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INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

Economics Department Working Paper No. 11

THE FOREIGN BENEFITS AND COSTS OF A PREVENTED BIRTH:
CONCEPTUAL PROBLEMS AND AN APPLICATION TO THE U.A.R.

January 23, 1968

This paper was completed by Mr. Zaidan before joining the service of the Bank. It is issued for the information of staff members in this form because it deals with a subject of considerable interest to the Bank. This draft has been submitted for publication and it is expected that the final version will be reissued by the Harvard Center for Population Studies, who supported the research on which the paper is based. The paper is not to be quoted without the author's permission.

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THE FOREGONE BENEFITS AND COSTS OF A PREVENTED BIRTH:
Conceptual Problems and an Application to the U.A.R.*

Introduction:

1. Among the chief problems that many underdeveloped countries face today, is the "problem of overpopulation." As a result of the large drop in death rates following World War II, the rate of population growth has accelerated to an extent which seriously imperils the success of many efforts at economic development. Since the manipulation of death rates cannot be considered a policy variable, various studies have tried to investigate the effect of a lower fertility on economic development. Attempts to quantify this relationship have taken two forms. The first is that of Coale and Hoover, who use various assumptions which enable them to trace the path of per capita income with and without a reduction in fertility.

* This paper is an abbreviated version of part of my unpublished Ph.D. dissertation, "Benefits and Costs of Population Control with Special Reference to the U.A.R. (Egypt), "Harvard University, 1967. (Henceforth this source is referred to as BCPC). It is Contribution No. 37 from the Harvard Center for Population Studies. I wish to thank Professor H. Leibenstein for many helpful comments. This research was supported with a grant from the Harvard Center for Population Studies, for which grateful acknowledgment is made.

The second, introduced by Enke, is to treat investment in population control as any other economic project, and to work out a benefit-cost analysis of such an investment. Very briefly, the essence of this approach is to work out the consumption and productivity streams of an unborn child, and - after appropriate discounting - to subtract the latter from the former to get the net economic benefits of preventing a birth. These benefits are measured in terms of the income stream that becomes available to the economy as a whole, as a result of preventing one birth. Taking this approach as our starting point, the object of this paper is (a) to refine and extend this analysis, both by working out the upper and lower limits of the above benefits, as well as trying to include additional effects that are capable of being quantified, and (b) to explicitly analyze the assumptions and hence limitations of such a procedure. To this end, we can conveniently break down the discussion of this paper into three separate parts. The first is a description of the various effects and their combination in a benefit-cost criterion. The second considers the conceptual problems arising out of the application of such a criterion, and the third applies our framework to the case of the U.A.R., in order to get an estimate of the various magnitudes involved.

2. The effect of preventing a specified number of births can affect per capita income through several possible paths. First, and almost by definition the per capita income is increased because the unborn child would have added nothing to production, whereas he would have been a consumer. Thus, the same national output is divided among a smaller population. This is so in the short-run\(^1\) when the size of the labor force is unaffected by what is happening to fertility. In a longer perspective, however, the unborn child would have joined the labor force, so that output is smaller in the lower fertility case. This reduction is measured by the marginal product of labor. Thus the net benefits of this initial effect can be measured by the difference between the consumption stream and productivity stream of an unborn child.

3. Second, as a result of the initial increase in per capita income, either consumption per worker and/or savings per worker will rise. This in turn will increase the rate of growth of income. Hence, not only is the same national output being divided among fewer people, but also the national output itself may be larger, as a result of a lower fertility. Let us look at how this can occur.

4. First it can occur through the wage productivity effect, which has been analyzed by H. Leibenstein.\(^2\) The basis of this effect is that the increased food consumption resulting from the initial increase

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1/ The "short-run" is defined here as the length of time between birth and the average age at which persons enter the labor force.

in per capita income will lead to an increased supply of effort resulting in a greater output. The strength of the relationship between increased income per capita and greater output depends on the following intervening links: It depends on (i) the marginal propensity to consume food, (ii) the resulting increased calorie intake, (iii) the increased supply of effort, (iv) the marginal product of effort.

5. The greater the magnitude of relationships (i) through (iv), the greater the magnitude of the wage productivity effect. In the context of underdeveloped countries, the existence of such an effect implies that (i) the per capita consumption is below the minimum calorie requirements and (ii) that the marginal product of effort is not zero. Even when this effect is present, one must allow for the fact that it is only the consumption of workers that adds to output. Thus one must only take into account the proportion of the initial increase in income that goes to members of the labor force, and only in those periods of the year where there is no seasonal unemployment.

6. Next, turning to the savings effect, we note that the total output may be larger because of changes in savings patterns resulting from the initial increase in income. Here it is worth noting that the relevant changes are those that occur in savings per worker and not savings per head. (Since, in the short-run the size of the labor force is constant, requiring more savings per worker is the same as requiring larger total savings). Because the population is smaller in the low
fertility case, a higher savings per head need not imply more capital per worker.\footnote{Here it is worth noting the difference between the wage productivity and the savings effect. In the former, if the marginal propensity to consume (out of the increased per capita income) is the same as the average one, then there will still be an increase in output, because workers will be getting more food per head. With the savings effect, however, a marginal propensity to save (out of the increased per capita income) that is equal to the average one, will only lead to an increase in savings per head, but not to an increase in savings per worker. Hence, there are no benefits of increased output. The latter arise only if, and to the extent that, the marginal propensity to save exceeds the average one. The reason for this difference is that all capital is used by the labor force, whereas it consumes only part of total consumption. This means that in order to increase capital per worker, total savings must increase, (which in turn means that marginal savings must exceed average ones), whereas it is not necessary for total consumption to increase, in order to raise consumption per head. The latter can occur by switching food from the "non-labor" force to the labor force. In the case of a prevented birth, this would occur because part of the consumption that the unborn child would have used up, is diverted to the labor force. Hence, food intake per worker is increased, even with the same total consumption.} It is the latter which is necessary to secure a higher rate of growth of output. Thus, in the short-run what is necessary are larger total savings, and not merely more savings per head whereas in the long-run - when the labor force is smaller in the low fertility case - even the same total savings result in more capital per worker - and which is beneficial.
Combining the above three effects we shall measure the net foregone benefits of a prevented birth by applying the following formula:

\[
\sum_{i}^{j} \frac{y_i}{(1+r)^i} + f_s k s + r(s-s) \sum_{i}^{j} \frac{y_i}{(1+r)^j} + r \sum_{i}^{j} \frac{x_i}{(1+r)^j}
\]

where \( y_i = (c_i - mp_i) (1-q_i) \) and where the summation extends to the end of our time horizon.

In this expression the symbols have the following meanings:

- \( c_i \): annual foregone consumption of the unborn child between ages \( i \) and \( i+1 \).
- \( mp_i \): annual foregone production (the marginal product of labor) of the unborn child between ages \( i \) and \( i+1 \).
- \( q_i \): probability of death between ages \( i \) and \( i+1 \). \( 1 - q_i \) is therefore, the probability of survival.
- \( y_i \): is therefore, the net income stream of an unborn child, allowance being made for the possibility that that unborn child may have died at various ages.

One other effect which we do not consider is the possibility that different fertility patterns will affect the capital-output ratio. The argument here is that a reallocation of resources away from sectors with a high capital-output ratio (such as housing) will lead to a faster rate of growth of output. The reason for not considering such an effect is threefold: First, only a small proportion of total investment can be thought of as being linked to population. Second, even here the relationship is not clear. Housing for instance is related to urbanization as well as changes in family size, and the relationship between the latter two and a reduction in fertility is not direct. Finally, even if there is a reallocation of investment, the time lag is so long that even moderate discounting would make this effect quantitatively negligible.
$f =$ marginal propensity to consume food by the labor force in periods of the year when there is no seasonal unemployment.

$k =$ a constant that converts expenditures on food into an extra supply of effort via increased calorie intake.

$h =$ the marginal product of effort.

$x_i =$ the cost of education between ages $i$ and $(i + 1)$.

$r =$ discount factor $=$ marginal product of capital.

$S =$ propensity to save before the reduction in fertility.

$s =$ propensity to save out of the increased per capita income.

8. This expression is the net income stream made available to the economy as a result of preventing one birth. Its first term is the net discounted consumption stream minus productivity stream of an unborn child, which is our first effect. The second term is the wage-productivity effect, whereas the last two terms are the savings effect for individuals and the government respectively. The reason for making a distinction between both, is that different assumptions may be justified in each case. For individuals there is very little information as regards the relationship between demographic trends and savings behavior.¹/¹

¹/¹ The theoretical relationships between savings behavior and the rate of the population growth have been analyzed by P. Demeny in "Demographic Aspects of Saving, Investment, Employment and Productivity", Paper No. 460, United Nations World Population Conference, Belgrade, 1965. The discussion is inconclusive and there are no empirical studies at the micro-level of the relationship between family size and savings in less developed countries. However, some unpublished work shows that the dependency burden is an important explanatory variable in accounting for differences in gross domestic savings among a large sample of developed and less developed countries.
9. To return to our expression, it is seen that each of its terms correspond to one of our effects. It may be helpful to see the interaction of these effects with the aid of a diagram. In Part I of Figure One the increased consumption per head resulting from the prevention of a specified number of births, is measured on the vertical axis while the increased savings per worker is measured on the horizontal axis. In Part II we show the effect of the increased consumption per head on the increased income per head during the current period--i.e. income per head today. This curve subsumes many relationships behind it, that have already been mentioned. In particular the following leakages account for the fact that it exhibits diminishing returns: (1) Only part of the increased consumption per head results in increased food intake per head. (2) Not all of the increased food intake per head goes to people who are in the labor force. (3) Because of seasonal unemployment in agriculture the increased food intake during some parts of the year does not result in an increased supply of effort. (4) Because of diminishing returns to factor equal increases in the supply of effort lead to less than proportional increases in output. In Part III, assuming all savings are invested, the increased capital per worker is plotted against the increased income per head that it is likely to generate in all future time periods. Here, too, diminishing returns to capital are shown. Finally in Part IV we see the alternatives that are possible between income today or in the future, and time preference will determine what proportion of the increased income is saved and what proportion is consumed. Enlarging Part IV we can think of $O_2$ as the point at which the economy would have been if there had been no reduction in fertility.
The initial increase in per capita income can be thought of as providing \( O_{203} \) more of present income. Then this increased income could be either wholly consumed or saved. If it were all consumed, the increased income would be \( O_{3S} \). If on the other hand it were all saved, the income increase in the future would be \( O_{3S} \). Note that all the sequence portrayed in figure one refers to the foregone consumption and production stream of the unborn child during one year (all variables have an \( i \) subscript). If we sum these benefits over all years, and discount appropriately we would get our previous expression.

10. In conclusion, it may be helpful to point out that underlying all the above effects, is the change in the age distribution of the population, that accompanies the lower fertility. In the short-run our initial impact effect is a consequence of this, since it is the fact that (a) the labor force is unchanged while (b) the proportion of young people who consume but do not work decreases, that allows output per worker to remain unchanged while output per person increases. This initial increase in per capita income is in turn the basis of the wage productivity effect. Also the lower dependency burden is often one of the reasons for expecting larger total (private) savings. Finally, this changed age-distribution may influence both the total amount of government savings - because it allows resources that are devoted to the "consumption" of the young such as education to be diverted to material capital formation - as well as its allocation between different sectors. Thus the altered age-distribution turns out to be a major factor underlying all our effects.
II - The Applicability of our Criterion:

11. Before proceeding to apply our framework to the case of the U.A.R., it is well to discuss explicitly the assumptions, and hence limitations of the criterion developed above. At the outset, three points are worth emphasizing. The first is that our criterion views children exclusively as investment goods - no account being taken of the satisfaction of the parents derived from the "consumption" of their children. In an overpopulated and underdeveloped country, it can safely be assumed that the "social welfare function" - as opposed to the individual one - should not pay attention to such aspects. This brings us to the second point which is related, but distinct from, the above. This is that the returns from investment are viewed exclusively from the point of view of the country rather than the family. The discrepancies between both approaches can be large. For instance, from the point of view of the family, the two main returns from "investing" in a child are (a) the earnings of the child, once he starts to work, and (b) the child as a source of old-age security. As far as (a) goes, what an individual is paid may be very different from the marginal product.

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of labor - which is his contribution to society. As far as (b) goes, preventing a birth may increase rather than diminish old-age security, from the point of view of society. This is so because a lower fertility reduces the proportion of dependents to the labor force. \(^1\) This means that the former (both the older groups and the "unprevented" or remaining young ones) can get more expenditure per head in the form of old-age security in the low fertility case.

12. The third point is that the benefits of our criterion assume that the birth is permanently prevented. If it is delayed, the benefits would be smaller depending on the form of the delay. This point is worth making because the benefits computed according to our criterion are often compared with the costs of a family planning program and the latter ones are found to be relatively insignificant. However, this comparison is legitimate only if the birth is permanently prevented. If it is merely delayed (as for instance if the initial acceptors in a family planning program are middle class urban women, who have not yet had the number of children they desire), then the costs of a family planning program

\(^1\) For a general treatment of the determinants of the age distribution see A.J. Coale, "The Effects of Changes in Mortality and Fertility on Age Composition," *Hilbank Memorial Fund Quarterly*, January 1956.
program are unchanged, but the net foregone benefits may be greatly affected, depending on the form of the delay. 1/

13. Having cleared these points, there remains one disturbing aspect about our criterion, which should be cleared up. This is that there is a built-in bias in our criterion that ensures that benefits will always exceed costs. This is as it should be for the case of the overpopulated and underdeveloped countries of today, but what is troubling is that this should also be the case for both (a) the developed countries of today and (b) those same countries in their early period of industrialization in the nineteenth century. In the latter case, our criterion would have shown large benefits from population control, whereas the subsequent development of these countries shows their economic growth to have been highly successful, partly because of the stimulating effects of

1/ As a simple but unrealistic example, consider a woman who in the absence of a family planning program had a child every three years. Assume that she joins the program for one year, drops out, and then immediately has a child. As a result of this, there is a four year gap between her latest births. If it is further assumed that her next child follows after two years and that all following births are unaltered, then all that has happened is that the birth has been delayed for one year. The foregone benefits are the income stream of the unborn child minus the income stream of the born one. The absolute magnitude of both streams is the same, but discounting introduces a difference and determines the benefit. Other forms of delay can be imagined in which woman do not catch up on lost time, but simply go on to have the same children over a longer total span of time. Here the benefits would be larger because several children are delayed. In general, the influence of discounting is such, that even "minor" forms of delay, result in benefits that are quantitatively larger than the government expenditures required to prevent one birth.
population growth. True, we have no way of checking whether these rates of population growth were "optimal," but at the very least they did not appear to hinder economic development. Under the circumstances, there appears to be an inconsistency between our criterion and the observed historical experience. It is this that has lead us to spell out the reasons and implications of the bias in our criterion. To this we now turn.

14. The large positive bias in expression (1)\(^1\) arises because the initial effect is always large and positive (as a consequence of this the wage-productivity and/or savings effects are also positive and further add to the benefits). This is due to three reasons.\(^2\) The first is that the average consumption is being compared with marginal product. In the long-run, average consumption and average production are identical. However, whereas an unborn child consumes, through his lifetime, as much as the average person, his marginal output falls short of the average.

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1/ In the following paragraphs, and as was pointed out above, the child is viewed exclusively as an investment good. If the consumption aspects were also allowed for, and assuming that children are a joy to their parents, we would have to include the satisfaction that parents would have derived from their children, as well as the satisfaction of the latter from "being alive," to the cost side of preventing a birth. In practice, this presents insuperable problems of putting a subjective value on human life, as well as interpersonal and intertemporal comparisons of utility. In principle, however, this point may reduce the positive bias in our criterion.

2/ Besides these, Enke lists other (minor) reasons for this bias. See, "The Economic Aspects..." op. cit., footnote to p. 56.
Insofar as the difference between the average and marginal output is a measure of the extent of the pressure on limited resources, this source of bias is legitimate. If it were the only source of bias, it would not lead to the inconsistencies noted at the end of the previous paragraph. However, there are two other reasons for a large positive bias. The first is that the consumption and productivity streams are discounted. Since consumption starts immediately after birth, whereas production is delayed for at least ten to fifteen years, even moderate discounting greatly exaggerates the difference between the present value of both streams. The second is that throughout, consumption is treated as a cost - and, hence, the foregone consumption of the unborn child as a benefit. In general, it is not clear why this should be so, although it is certainly legitimate in some instances. Let us then look at the implications of (a) discounting and (b) treating foregone consumption as a benefit.

15. The discount rate that is used is meant to reflect both the time preference of society, as well as the productivity of capital. The existence of a preference for the present as given by Bohm-Bawerk is in terms of (i) the shortness of life, (ii) the deficiency of the imagination and (iii) limited willpower. Of these three, we may assume that the last two are not present in the farsighted leaders of a society - i.e. that, if at all present, they are limited to the "private" rather than social time preference. As for the first reason, its presence depends essentially on what exactly we mean by "society." If we take this to mean the individuals that compose it, then the first reason is a valid
basis for time-preference. On the other hand, if we view society as an abstract entity that never dies—although the individuals that compose it do—then even the first basis of time-preference is invalid. This may explain to some extent the paradox outlined above. From the point of view of the persons living in the nineteenth century in countries that subsequently experienced rapid economic growth, it may have been valid to advocate a policy of population limitation. Viewing the matter from the present, however, and looking at a certain country as an abstract entity, it is doubtful whether we could endorse such a policy. Thus our criterion does not lead to inconsistencies so long as it is remembered that the benefits that are being considered are those accruing to the people that are living at the time the policy recommendation is made.

Taking this point a step further, we can say that by specifying which age group within a population we are particularly interested in, will determine the length of our time horizon. For instance, if our time horizon extends to the average expectation of life at birth, then our net benefits are those that accrue to children being born today. Those who are older will reap only part of those benefits. Alternatively, if we take the time horizon to be, say only ten years, then those benefits accrue to all those who have a remaining expectation of life exceeding ten years. We may, therefore, conclude, that the use of a (high) discount rate implies that we are considering the benefits for people alive today, rather than for society in an abstract sense, and that the length of the time horizon implicitly determines which age group we have in mind.
16. Turning next to the treatment of foregone consumption as a benefit, it is to be noted that this is by no means obvious or necessary. Indeed, there are various circumstances in which consumption could be assumed to exert a stimulating effect on economic growth. The crucial point is whether and to what extent insufficient demand constitutes a bottleneck on economic growth. If insufficient demand is a serious bottleneck, then population growth may be beneficial by stimulating consumption. This stimulating mechanism can take one of three forms. Faster population growth leads to a larger total consumption (even with no changes in per capita consumption), which by allowing the full exploitation of economies of scale, may make the introduction of certain industries profitable. Second, by leading to a faster rate of growth of total consumption, faster population growth can, via the acceleration mechanism, lead to a faster rate of growth of output. Finally, differentials in the rate of growth may have beneficial effects on consumption. This latter argument is that of Kuznets, and it can be summarized as follows: because the differential rate of population growth both as between urban and rural areas, and as between the higher and lower income groups, has moved historically in an opposite direction to the growth in economic opportunities, economic growth, when it had succeeded, was accompanied by a tremendous geographical and social mobility. A migrant into the cities is likely to consume a higher proportion of his income than his counterpart in the country because of the different values

prevailing in urban areas. He is also likely to respond and switch more quickly to the new and expanding industries. Both factors have a stimulating effect on economic growth.

17. In the light of the foregoing we may ask in what cases insufficient demand is a bottleneck to economic growth. Taking the case of the developed countries of today first, we observe that by looking at the various theories of growth that are an outgrowth of the Keynesian framework (Harrod-Domar and their offshoots) we see aggregate demand occupying a central position. Here we would argue that the opportunity to invest is an important bottleneck. Modern corporations have huge amounts of capital at their disposal in the form of undistributed profits. Alternatively they are able to raise all the capital they require if the investment opportunity is there. This is so from a long-term point of view even though they may experience temporary difficulties of financing in times of credit restriction. They also have the necessary skilled manpower and the managerial abilities of organization, so that their chief problem is one of finding an outlet for their products rather than satisfying a pre-existing demand.¹ In this creation of demand, population growth is an important stimulating factor, although less so than at the time A. Hansen was developing his stagnation thesis.² This is because of the increasing rate of technological progress during the postwar

¹/ This is the thesis of J.K. Galbraith, The Affluent Society, New York, 1958. See especially Chapter XI, on "The Dependence Effect."
period. Without wishing to assign a particular weight to the population factor, the point that the faster rate of growth of consumption associated with a faster rate of population growth has both cost and benefit elements which are not readily separable remains valid.

18. Next taking the case of underdeveloped countries of the nineteenth century and comparing them with those of today, we observe that they differ in one fundamental respect. The best summary of this difference is in a paper by H. Wallich. Very briefly put, the thesis is that in the development of the advanced countries of today the driving force was the entrepreneur, the process was innovation and the goal was the enrichment of the entrepreneur. This picture, which is portrayed in Schumpeter's theory of economic development, no longer reflects the situation as it is today. Instead the impetus comes from the government, the process is imitation and the goal is the higher living standard of the masses. The former mechanism is production or supply oriented, the latter is demand or consumption oriented. Production and consumption are, of course, interdependent and each has a place in both outlooks, but there is nevertheless a genuine difference of where the impetus originates. In the former case the problem is to ensure that what is produced is sold. In the latter case consumption is present (and most would say "overpresent" pointing to the efforts of underdeveloped countries today to curb their excessive consumption) and it is a question of

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breaking through another bottleneck. What this other bottleneck is, is immaterial from our point of view. Whether it is the low levels of capital formation (savings) according to Nurkse,¹/ the small share of profits in national income—all savings coming only from profits—as in the theory of Lewis²/ or the "inability to invest" as developed by Hirschman,³/ or finally any of a multitude of other reasons, insufficient demand is never the culprit.

19. We may, therefore, conclude that in both the case of the developed countries of today and these same countries in their early phase of industrialization, consumption had a different role than in that of most underdeveloped countries today. In the former cases, consumption—through the mechanisms outlined above—had stimulating, as well as braking effects, and it is impossible to disentangle the two. In such cases it is illegitimate to treat foregone consumption exclusively as a cost. This is yet another reason which resolves the paradox between our criterion and observed historical experience. Thus, even if we were looking exclusively at the interests of the people then living in countries about to embark on industrialization (i.e. even if we were discounting), it may have been of no benefit to them to have a policy of population limitation. We cannot say for sure, for it is impossible to

disentangle the stimulating from the retarding effects of consumption.
However, the major point of this whole analysis serves to emphasize that the applicability of our criterion is limited only to those situations in which insufficient demand is not an impediment to economic growth.

III - A Case Study of the U.A.R.:  
20. The application of formula (1) requires information which can sometimes be obtained from the relevant data, and also some assumptions that must be made when the necessary data is unavailable. In the latter case, the net benefits will largely depend on these assumptions. For instance, no perfect capital market exists, and assuming social time-preference to lie between 10% and 15%, we made calculations for these two extremes. As far as the other assumptions go, these differ for each of our effects. Let us briefly look at them and their implications for the magnitude of the net benefits.

A. The Initial Effect:
21. The information that is required here is the consumption and marginal product of the average person at every age, together with the probability of survival to various ages. The latter can be deduced from vital and census statistics, which though inaccurate, do not greatly affect the final net benefits. Let us, therefore, concentrate on the former.

22. On the consumption side two problems arise. The first is the definition of "consumption." In his study for India, Enke defines this as GNP minus gross capital formation. This is the standard definition in the national accounts, but as a measure of benefits of an unborn
child, it can be criticized on three grounds: (1) that a lot of what is consumption is really investment from the point of view of economic growth. Examples of this are expenditures on education, health and other investment in human capital. (2) There is an element of grossness in consumption. Some government expenditures (such as maintaining law and order) as well as the higher costs of urban living resulting from greater concentration rather than because the goods are different from their counterpart in the country - both these forms of expenditures can be regarded as intermediate goods rather than final output. (3) Finally, some consumption expenditures are made independently of the rate of population growth and are, therefore, non-marginal. An example of this is defense expenditures. Adjusting for some of the above factors has a sizable effect, since for the U.A.R. it would reduce average consumption by about 25%. It can be argued that such a figure is a better measure of benefits because increased intermediate goods, as well as more (human) capital formation, does not increase the present welfare of the reduced population. However, increased (human) capital formation does increase the productivity of the labor force, but we have (a) no measure of this increase, and (b) the benefits accrue so far into the future that any discounting makes them negligible. Hence, it can plausibly be argued that the second definition - or an intermediate one - is more plausible. Our calculations take both definitions into account as possible upper and lower limits of the benefits.

23. The second problem on the consumption side concerns the allocation of this consumption figure to different age groups. No data is available for this. Enke assumed that persons aged 35 consume 13 to
14 times as much as children in their first year. 

By looking at actual studies in developed countries (for a "typical" middle class family), or alternately by looking at food requirements and assuming that actual expenditures at different ages are made in proportion to the requirements of these ages, we arrived at a different conclusion. In both the latter cases the ratio of children's consumption to adults varied by a ratio of between 1:2 and 1:2.5. Since the future is heavily discounted, adopting our ratio substantially increases the benefits, as we shall see below.

Turning next to the production side, we were confronted with exactly analogous problems as on the consumption side. The determination of the marginal product of labor is a question which has received a lot of attention in the literature, but on which no agreement has emerged. Opinions range from a zero marginal product - usually based on either actual experiments or a calculation of labor requirements which are shown to be well below the actual number of laborers - to a marginal product not substantially different from the wage-rate - based on the

1/ See his calculations for India, in "The Gains to India..." op.cit.
3/ Such as W. Cleland's study ("Egypt's Population Problem," L'Égypte Contemporaine, January 1937), which estimates that 3/5 of Egypt's rural population is redundant.
4/ Such as the study by H.R. El Ghonemy, "Resource Use and Income in Egyptian Agriculture before and after the Land Reform, with particular reference to Economic Development," unpublished Ph.D. dissertation, North Carolina State College, 1953. The conclusion here is that 50% of the agricultural labor force is redundant.
fitting of production functions to the data, on the observation that the hypothesis of zero marginal productivity is inconsistent with profit maximization, and on the analysis of the geographical, seasonal, and male vs. female and child wage differentials. Since the debate on this issue is far from settled, and although our inclination in this debate is that a lot of labor is redundantly, we have taken for purposes of calculation the national marginal product to be equal to the agricultural wage-rate, in order to ensure that our net benefits may be regarded as a minimal figure.

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3/ For the latest word in this controversy see R. Mabro, "Industrial Growth, Agricultural Underemployment and the Lewis model: The Egyptian Case: 1937-1965," Journal of Development Studies, July 1967. The author argues that considerable surplus labor exists in small farms, while none exists in large ones. This is the result of regional immobility, and explains the fact that seasonal wage variations may exist together with a labor surplus.

4/ This redundancy does not necessarily mean that if part of the labor force were suddenly withdrawn output would not be reduced, but rather that if we compare two situations, one with constant fertility and the other with declining fertility (and hence a slower rate of population growth), then the "withdrawals" from the labor force in the latter case (actually the slower rate of addition to the labor force), which are very gradual, can be accommodated by adjustments that would leave total output unaltered in both situations. It is worth noting that the concept of marginal product as it is discussed in the literature - namely, as a (i) sudden withdrawal of labor, with (ii) all other factors remaining constant - is not strictly relevant to our case of comparing a high with a low fertility situation. In this case rather than sudden withdrawals there is a gradual transition which allows the adjustments necessary to leave total output unchanged.
25. From the previous discussion it will be seen that taking maximum and minimum values for the level of consumption (marginal productivity), the allocation of the consumption (production) stream to different ages and the discount rate gives eight different possible consumption (production) streams. Table I summarizes the result of these eight different benefit streams. It also gives the same eight possibilities for the year 1947 - only mortality having changed between 1947 and 1960. From this table we notice that the benefits of a prevented birth in 1950 to 1.5 to 1.2 times the per capita income - i.e. when all factors and since to vary at the same time the difference between the maximum and minimum varies by a factor of nearly 4. But before it is concluded that this measure suffers from a great degree of imprecision, it should be pointed out that it is unlikely that we would want, in any particular situation, to vary all the factors at once. What particular ones we would want to vary would depend on the use we would want to make of our figure and in this context it is well to distinguish between two possible uses.

26. First we may wish to compare the value of a prevented birth in one year with that value in another year, to get an indication of how far the situation has improved or deteriorated. In this case we would use the same definition of the level of consumption (production), and the

1/ As far as the allocation of the marginal product to different age groups goes, we arbitrarily assumed that children start work at age 10, and that the productivity of children aged 10-14 and 15-19 was one-third and two-thirds, respectively, of those aged 20 and over. By contrast Enke's figures (S. Enke, Economics for Development, op. cit., Ch. 20) vary by a factor of 7 between ages 10 and 35.

2/ This is the result of applying formula (1) to the eight different streams. The method is set out clearly in S. Enke, "The Gains to India from Population Control," loc. cit.
### Table I. The Initial Impact Effect

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**PRESENT MORTALITY (1960)**

1. **Our Consumption and Productivity Stream**
   - 151 281 91 260 189 4.5 3.3 206 165 31 175 134 3.0

2. **Enke's Consumption and Productivity Stream**
   - 278 222 79 198 143 3.4 2.5 136 109 24 112 85 1.9

**PAST MORTALITY (1947)**

3. **Our Consumption and Productivity Stream**
   - 294 235 71 223 164 3.9 2.8 175 130 25 151 116 2.6

4. **Enke's Consumption and Productivity Stream**
   - 223 179 61 162 118 2.8 2.0 113 90 19 94 71 1.6

**Column 1:** Discounted Consumption Stream. Consumption defined according to standard procedures.

**Column 2:** Discounted Consumption Stream. Our revised definition of consumption.

**Column 3:** Discounted Productivity Stream.

**Column 4:** Net benefits according to first definition of consumption.

**Column 5:** Net benefits according to second definition of consumption. Figures in cols. 1 to 5 are Egyptian pounds.

**Column 6:** Net benefits (first definition) as a proportion of per capita income (=58 Eg.P.).

**Column 7:** Net benefits (second definition) as a proportion of per capita income.
same method of allocation between different age groups in both years. In addition we would use the same discount factor, so that the main variable in such a comparison would be the different number of survivors in the various age brackets. For instance, comparing the year 1947 with 1960 we could say that the effect of reduced mortality has been to increase the net value of a prevented birth by something between 15% and 25%. We may further argue that this is an underestimate if we believe that either (a) the productivity of labor has declined between both dates because population has been growing faster than other resources, and/or (b) a higher rate of interest should be used in 1960 than in 1947, because with a greater international demonstration effect and more government propaganda leading to a rising level of expectation of the masses, time preference for the present has increased. Thus although (a) and (b) cannot be measured, it can be concluded that as a minimum the value of preventing a birth has substantially increased, which makes a population program correspondingly more urgent now.

27. Alternately we may wish to compare investment in population control with investment in other projects. In this case we would be using the same interest rate to discount the benefits and costs of both a prevented birth and of other projects. Hence we would allow only for

\[ \text{If we do not want to take into account the scale of the alternative investment choices we can take the ratio of benefits to costs. But if the scale does matter then we have to specify a size for the population control program, and multiply the difference between benefits and costs of one prevented birth by the number of prevented births, before comparing this figure with that of alternative investment opportunities.} \]
a change in our concept of consumption and the allocation of both con-
sumption and production to different age groups. Here the range between
maximum and minimum values of a prevented birth would vary by a factor
of 2. \((4.5/2.5 \text{ for a } 10\% \text{ discount rate and } 3.0/1.5 \text{ for a } 15\% \text{ rate})\).

Given the uncertainty about the future, the difficulty of calculating
shadow prices and many other difficulties that beset the evaluation of
returns on industrial projects our range of variability does not seem
to be, by comparison, excessive.

The Wage Productivity Effect:

By referring back to the second term of expression (1), it will be seen that the benefits to be derived via the wage-productivity
effect are a proportion of the initial effect. This proportion depends
on (1) the marginal propensity to consume food, (2) the proportion of that
food consumption that goes to members of the labor force, (3) the propor-
tion of the year for which this labor force is employed, (4) the increased
calorie intake resulting from higher per capita food consumption, (5)
the increased supply of effort due to a higher calorie consumption, and
finally (6) the marginal product of effort. Various upper and lower
bound estimates can be made for each of these factors. Items (1) to (3)
need not detain us here, for their variability is not very large. As far
as items (4) to (6) go, we note the following: In (4) we assume that
calories increase in proportion to the increased expenditure on food.
This implies that diets remain unchanged, which for (a) marginal changes,
and (b) low levels of income (implying diets that are restricted to one
or two staples) is realistic. In addition, it is implicitly assumed
that malnutrition exists. Calorie requirements depend on various factors
such as age, sex, weight temperature and especially work. Although these requirements are periodically revised, if we assume an eight hour day of agricultural work, then they all point to an average well above that of 2500, which is the present daily average consumption of the U.A.R.\footnote{For instance, taking the requirements (for a full eight hour working day), listed in H. Correa, The Economics of Human Resources, (Contributions to Economic Analysis, 34), Amsterdam, 1963, Table IV, p. 36, for each of the agricultural, industrial and service sectors, and weighting these requirements by the corresponding proportions in the U.A.R. gives a nation-wide requirement of 3150 daily calories. By contrast the actual consumption is 2500. See, also S. Shehata, "Cooperative Efforts and Food Consumption in the U.A.R.," L'Egypte Contemporaine, January 1964. The author mentions the figure of 3000, as the minimum calorie requirement for the U.A.R. We may mention the following three sources: (a) H. Leibenstein, Economic Backwardness... op. cit., and references therein, where the conclusion is that 100 extra colonies are required to produce the equivalent of an hour's work, (b) S. Shehata, op. cit., who gives 1700 calories required for basic metabolism and 3000 as the minimum for an eight hour day. This implies that around 350 calories are required per hour, and (c) H. Correa, op. cit., Ch. 4, from which we deduced a figure of around 200.} Because of the large calorie requirement for basic metabolism, small increases in calorie intake lead to large increases in the supply of effort. Estimates vary widely, from 100 to 200 extra calories \footnote{\textit{\textsuperscript{1}}/} required to produce the equivalent of an extra hour's work. Together with total extra number of calories consumed, this allows us to determine the total number of extra hours of work. This does not mean that workers actually work more hours, but that during the same workday, they produce - in terms of effort - the equivalent of more hours of work. It remains to convert this increased supply of effort into an increased output. Here "the marginal product of effort of the equivalent of an hour's work," is calculated by assuming the marginal product of labor to be equal
to the wage-rate. (≈35 Egyptian Pounds per year). In addition, it was assumed that at present the labor force worked the equivalent (in terms of effort) of a four-hour day. This was deduced from the fact that the average daily calorie consumption was 2500 calories and that at this level of calorie intake, one is working at 50% of full capacity in both the agricultural and industrial sectors.  

1/ A four-hour day gives 1200 hours per year (assuming 300 working days). Dividing this figure by the yearly wage-rate, gives an approximation to the marginal product of the equivalent of an hour's effort (found to be 0.03 Egyptian Pounds in our case). Thus, we have all the required information, and on this basis it turns out that the wage-productivity effect varies between 4.5% and 18% of the initial effect, with 8% being a "likely" or reasonable value.

29. Before proceeding, it may be worth pointing out that the above calculations are marginal in the sense that large increases in the supply of effort may affect (and lower) the marginal product of effort, and also in the sense that after income has increased to a certain level, there is no longer any malnutrition. In the latter case the wage-productivity effect would no longer hold, whereas in the former it may be reduced. On the other hand, we may note that not only is the total number of calories important, but also their distribution among proteins,

1/ H. Correa, op. cit., Table IV-2-3, p. 36.

2/ The initial effect which we are referring to is that defined on the assumption that consumption is defined as GNP minus gross capital formation (i.e. as a proportion of Col. 4 of Table 1). It is a higher proportion of the minimum definition of consumption (Table 1, Col. 5). Similar comments apply below, in our discussion of both private and government savings as a proportion of the initial effect.
carbohydrates and fats. The present diet of the U.A.R. is far from balanced,\(^1\), so that even after daily consumption reaches the minimum requirement level, there is still room for increases in productivity.

A final comment is that the productivity of the labor force can improve because of increased consumption of other factors besides food. In particular, improvements in health could have tremendous effects,\(^2\), but we have not included these.

C- Increases in Private Savings:

30. As a matter of arithmatic, the magnitude of the savings effect as a proportion of the initial increase in income depends on, and is in fact equivalent to, the assumed marginal propensity to save. In other words, a propensity to save of \(n\%\) leads to an increase in benefits equivalent to \(n\%\) of the initial effect. Thus, if all the income were saved, the benefits would be doubled. The interesting question is whether

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\(^1\) S. Shehata, "Co-operative Effects and Food Consumption in the U.A.R.," op. cit. In the U.A.R. carbohydrates (grains) account for 80% of the diet, while fats and proteins account for 20%. By contrast the ideal balance is 50%, 35% and 12% respectively. This may be an explanation for the results obtained by W. Galenson and G. Pyatt, (The Quality of Labor and Economic Development in Certain Countries, International Labor Office, Geneva, 1961), who found that both in the case of developed (who were well above the minimum requirements) and underdeveloped ones, the quantitatively largest and statistically most significant factor explaining the rate of growth of labor productivity was calories per head (twelve quality improvement factors were tested altogether).

\(^2\) H. Correa, op. cit., pp. 43-47, calculates that for Egypt the black in output due to deficient health is larger than that arising from undernutrition. Correa's estimate of the former is biased downward because he only takes account of illnesses that result in death while a lot of the loss in output results from chronic illnesses that reduce vitality, but do not lead to death (e.g. bilharzia).
total savings will in fact increase. In theory the interrelationships
between population growth and savings behavior are complex and no
empirical studies are available of the influence of family size on
actual savings. On a speculative basis we would argue that unless there
were positive government efforts to mobilize this saving, no increases
should be expected. This argument is based on a point made by S. Kuznets\(^1\)
which is that if the only problem in economic growth was to curb consump-
tion, then this could be achieved very easily. Calculations show\(^2\) that
a (linear) increase in savings proportions from 9\% to 15\% of national
income over a ten-year period, and with no reduction in fertility, can be
achieved by a decrease in the absolute level of consumption by an average
of 1.2\% of GNP in the first seven years (and by a maximum of 2.2\% of
GNP in any one year). After this initial period, saving proportions are
increased by foregoing some increases in the absolute level of consump-
tion. Put in these terms, the increase in savings proportions can be
achieved at a remarkably low sacrifice.

31. It is, of course, true that if fertility were reduced, then
no reduction in the absolute level of consumption would be necessary to
raise savings proportions. But the difference between both cases seems
so small that it would be unwise to believe that a fall in fertility would
automatically raise total savings. Rather, it seems that the causes which
make the raising of saving proportions so difficult even when fertility
is not reduced would also be present in the case of a fertility reduction.

\(^1\) S. Kuznets, "Demographic Aspects..." op. cit.
\(^2\) See Table IV, p. 75 in BCPC, op. cit.
These will differ from case to case, but perhaps a common basis is the consumption-oriented form of economic development today. The demands of the population for higher living standards today (enhanced by propaganda and an international demonstration effect) may be an explanation for the vain efforts of many governments at curbing consumption. If this explanation is correct, it would be wrong to infer that a reduction in fertility will stimulate savings, unless it can be shown how fertility reduction will affect these underlying factors. It may be that the desire for smaller families is the result of a desire for more consumption (this is often the basis of the propaganda of many family planning programs), in which case no larger savings can be expected. We may then conclude as follows. In order to be conservative, we have argued that it is preferable not to expect any benefits from the savings side. However, the magnitude of this effect shows the large potential benefits that can be expected if government policies of taxation etc., are successful in mobilizing the released income resulting from lower fertility.

D - Government Savings:

32. As noted in section one, the only assumed increase in government savings as a result of a reduced fertility are the increased savings resulting from the reduced expenditure on primary education. This is so because the government is committed to universal primary education so that - assuming the marginal costs of education are the same as the average ones - a reduction in fertility may reduce such expenditures. The further assumption is made that these expenditures will be invested rather than directed to government consumption. This assumes a high priority on the part of the government for development. In addition
several other benefits can be expected which we have not taken into account. These arise because either fewer persons will be educated on other levels than primary education (if educational policy is determined by a given proportion of students in each age-group) and the sums of money thus saved may also be invested, and/or because a higher proportion of persons will be educated (if educational policy is formulated in terms of a fixed sum of money) with a resulting improvement in the quality of the labor force. The existence of such benefits that we will not take into account, may counteract the fact that some of the reduced expenditures on primary education may end up in increased government consumption.

33. With all the above provisos in mind, we find that the magnitude of this effect is substantial. It amounts from 1½% to 19% of the initial effect which in terms of the income stream generated per prevented birth is equal to about two thirds the per capita income.

Conclusions:

34. We may conclude as follows: the magnitude of the initial effect of permanently preventing one birth was found to give rise to a net income stream equal to somewhere between 2.5 and 4.5 times the present per capita income when a 10% discount rate was used and to between 1.5 and 3.0 times per capita income when a 15% discount rate was used. To this effect we can add the wage productivity effect and the effect of increased government saving. These amount to somewhere between
18.5% to 37\% \textdagger of the initial effect. This is a minimum, for other possible benefits include: (1) The increase in private savings, which can be sizable (as large as the initial effect if all increases in per capita income are saved), but not likely without positive government policy.

(2) The possible increase in government savings as a result of reduced expenditures on forms of education other than primary, and for the improvement in the quality of the labor force because of more education per head.

(3) The improvement in the quality of the labor force because of larger expenditures on health, per head, by both the private and government sector.

Finally we re-emphasize the limitations of this calculation. First these benefits are the result of looking at the child exclusively as (a) an investment good and (b) from the point of view of society. Second, the "benefit for society" is simply defined as the sum of the benefits accruing to the people that are alive today. More precisely, our calculations refer to the benefits of persons born today since our time-horizon was of the same length as the average expectation of life at birth. Older sections of the population would resp only part of those benefits. Third, the treatment of consumption exclusively as a cost is

\textdagger As previously noted, this percentage refers to the income stream computed on the basis of the maximum definition of consumption (Col. 5, Table 1). Since both effects are defined in absolute terms, they amount to a larger proportion (23\% to 46\%) of the lower estimate of consumption.
based on the premise that the development of the U.A.R. is of the consumption-oriented type, and that whatever the obstacles to growth, insufficient consumption is not one of them. Finally, these benefits are those of permanently preventing a birth. A delayed birth would have led to only a part of these benefits, this proportion depending on both the exact form of the delay and the discount rate that is being used.