one another, econo-mies achieved are likely to make for a higher output per worker than would be possible for a smaller group whose coverage of these different but related fields is, perforce, spotty. Second, creative effort flourishes in a dense intellectual atmosphere, and it is hardly an accident that the locus of intellectual progress (including that of the arts) has been pre-ponderantly in the larger cities, not in the bucolic surroundings of the thinly settled countryside. The existence of adequately numerous groups in all fields of creative work is one prerequisite; and the possibility of more intensive intellectual contact, as well as of specialization, afforded by greater numbers may be an important factor in stepping up the rate of additions to useful knowledge. While, for obvious reasons, no simple measure of the stock or flow of new knowledge is available, the course of development of science, technology, and the useful arts suggests acceler-ation rather than retardation, with no diminishing returns, even taking account of the large increase in the human resources flowing into this particular area of activity. Compared with the two factors mentioned above as likely to make for greater per capita productivity of larger numbers of creators of new knowledge, the possibility of diminishing returns is remote: the universe is far too vast relatively to the size of our planet and what we know about it. Recent spectacular changes in the means of exploring the universe and the wide possibility of new, and eventually usable, knowledge that they suggest, only serve to strengthen this point.

Growth of economic output is a function of the growth of the stock of tested knowledge. Since, on the assumptions stated, population increase adds proportionately to the number of creators of new knowledge, it should result in at least a proportional addition to the stock of tested knowledge, and, therefore, to growth of product per capita at least as large as that in the past. If, for reasons suggested just above, we also assume increasing returns on output of new knowledge, per head of knowledge-creator and hence per head of population, we may infer that, *ceteris paribus*, population growth will contribute to *greater* growth of per capita product.[3] The argument is clearly venturesome; for example, it

[3] I am indebted to Professor Moses Abramovitz for a comment that led me to restate this argument in a form different from the original.

implies a theory of production of knowledge such that a smaller number of humans could not be compensated for by more intensive training. And I am sure that other objections could be raised, but for the present let me advance this argument as a plausible hypothesis which merits attention if only because of the far-reaching importance of the issues it poses.

Two final comments in this connection may be relevant. First, the argument stresses the importance of human beings not as producers of commodities and services, but as producers of new knowledge—as the only carriers of the learning and creative ability that provide the basis for our economical and social progress. This concept is quite close, of course, to the idea of the divine spark in human beings, which is at the core of much religious resistance to policies aimed at limitation of population. Passing over these matters, which are beyond my ken and interest, let me just point out that there is an element of sound instinct behind such resistance: insofar as it is possible to give the new generations the education and other requisites of *Homo sapiens*, failure to increase means failure to add to the possible carriers of light and knowledge—and the implicit losses may be far larger than the costs avoided.

Second, we should recognize that the creative and educated groups in the developed economies—and they are the central reference point here —serve partly, and should serve more fully, the economic needs of the whole world, not merely of their own countries. Knowledge is transnational in its application, and the returns on the input of effort into new discoveries, inventions, improvements, and so on, should be measured in terms of increased output per worker not only in the country of origin but elsewhere. In that sense, greater population growth that leads to a substantial increase in the cadres of creative workers at various levels— and this is likely to occur in developed economies alone, although there have been striking isolated instances elsewhere—may produce a *greater* rise in product per worker both in those countries *and* elsewhere than would result from lesser or no population growth.

3. Population as Savers

All the arguments above claiming that population increase may contribute to a higher per capita product are contingent upon the provision of sufficient capital to educate and train the additional workers, equip them with adequate tools, and implement the inventions and innovations they may introduce. We should now consider whether population growth impedes capital formation. A family with ten children is not likely to be able to spend as much on the education and training of each as a family

with two, nor is it likely to contribute as much to the savings that finance material capital formation. Generalizing this case, we could argue that population growth, in and of itself, reduces the resources for investment in training and reproducible capital per head of new additions to population. If this argument were valid it would severely limit all those advanced above because the assumption of adequate capital would be removed.

The contention just set forth may be unchallengeable for under-developed countries, but in the advanced economies the situation is not that simple and determinate. There are reasons to assume that any *private* failure to make the proper investment in education and training can easily be corrected (and in many cases has been so corrected) by public action, and that the very process of population growth contributes to an increased flow of savings to finance additional material capital formation.

We begin with the case where population growth, stemming from natural increase, may result in inadequate investment in the education and training of the younger generation (I include all expenditures needed to develop an effective member of society, over and above bare suste-nance). Such inadequacies may result either from inability of the family unit to cover the necessary costs; or, despite such ability, failure to appreciate the need. In either case, the shortfall, relative to the economic output of the advanced economies, is likely to be small; and in the past many countries have instituted free primary education, subsidies for higher education, etc. We are positing here limits to the birth rate: naturally, if every family unit attempts to raise twenty children, the problem assumes different dimensions. But we shall deal with this qualification toward the end of the paper, since it is relevant to most of the arguments here.

The effects of population increase on the possible shortage of savings to finance material capital formation pose a more serious problem. Indeed, it is the central problem in this section because we are assuming now that investment in raising and educating the younger generation is adequate. Consequently, the additional drain upon resources represented by population increase affects material capital formation alone. Can we assume that in the very process of population growth some forces emerge that tend to augment savings and hence capital formation? Several such forces can be suggested.

First, there is little ground for supposing that where population grows by natural increase, the added outlay by either parents or society is all at the expense of otherwise proportionately larger savings. So far as

private spending-saving units are concerned, it is not clear that expenditures on children are a substitute for savings (particularly in the advanced economies) rather than for more consumer goods or for more leisure. While correlations are often deceptive, one may point to the fact that the birth rate is higher in those areas where the per capita consumer expenditures are lower; and in the big cities the choice is largely between children and a relatively more costly mode of living. Inasmuch as children provide an incentive to work and to save, it is not certain that the savings per child (or per future member of the labor force) generated in a family unit with a large number of children would not be at least as high as in the same family if it had fewer or no children. Nor is it certain that funds allocated by governments for education mean a reduction in governmental capital formation, or in the savings of the economic units who pay for public education in taxes.

Second, some major components of aggregate savings tend to be raised when population is growing. One of these, discussed in some detail in an earlier paper, may be briefly noted here.[4] Assume that part of savings is for retirement, to be completely offset by dissavings of the individual or family during post-retirement years. If the labor force is constant, then, given a fixed age at which withdrawal from the labor force occurs, and perfect foresight in estimating the amount of post-retirement expenses, it follows that, all other conditions being equal, positive savings in the process of accumulation for retirement will balance post-retirement dissavings and the net contribution to aggregate savings will be zero. By contrast, if population and the labor force are growing, the number of active' members of the labor force who are saving for retirement is that much larger than the number of the retired; and their positive savings are larger than the dissavings of those retired. The resultant positive contribution to aggregate savings will reflect the past rate of growth of the labor force, and hence the past rate of population increase stemming from the birth rate or immigration. (An increase in population resulting from a decline in the death rates of the retired has an opposite effect, serving to diminish savings.)

This argument can be applied to all future-expense oriented savings. If savings are being accumulated to finance future outlays—for a house, a family, and so forth—the net contribution to the countrywide pool of savings is the excess of their flow into stock over their outflow at the end

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[4] See the author's "International Differences in Capital Formation and Financing," in *Capital Formation and Economic Growth*, edited by Moses Abramovitz, National Bureau of Economic Research, Princeton University Press, 1955, particularly Appendix D, pp. 98–103.

of the period of accumulation and waiting. For the total body of individuals, the net balance of such future-expense oriented savings will be zero if the population is constant, assuming no indebtedness to the business or government sector, and assuming also that the calculations are correct. On these assumptions, growth in population will produce an excess of accumulation over disbursements, or positive net savings.

Third, there is an indirect and somewhat elusive effect of population increase on the consumption and savings patterns of the *upper* income groups, which may be worth noting. I argued above that in a developed country children may be a substitute for higher levels of consumption or for more leisure. Insofar as they are a substitute for the former, greater population growth means for those groups whose birth rate is higher than elsewhere, a lower per capita consumption level than would otherwise be enjoyed. This usually pertains to groups at the bottom rather than the top half of the economic scale. There tends to be a definite gradation of consumption expenditure through the whole structure of economic and social groups: we find no sharp break as we move along the scale—the consumption-savings pattern of the multimillionaires at the top is linked with that of the mere millionaires on the next lower rung, the latter is linked with that of the recipients of a $100,000 annual income, and so on for the entire array. The point is that, all other conditions being equal, particularly the size distribution of income, lower per capita consumption expenditures at the bottom, necessitated by population increase, will make for lower per capita expenditures and hence higher savings proportions for all groups—of *those* savings that are not oriented to any necessities, etc., but are a kind of automatic excess of large incomes over limited consumption expenditures. The argument is not that the greater impact of higher birth rates at lower income levels results in a wider inequality in the size distribution of income (on a per capita basis), and hence, other conditions being equal, in a greater proportion of savings. It is rather that, with a given size distribution of income on a per capita basis, greater population increase due to higher birth rates keeps down the per capita consumption levels of those in the lower and intermediate brackets who are in the childbearing and rearing ages; and that, because of the interconnection of consumption levels in the income pyramid, it also keeps down the consumption levels of those groups high enough in the array to save "automatically" and thus raises the savings of these upper income groups.

Finally, it has been assumed throughout that the reproducible capital-output ratio is constant, an assumption contrary to historical experience.

The marginal capital-output ratios, and it is with these that we are particularly concerned, have varied considerably over both the short-run business cycle and longer periods. In the early phases of the development of the advanced economies these ratios showed a secular rise, as in the United States from the 1870's to World War I; in the later phases they showed a marked decline, in the United States since the 1920's. The problem therefore assumes different aspects in the different secular phases of the movement of the capital-output ratios. Particularly in the declining phase, such as that in the United States since the 1920's, the presumed pressure of population increase on the supply of savings to finance capital formation would have been much less than during the period prior to World War I. Yet the changes in the capital-output ratios are not independent of the supply of savings or of the absolute level of the ratios at any given time. Greater pressure on the supply of savings, other conditions being equal, induces more capital-saving inventions, innovations, and improvements; and a high capital-output ratio provides greater incentive and more room for such capital-saving changes. The bearing upon the present discussion is obvious: if population increase does create greater pressure upon savings and the available stock of material capital, inventive and managerial ability forced in the appropriate direction may result in a greater emphasis on and success with capital-economizing innovations than would otherwise be the case. While this argument may seem like the resolution of a problem by a *deus ex machina*, it does seem plausible for developed economies with a variety of resources responsive to the task.

4. Population as Consumers

The arguments advanced in the two preceding sections, if valid, justify the expectation that population increase would lead to a higher per capita product than would failure to increase. They implicitly assume the adequacy of final demand, or, more precisely, a distribution between expenditures and savings that assures full employment of resources and the greatest growth possible with these resources, technological changes, related social innovations, and the demand of ultimate consumers. While consideration of the behavior of the population as consumers is implicit in the discussion of their behavior as savers, some specific aspects of consumption lend additional support to the suggestion that population increase may be a positive factor in making for higher per capita product.

The first of these aspects of consumption is related to its impact on the size of the domestic market. I argued above that population growth may

be partly at the expense of greater leisure. On that score alone, without considering any of the other arguments in the preceding sections, the demand of a rapidly growing population for consumer goods would be greater than that of a constant or slowly growing population—since even the larger per capita demand of the latter would not be sufficient to compensate for their smaller numbers. If the other arguments in the preceding sections are granted, the total demand (output), including that for producers' goods, of a rapidly growing population can be expected to exceed that of a constant or slowly growing population. Once this is admitted—and the larger demand would be assured *even* if the per capita product of the rapidly growing population were equal to or less than the per capita product of the slowly growing or constant population—it will affect productivity and product per worker in ways not explicitly considered above. A larger domestic market will permit greater economies of scale; the development of industries that, because of the larger optimum size of their plants, are not feasible in countries with small domestic markets unless unwarranted reliance is placed upon foreign markets; and a more diversified productive structure providing more varied opportunities to the population. A smaller population and a smaller domestic market would make certain industries economically unfeasible, that is, too expensive; might limit the economies of scale for such industries as are indispensable within the country's boundaries; and would result in a domestic industrial structure which, because of its limited size, would tend to be more concentrated in fewer sectors. It is reasonable, I believe, to argue that since reliance on foreign trade is, perforce, limited, particularly in these times of international strain and strife, a large domestic market is an important prerequisite to the economies of scale of many modern industries and to the diversification of the domestic productive structure that provides varied opportunities for the growing population. A higher per capita product is more likely under such conditions than under conditions where no growth or only slight growth of population limits the size of the domestic market. To be sure, larger size poses other dangers, particularly the possibilities of greater disunity among the various parts of a large and regionally diversified population and the consequent difficulties of making promptly and without great cost the secular decisions essential in setting and adjusting conditions for a country's economic growth.[5] But let me limit myself at this point to the positive aspects of population increase.

[5] See discussion of this topic in my paper, "Economic Growth of Small Nations," in *Challenge of Development*, Alfred Borné, ed., The Hebrew University, Jerusalem, 1958, pp. 9–23.

Second, it is not only the size of the domestic market but its responsiveness to new products that is important. The technological changes that constitute the basis of modern economic growth affect consumer goods as much as they do the productive processes; and in a free market economy, lack of responsiveness by individuals and families to such new products would be a major obstacle to the growth of total and per capita output. It may be argued that the younger individuals and families are more responsive to new products than the older ones. The latter have more firmly established habits, which are largely a carryover from the past, and they have many more commitments, e.g., most of their durable consumer goods have already been acquired and they may find it more difficult to incorporate many new products. Comparable differences in responsiveness to new products may exist, at a given age and income level, between the migrant and the settled unit: the former, uprooted from his customary surroundings, may be freer in his choice of the new products, and may perhaps be psychologically more disposed toward them. It follows that population increase, accompanied as it usually is by a higher proportion of young and migrating units, may also be associated with greater responsiveness of the body of ultimate consumers to new goods—which in turn facilitates modern economic growth and may contribute to a higher product per capita.

We have dealt here, and in the preceding sections, with the direct effects of population increase on productivity, savings, and consumption, and with the effects of the latter two on productivity. There are some indirect effects of population increase, or rather effects of the general atmosphere accompanying it. Allowing substantial immigration reflects a faith in the country's power to absorb the immigrants and put them to productive use, a faith in the country's future. Having children is also evidence of faith in the future—not in the underdeveloped countries where the motivation may be a desire for support in old age, but in the developed countries where children are not expected to support their parents, where family planning is an accepted pattern, and where the social level of the majority of parents warrants the assumption of intelligent choice in the matter. Granted, in recent decades this faith has an apocalyptic tinge, colored by visions of atomic holocausts and Armageddons. It is a faith, nevertheless, in the country's future, unless or until terminated by such calamities as transcend the limits of planning of a household, a firm, or even a country. Contrariwise, a constant or slowly growing population is implicit evidence of lack of faith in the future.

This being the case, it can be argued that the climate of belief in the

future within which population increase occurs, as compared with the atmosphere within which no increase or very limited increase occurs, is itself conducive to greater economic growth and greater growth of product per capita. For it presumably encourages forward-looking ventures by individuals planning their careers and by entrepreneurs planning their investments. The expectation of a future in which larger markets and wider opportunities will prevail encourages extension of capacity, both personal and material, and it discourages the stagnation which results when individuals cling to unsatisfactory but "safe" routine jobs or when entrepreneurs, bankers, the labor force, and other important agents of economic enterprise hesitate to commit themselves to ventures that depart from the "tried and true." It is naturally difficult to assign weights to this factor of buoyancy accompanying population increase, when the latter is a matter of choice rather than of obsolescent patterns of individual behavior under changed conditions. But the effect of the implicit view of the future on decisions by entrepreneurs and households can hardly be denied—particularly for entrepreneurs, for whom there is an economic rationale in being more venturesome, more forward-looking, under such conditions than when the view of the future is pessimistic. Greater venturesomeness, greater willingness to build for the future, is likely to contribute to more vigorous growth of both total and per capita product.

5. Concluding Comments

The preceding discussion has dwelt, by design, on the positive contributions that population growth may make to the increase in per capita product; and it has been pursued largely against the background of advanced, developed countries. The concluding remarks are addressed primarily to qualifications, to avoid dismissal of this discussion as an expression of exuberant, but unfounded optimism.

First, few if any of the points made are relevant to the underdeveloped countries. By definition, the latter suffer from an acute shortage of capital, not only for material investment but also for adequate raising and education of their younger generations; and the whole structure of their society is unfavorable to the adoption of many potentials of modern technology, since it necessitates major changes that no living society can absorb within a short period. It is, therefore, unrealistic to assume that population increase in an underdeveloped country is followed by the adequate investment in both human beings and material capital, by the advantages of greater mobility, and by the stimulus of a wider and more

responsive market associated with population increase in developed countries and which contribute to greater product per capita. This is particularly true in view of the actual (or threatening) acceleration of rates of natural increase in the underdeveloped countries resulting from the maintenance of, or even slight rise in, the already high birth rates combined with the remarkably rapid reduction in death rates made possible by recent revolutionary changes in public health and control of diseases.

Second, even in the advanced and developed economies, population increase means further pressure upon limited natural resources, upon the supply of material capital, and above all, upon the capacity of the social and economic structure to adapt itself to it. All the factors cited in the current (and past) literature that make for the increased burden or larger populations—if higher per capita product is to be attained—are relevant here. In particular, an acceleration of population increase from a previously lower rate (like a marked retardation from a previously high rate), may mean a lag in the adjustment of economic and social institutions, with painful consequences resulting from delaying the kind of response that maximizes the advantages of a growing (or retarding) population and minimizes its disadvantages. The recent delay in this country, particularly on the part of the public sector, in responding to the obviously increasing educational needs of our growing population is a clear case in point, as are some of the lags in response to the reduction of immigration and to the retardation of population growth in the 1920's.

Third, for a single developed country, the impact of growth of its population, compared with the growth of the population of its partners in the concert of nations, should be considered. The contribution to new knowledge and technological change that its increased population may make would most likely become common property, after a short period of initial, pioneering advantage; but if a country's population grows proportionately more than that of its partners in international trade, it runs the risk of greater disadvantages—pressure for more imports, without a fully compensating reduction in cost of export goods and hence of exports. This problem of external balance has not been considered at all in the previous discussion, and yet it may impose limits upon the contribution of population growth to the economic performance in any single country.[6]

Hence, even in the advanced economies, there is the question whether the positive advantages of population increase outweigh its cost in terms of greater pressure upon limited resources, slowly changing organizational

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[6] I am indebted to Dr. Hans Singer for calling my attention to this point after the paper was presented at the conference.

facilities, and external balance. It is at this point that the major qualification of our discussion, and indeed of most of the analysis in the field of relations between demographic and economic processes, becomes patent. Obviously, there can be in any country, no matter how advanced, too much population growth in that its contribution to increased productivity per head is outweighed by the costs. But how much is too much we cannot tell in general terms and often cannot fully ascertain in specific instances. Conversely, there can be too little growth of population in that the various undesirable corollaries in the way of increasing rigidities, the lag in shifting from extensive to intensive investment opportunities, the failure to add to numbers of creators of new knowledge, and the general pessimism about the future, are likely to outweigh the advantages of lesser pressure upon limited resources. But, again, we do not know how little is too little. To put it somewhat differently, we have no tested, or even approximate, 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.

This is, of course, no excuse for not trying to secure a complete and balanced view, and provide, if policy needs compel it, the most considered answer to a specific problem. In particular, it is no excuse for the consistent bias in the literature in the field, in which the clearly observable limits of *existing* resources tend to overshadow completely the dimly discernible potentials of the new discoveries, inventions, and innovations that the future may bring. Perhaps only those who are alarmed rush into print whereas those who are less concerned with the would-be dangers are likely to be mute. And, to be sure, what exists can be observed; what is yet to come can only be surmised; and scholars naturally tend to dwell on the observable and tangible, and are wary of pies in the skies. Yet it must be recognized that we are concerned here with processes which have been vitally affected by additions to knowledge, unforeseen and undreamed of (except by Jules Verne, H. G. Wells, and others of their ilk); and that scientific caution should not extend to the exclusion of a dominant factor because it is difficult to grasp and fit into a model with a determinate, and hence limit-bound, outcome.

Finally, we should note that increase in per capita product has been a central reference point because it permitted me to handle conveniently the assigned topic of the relation between population change and aggregate product. It is not necessarily a superior, desirable criterion for

guidance in population policy, nor is it a dominant criterion in population policy as currently practiced (implicitly or explicitly). For example, in an authoritarian society managed by a power-hungry political elite, no real concern is shown for per capita product. The aim there is to accumulate the maximum surplus of resources, material and human, compatible with internal stability of the party elite, for the purpose, however ideologically motivated, of extending its power elsewhere. Assume that of the labor force in such a country 5 per cent are the political elite; 15 per cent are its policemen, administrators, propagandists, and favored professionals; and the remaining 80 per cent are its workers—exploited to yield the surplus, either in labor camps, or by bamboozling propaganda concerning the coming millennium and the threats of the rest of the world. Now, if X of these exploited workers yields Y of power-orientable surplus, $X + a$ might yield $Y + b$; and the underlying population increase would be desired by the political elite even if b/a were a lower ratio than Y/X, that is, even if, with constant per head consumption levels of the exploited workers, product per head declined as population increased.

But even in free societies, where the consumer is sovereign, maximization of per capita income may not be the paramount or even an important aim; and population change will not be judged in these terms. A society may prefer a smaller population, even if it means smaller aggregate and per capita product; or, what is more likely, it may prefer a larger population, even if it means a lower per capita product than would smaller numbers—if the population feels itself to be in danger and considers that there is greater safety in greater numbers. Many other criteria than per capita income can be used for evaluating population change and formulating population policy in the free countries, but they are outside the scope of this paper. The only reason for raising this question is that any discussion, even if it is only an attempt to interpret the past or speculate upon the possible relations, inevitably carries policy connotations. And it is well to emphasize that concentration of the discussion here on the relation between population growth and per capita product does not mean that maximizing the latter is a dominant, or even important, criterion in policy evaluation of population change.

C O M M E N T

RICHARD E. QUANDT, Princeton University

Simon Kuznets has observed that substantial rises in population are usually accompanied by increases in per capita output. He poses himself

the problem of finding causal relationships between an increase in population and an increase in per capita output. If I understand his argument correctly, it rests basically on the following three points: (1) If the increase in population is not accompanied by a reduction in the amount of available per worker capital (and if the capital-output ratio remains unaltered), a certain train of events will be set in motion which will result in an increased per capita output; (2) An increase in population will affect the savings behavior of the population in such a manner that per capita or per laborer capital remains the same or increases; (3) The receptivity of an increasing population to more products and new products is sufficiently high to create a favorable climate for expansion and economic growth and thus also for achieving higher per capita rates of output.

First of all, I would like to discuss the condition under which, given Kuznets' assumptions, an increase in population leads to an increase in per capita output. Assume an aggregate production function

$$X = f(L, K) \tag{1}$$

where X denotes output, L the amount of labor, and K the amount of capital. I shall assume, as does Kuznets, that the total population and the labor force differ only by a constant factor of proportionality, that is,

$$L = bP \tag{2}$$

where P denotes the population and where b is positive but less than one. Per capita output is X/P, and we wish to find the rate of change of this quantity with respect to time. We obtain

$$\frac{d\left[\dfrac{f(L, K)}{P}\right]}{dt} = \frac{\left(f_L \dfrac{dL}{dt} + f_K \dfrac{dK}{dt}\right) P - f(L, K) \dfrac{dP}{dt}}{P^2} \tag{3}$$

where f_L and f_K are the partial derivatives of the production function. In order to make certain that the amount of capital per worker is not decreasing and is perhaps increasing, we must require that the marginal increase in capital per unit addition to the labor force be no less than the average amount of capital per worker, that is, that

$$\frac{dK}{dL} = a\frac{K}{L} \qquad \text{where } a \geqq 1 \tag{4}$$

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From (4) we obtain that

$$\frac{1}{K}\frac{dK}{dt} = a\frac{1}{L}\frac{dL}{dt} \tag{5}$$

that is, the percentage rate of increase in the capital stock must not be less than the percentage rate of increase in the labor force. Substituting in (3) for dK/dt from (5) and also for dL/dt which equals bdP/dt by (2), we have

$$\frac{d[f(L,K)/P]}{dt} = \frac{(bf_L P + af_K K - f)\dfrac{dP}{dt}}{P^2} \tag{6}$$

$$\frac{d[f(L,K)/P]}{dt} = \frac{(f_L L + af_K K - f)\dfrac{dP}{dt}}{P^2} \tag{7}$$

Since P^2 is always positive, an increase in the population $[dP/dt > 0]$ leads to an increase in per capita output if and only if

$$f_L L + af_K K - f(L,K) > 0 \tag{8}$$

Now the following possibilities exist. If $a = 1$, that is, if the amount of capital per worker remains unchanged, (8) becomes $f_L L + f_K K - f(L,K) > 0$. This cannot occur if the production function is homogeneous of the first degree. In order for (8) to be true with $a = 1$ we must assume that increasing returns to scale prevail in some fashion. If, for example, the production function is homogeneous of the second degree, it is easy to show that (8) will be satisfied. If $a > 1$, it is no longer necessary to assume that there are increasing returns to scale. Returns to scale may be constant or diminishing so long as they do not diminish too rapidly. The argument to the effect that an increase in population tends to raise per capita output must therefore rest on some combination of the following factors: (1) That the aggregate production function shows increasing returns to scale; (2) that a given percentage increase in population results in a greater percentage increase of the stock of capital; (3) that the form of the production function itself changes when population increases.

Kuznets mentions each of these points in one place or another. In support of the first proposition he advances two arguments which seem open to some doubt. He assumes that "the reproducible capital-output ratio remains the same or decreases" in order to "take account of the possible effects of pressure upon a limited supply of irreproducible

resources." However, if the increase in population (and capital) resulted in a shortage of land and other natural resources, it would not be reasonable to assume that the production function, expressed as a function of labor and capital, would exhibit constant or increasing returns. It seems that his argument might be more applicable to under-developed economies which, however, he specifically rules out in his discussion. He suggests that increasing population will bring into use yet unexploited resources. Although it is difficult to debate the truth of this assertion, the yet unexploited resources may be of inferior quality. To use a simplified example, one may think that in a developed economy all the highest grade coal deposits are already being mined intensively; additional coal production could take place only by resorting to mines which are less efficient to operate, either because of the inferior heating quality of the coal or because of the greater labor effort required for the extraction of a ton of coal.

Kuznets' second point is that a greater population will allow greater specialization in production and therefore a higher output per capita. It is unquestionably true that one can subdivide a certain specified number of tasks among more men in such a fashion that greater speciali-zation results. It is not clear, however, whether there might not prevail counteracting tendencies in developed economies. I am referring to the increasing bureaucratization of life which seems to accompany growth in size in the developed economies. If the increase in the size of a firm results in a more than proportionate increase in the "non-producing" administrative staff, the economy's potential ability to achieve a higher degree of specialization may be effectively counteracted.

A third argument is intended to show that the production function itself may change its form in response to an increase in population. Assuming that the percentage of people born with given native capacities is constant, a larger population implies, other things being equal, that more geniuses and other talented people are born in absolute terms. Kuznets conjectures that useful knowledge increases more than in pro-portion to the number of people engaged in creating knowledge, that is, that knowledge exhibits increasing returns to scale (of scholarship). Finally, it is plausible to argue than an increase in the amount of know-ledge per capita will tend to increase output per worker. This conjecture is a very important and highly imaginative one. It must be emphasized that the truth of the conjecture and the magnitude of this "Kuznets effect" are purely empirical questions. It is tempting to say that the interrelatedness of knowledge strongly suggests that the per capita amount

of knowledge will increase with population. However, on an a priori basis a contrary argument can also be made. The counterargument is certainly not as persuasive as Kuznets' own and I am inclined to accept his. However, the possibility of arguing rather fruitlessly on a priori grounds about the conjecture leads me to suggest that an empirical test of the proposition is necessary.

To turn to another point, we must examine the implications of the requirement that a given percentage increase in the population result in a greater (or at least not smaller) percentage increase in the stock of capital. Starting again from Equation (5) and substituting from (2) we have

$$S = dK = aK \frac{dP}{P} \qquad\qquad (9)$$

Equation (9) shows that if the population is increasing at all, savings must be positive and that the faster population is growing in percentage terms, the higher must be aggregate savings. In other words, if the percentage rate of growth of the population increased, aggregate savings would have to increase too. Kuznets advances some reasons for aggregate savings to increase, yet one cannot help feeling a certain degree of scepticism. He believes that, as far as private spending units are concerned, it is not clear that expenditures on children are a substitute for savings rather than for more consumer goods or for more leisure. Nor is it clear, I feel, that the opposite is not the case. In fact, it is very plausible that an increase in the size of the family will make some inroads on the family's ability to save. Consider a population which is growing at 2 per cent per annum. If the capital/output ratio is three, savings would have to be 6 per cent of national product. If this population were growing at 4 per cent, savings amounting to 12 per cent of output would be required in order to provide labor with the same amount of per worker capital as before. If, in addition, we require that the coefficient a be greater than unity, the discrepancy between the respective savings percentages would be greater still. But even if we allow a to equal unity, it is not sufficient for the population to continue to save the same amount that they did before. As more children are born, not only must the parents deny themselves certain consumer goods in order to provide for the children, but they must deny themselves additional consumer goods if savings are to increase. Whether such behavior is plausible in a system where individuals are free to make their savings decisions is doubtful. It is also suggested that, as the population increases, the savings of those at the beginning of their

earning life will exceed the dissavings of the retired and that thus aggregate savings will increase. This proposition must be reevaluated in the light of the possibility that young people may begin to save for retirement at a later date in their lives than they used to.

It seems that the last major point of Kuznets reinforces the conclusion that a developed economy may have difficulties in providing sufficient savings to allow for an increase in per capita output. Granted that a growing population is favorable for an extension of old markets and the creation of new ones, such an expansion is basically consumption oriented. The more adventurous the young population is in trying out new products, the less willing they will be to withhold an appropriate part of their income for the purpose of capital formation. If we posit that the governmental machinery operates to keep aggregate demand at a full employment level, the aggregate volume of savings may not be sufficient to increase the stock of capital to the point where the collaboration of labor with capital results in higher output per capita. When Kuznets mentions, albeit with a warning, that the birth rate tends to be higher in places where per capita consumer expenditures are lower, one cannot help wondering about the direction of the causation. Perhaps we should examine this problem still further to see (1) whether it is not the low per capita consumption which is responsible for the higher birth rate, (2) whether the places where the birth rate is high are not also the places where per capita savings are low, in other words, where per capita income or output is low.

I do not know the answers to many of these questions. Kuznets has provided a useful framework and has raised numerous tantalizing questions. Many of these relate to empirical propositions, and I feel that Kuznets' framework will be most useful when these empirical questions are answered.

MILTON FRIEDMAN, University of Chicago and National Bureau of Economic Research

The historical covariation of population growth and per capita output is, of course, susceptible of a number of interpretations—it may be historical coincidence, population growth may be the result of the growth in per capita output, the growth in per capita output may be the result of the population growth, or both may be the common result of other historical forces. As Simon Kuznets notes, professional and popular discussion has in the main tended to be unfavorable to the possibility that population growth is on net favorable to growth in per capita output.

Yet the uniformity of the historical covariation inevitably leaves a nagging doubt whether this interpretation can so blithely be dismissed and whether in our analysis we may not have neglected some effects of population growth favorable for per capita output.

The economic literature bearing on the relation between changes in population and in output has two main themes. One is the limitation of resources which together with the law of diminishing returns or law of variable proportions makes population growth a factor unfavorable to growth in per capita output. The other is the possibility of "external economies" as the size of an industry or an economy or a trading world grows which can have the opposite effect.

In this stimulating and imaginative paper, Kuznets attempts to render this analysis more explicit and to extend its scope particularly with respect to forces other than traditional external economies that might render population growth favorable to per capita output. In the process, he certainly puts flesh on well-worn bones and offers much food for thought. He does not, however, seem to me to add any additional categories of favorable effects to those implicit in the literature.

The favorable effects Kuznets lists are of two very different kinds. There are, first, those which are favorable in the sense that they are reasons why population growth would on net mean a higher rate of growth in per capita output than otherwise. These all seem to me special manifestations of "external economies." There are, second, effects which are favorable only in the very different sense that they tend to offset some unfavorable effects of population growth. They are brought into play only by virtue of the existence of these unfavorable effects and can never counter them in full. They are not reasons why population growth is a stimulant to economic growth but only why it may be somewhat less of a depressant than one might at first think. They are like a long-run rise in output along a positively sloping supply curve that can make the long-run price rise in response to an increase in demand less than the initial price rise but can never convert a short-run price rise into a long-run price decline.

The first category of effects includes three items: the first and third listed by Kuznets under the heading "population as producers," and the first under the heading "population as consumers."

(1) In Kuznets' words, "The first is connected with the distinctive assumption that there exists . . . a variety of unexploited natural resources, and that . . . greater utilization of these resources . . . combined with a more specialized division of labor would, in all probability, lead

to a greater product per worker." This itself is a combination of the two categories of effects distinguished. The "more specialized division of labor" is an external economy, a positively favorable effect of a larger population. The "variety of unexploited natural resources" simply reduces the rate at which diminishing returns occur; it limits the unfavorable effects of the expansion of population but does not render such expansion favorable.

(2) The third item listed by Kuznets under the heading "population as producers" is the existence of external economies in the production of knowledge arising mainly out of the greater division of labor and specialization of function in intellectual activity permitted by the larger size of the industry of creating and maintaining knowledge. This favorable effect is further intensified by the fact that insofar as knowledge accumulates, it is available to all and is not consumed in the process of being used, an external effect of a more subtle kind.

(3) The first item under "population as consumers" is the "impact on the size of the domestic market." This is simply a different face of (1) above—external economies arising out of the more extensive division of labor permitted by the greater size of the market.

All of the other items listed by Kuznets seem to me at best to fall into the second category of effects distinguished—those that partly offset unfavorable effects. Let us consider each in turn.

(1) A growing labor force imposes a need for the reshuffling of the economy to adapt to the new conditions. Similarly, the disproportionate growth of population in rural areas requires an additional reshuffling. In both cases, movement of resources is required by the very factors that give rise to "the greater mobility of a growing than of a stagnant labor force" cited by Kuznets as the second item under "population as producers." And this movement of resources is required simply to hold to a minimum the reduction in initial levels of per capita income that would occur in the absence of external economies. Kuznets gives no reason, and it is hard to see any, why the increased mobility produced by higher population growth is not only enough to permit the new resources to be organized as efficiently as the old but to increase the efficiency with which the old resources are organized.

(2) In considering "population as savers," Kuznets' first item is that added expenditure on training and education of children is not necessarily "all at the expense of otherwise proportionately larger savings." True enough, but so long as any such added expenditure is at the expense of savings, the faster population growth reduces on this ground the aggregate

savings available for capital formation and even more the amount available per capita. Thus the need to educate and train the younger generation is a factor that on net renders population growth unfavorable to maintenance let alone growth in per capita output.

(3) His forth item under this head, that "greater pressure on the supply of savings . . . may result in a greater emphasis on and success with capital-economizing innovations" is of the same kind. At most this can make the deleterious effect of capital shortage less than otherwise; it cannot convert capital shortage into a positive good—for of course if it did, there would then be no capital shortage to act as an additional incentive.

(4) It is explicit in Kuznets' analysis that more rapid population growth requires a higher fraction of income to be saved than otherwise in order to keep capital per head constant or increasing. The second item on savings he lists, the stimulation of all "future-expense oriented savings" can at best be only a partial offset to this need. If the capital-output ratio, to take a figure relatively favorable to Kuznets' position, were as low as 2 to 1, then each one percentage poii.t increase in the annual rate of growth of population would require additional savings of 2 per cent of annual income to keep capital per head constant. But this would absorb an amount equal to twice the growth in aggregate income from the faster growth in population, with constant per capita income.

(5) The third item on savings, a possible effect of a higher rate of population growth on the "automatic" savings of higher income groups, is in a somewhat different category. It seems to me simply wishful thinking, derived from a theory of savings that is not only untested empirically, but has never even been fully and carefully elaborated theoretically. On this level, one can as plausibly argue that there is emulation of savings behavior as of consumption behavior, in which case the "automatic" consumption of upper income classes would have the opposite effect. And neither the one theory nor the other seems to me to derive any support from the large amount of empirical evidence and the fairly well elaborated theoretical analyses that we have.

(6) The greater responsiveness of a rapidly growing population to new products, Kuznets' second item under "population as consumers" is in a still different category. This implies a difference in tastes that makes it hard to compare per capita output under the alternative conditions or, alternatively, to attach economic meaning to a mechanical comparison —this is the kind of problem that Kuznets in some of his other writings has taught us so much about and has trained us to be wary of. The example that has always impressed me is the difficulty of comparing

Swiss and U.S. per capita incomes that arises out of the difference in attitude to new products. Casual observation suggests that the Swiss put far less emphasis than we on having the very "newest" and "latest" and much more emphasis on serviceability. By their standards, much of our so-called "production" is simply waste, involving the destruction of perfectly serviceable houses, electrical wiring, furniture, and so on indefinitely, in order to replace them by only moderately better items.

(7) The final item cited by Kuznets is "climate of belief in the future within which population increase occurs," a climate conducive to "forward-looking ventures." But this climate is not produced by the population increase. Rather the population increase is a result of the climate. The climate would, so far as this point alone is concerned, be even more favorable to increased output per capita if population did not increase. Hence the population increase is, in and of itself, an unfavorable factor, tending to offset any favorable effect of the general "faith in the future."

This examination of Kuznets' arguments does not of course justify any substantive conclusion about the effect of population change on per capita output, any more than Kuznets would claim that his own analysis does. It does suggest that classical "external economies" are the only category of effects we have yet found that can render population growth positively favorable to per capita output, and that Kuznets' contribution is, on the one hand, to spell out in more imaginative detail how these manifest themselves, and, on the other, to force us to be somewhat more sophisticated in evaluating the unfavorable effects of population growth.

In closing, I should like to note a point about external economies that seems to me to be of the utmost importance and yet frequently neglected because of our tendency to speak about a single country or a closed economy. An extension of the market giving rise to external economies can be achieved through more extensive international trade as well as through a growth in the national market. And external economies produced in this way are likely to give rise to none of the unfavorable effects accompanying external economies produced by population growth.

A striking illustration bearing on external economies in the production of knowledge is provided by recent Indian developments. There is a movement under way, backed by legislation, to eliminate the English language as the primary medium of higher education and to foster the use of native languages, with each region using its own major language though with some emphasis also on a common language other than English. If this movement is carried through, the effect will be in large

measure to fragment intellectual activity and greatly to reduce inter-communication not only between India and the rest of the world but also among the different regions of India itself. Along the lines of Kuznets' analysis, it is conceivable that a greater rate of population growth in each region separately would produce external economies in the production of knowledge, but it is ludicrous to suppose that it could do more than offset a tiny part of the external diseconomy arising from subdividing the economy into language areas or that it is relevant to regard the one line of development as a meaningful substitute for the other. Yet, on a less extreme level, this is just what is implied by our tendency to concentrate on intra-national expansions of the market and our relative neglect of international extension.

REPLY

I find it difficult to deal with the comments by Milton Friedman and Richard Quandt because I agree with the substance of much of what they say, but not with the implicit emphasis or weight. My paper was written in an intellectual uneasiness concerning the conflict between the pessimistic tenor of most literature on population growth and the historical records that reveal association in time, in many countries, between large increases in population and high rates of growth of per capita product. The paper was not intended to provide an explanation of this association: this would require far-reaching empirical analysis, most of which has yet to be undertaken. It was, rather, a series of speculative probings into the possible positive contributions of population growth to the rise in per capita product—probings that could not, under the circumstances, be accompanied by tested weights.

Within this framework, it does not seem to me to matter whether the positive contributions suggested are, to refer to Friedman's comments, (a) offsets to the additional burden of larger population, (b) types of external economies, or (c) results of the wider complex of circumstances of which population growth is a corollary not in itself favorable. In the case of (a), offsets are welcome and significant since they leave so much more room for net contributions of other positive effects. In the case of (b), I am quite content to see the positive contributions classified as external economies, if cognizance is taken of the fact that they embrace the production of basic knowledge and of social innovations—processes not included in traditional economic analysis. In the case of (c), population growth is one way of *realizing* the wider complex (that is, a favorable climate of belief in the future), and without it such a climate would not

come into being. In such case, it seems to me artificial to argue that population increase is a pure cost, to which no credit for the effects of the favorable climate is assigned.

Two more observations on Friedman's comments are appropriate. First, offsets may have a dynamism of their own which carry them far beyond the initial cost or burden that they are intended to counteract—as has been the case with many need-provoked innovations, both technological and social. Second, it is difficult for me to entertain the proposition that social imitation—internal demonstration effect—applies to savings patterns as effectively as it does to consumption patterns; and I am probably less willing than Friedman to accept the conclusions of the existing theoretical analysis.

I am in essential agreement with Quandt's comments on the implications of my discussion for the production function, while, for obvious reasons, it is difficult to counter his scepticism over some substantive points, for lack of empirical evidence. It is relatively easy to find both positive and negative effects of any trend within the complex process of economic growth—even of such an apparently wholly favorable movement as growth of the stock of material capital per worker. Thus, one could argue that if there is too much capital relative to other factors, the resulting inefficiency could depress our per capita product appreciably. We could in fact apply Parkinson's law to any and all productive factors. We are rescued from the bewildering conflict of the possible effects by a combination of empirical constraints and realistically guided reasoning. And in the light of both, it does seem to me that in the competition between geniuses and incompetents, the triumph of the former, in adding to the stock of useful (vs. worthless) knowledge, is clearly manifest; that continuous innovations permit an increasingly effective specialization and division of labor among larger numbers that more than offsets the effects of Parkinson's law; and that with the increasing substitutability between investment in human beings and knowledge and in material capital the deleterious effects of population growth on the supply of savings (in the traditional sense of funds available for investment in material capital) can be quite limited.

Let me conclude by stating that the aim of the paper is to suggest problems for further research, and that the claim of validity for any of the speculative suggestions, if made, is intended as an irritant, not a sedative. My purpose is to call attention to the interrelations between population growth and economic growth, which have been studied much less than their apparent importance in the field warrants.