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GEORGE C. ZAIDAN

THE COSTS AND BENEFITS
OF FAMILY PLANNING
PROGRAMS

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FOREWORD

I would like to explain why the World Bank Group does research work, and why it publishes it. We feel an obligation to look beyond the projects we help to finance toward the whole resource allocation of an economy, and the effectiveness of the use of those resources. Our major concern, in dealings with member countries, is that all scarce resources, including capital, skilled labor, enterprise and know-how, should be used to their best advantage. We want to see policies that encourage appropriate increases in the supply of savings, whether domestic or international. Finally, we are required by our Articles, as well as by inclination, to use objective economic criteria in all our judgments.

These are our preoccupations, and these, one way or another, are the subjects of most of our research work. Clearly, they are also the proper concern of anyone who is interested in promoting development, and so we seek to make our research papers widely available. In doing so, we have to take the risk of being misunderstood. Although these studies are published by the Bank, the views expressed and the methods explored should not necessarily be considered to represent the Bank's views or policies. Rather they are offered as a modest contribution to the great discussion on how to advance the economic development of the underdeveloped world.

Robert S. McNamara
President
International Bank for Reconstruction and Development
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The objective of this paper is twofold. One is to extend a widely accepted technique for measuring the economic returns of investing in population control. The second is to discuss the limitations of this approach. The author has become acutely aware of these limitations as a result of basic and searching questions posed mainly by non-specialists. Such questions have forced him to go to the assumptions underlying this as well as other approaches to the economic analysis of population programs.

The Bank's interest in the population field arises from its awareness that the high rates of population growth in many member countries can severely impede their economic development efforts. At the same time it is aware that population policy is not framed solely or even primarily with reference to economic aspects. The population field is a complex and sensitive area involving difficult ethical, political and social issues; the professional disciplines needed to bear on the solution of the problem are numerous and complex. Besides the economic aspects of population planning, other considerations—demographic, medical, sociological, religious and ethnic—are crucial to the evolution of population policies and their effective translation into fertility reduction. The economic analysis comprises one small facet in this process. The fact that this paper concentrates on the more narrow economic analysis, and is furthermore limited to a discussion of those items that can be quantified, is in no way meant to detract from the importance of other considerations. The Bank is in the process of evolving a methodology on how to ap-
praise its population projects effectively, and is actively discussing the best ways of measuring the varied dimensions of the population problem.

It has to be emphasized that the uncertainties and sensitivities of quantified analysis of the benefits of population projects have not deterred the Bank's pursuit of the measures needed to assist countries to become aware of the population problem and to provide, where required, assistance to their programs.

The author, now with the Population Projects Department, started this study in his doctoral dissertation in Economics (Harvard, 1967). It has been considerably revised as a result of the author's subsequent experience in research and operational work within the Bank.

The author has benefited from the constructive comments, oral and written of his colleagues: in particular B. Balassa, E. K. Hawkins, E. Holland, T. King, G. Ohlin, H. G. van der Tak. Finally special thanks are due to T. H. Silcock and Miss Judith Maguire, for their patience in editing this paper.

Andrew M. Kamarck
Director
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THE COSTS AND BENEFITS OF FAMILY PLANNING PROGRAMS
SUMMARY

This study has two main purposes. First, it applies a benefit-cost technique in order to measure the economic returns of family planning programs. Second, and more importantly, it discusses the assumptions and limitations inherent in this type of analysis.

This approach, first developed by Enke, takes the present value of the discounted consumption stream of an unborn child as the main measure of the benefit accruing to society from the prevention of a birth. This benefit is then compared with the cost of preventing a birth through the provision of family planning services. The acceptability of such a technique can be questioned on the grounds that it leads to implausible conclusions. The benefit-cost criterion is valid not only for the ninth or tenth child, but also for the first and second. It implies that a birth-rate not far from zero is economically the most desirable. It leads to the same conclusion—the need for a reduction in fertility—in all countries at all periods of time.

Such implausible conclusions make it imperative that economists spell out the assumptions and limitations of this technique. It will be noted that these conclusions follow because benefits exceed costs under almost all conceivable circumstances. This can be largely attributed to two factors:

Discounting. Because benefits occur immediately after the reduction in fertility, while costs must be considered only after a time lag of fifteen years or so, discounting insures that benefits exceed costs. Alternatively, the results of this analysis can be presented in the form of a time stream instead of a
present value. This does not get around the difficulty of what weight to attach to different time periods, however, but only shifts this responsibility from the economist to the policy-maker.

**An Implicit Welfare Function.** The implicit objective of this approach is to maximize only per capita income. Other important variables such as the utility of children, total output, income distribution, etc. are not included. This explains why this technique shows that a birth-rate not far from zero is economically the most desirable. It is argued that such an objective is especially valid for small changes, which are the changes that can reasonably be expected in fertility over the next ten to twenty years, and for poor countries living close to subsistence levels. In those instances where births are not wanted by the parents, changes in per capita income are a good index of changes in welfare, and these changes alone are a good approximation of the welfare of the country. The benefit-cost technique becomes less acceptable as each of these conditions is relaxed.

This paper applies the benefit-cost technique to the specific case of the United Arab Republic. In estimating the benefits and costs of a prevented birth it includes on the benefit side:

- **a)** The main effect—the consumption expenditures that would have been required for an averted birth and which are now available to the population;
- **b)** The increase in total public savings resulting from the diversion of resources that would have been required to educate the averted birth;
- **c)** The wage productivity effect—the increase in output resulting from better nutrition of smaller sized families; and
- **d)** The potential increase in private savings resulting from reduced fertility. (This is not included in the calculations for the U.A.R.)

The costs (i.e. foregone benefits plus incurred expenditures) take into account:

- **a)** The magnitude of the loss of output resulting from a smaller labor force as the result of the delayed effects of lower fertility; and
- **b)** The costs of averting a birth through the provision of family planning services.

The results show that the benefits are 2.5 to 8.7 times as large as the costs, and that the difference between benefits and costs ranges from 1.6 to 6 times the per capita income. The benefits consist mainly of the present value of the discounted consumption stream (80–85 percent of total benefits), increases in public savings (about 10 percent of total benefits) and increases in output due to better nutrition (about 5 percent of total benefits). Increases in private
savings present a great potential source of benefits but are not included because of uncertainties regarding this effect. The costs are mainly those of smaller output resulting from a smaller labor force, while the costs of providing family planning services account for about 12 percent of total costs and about 3.5 percent of total benefits.

Many important factors are excluded from the benefits because of difficulties of measurement—in particular, the better health of mothers and children, the greater care that can be given to children of smaller families, the averted psychological costs of an abortion and/or an unwanted child, the greater output resulting from the improved health of the population, the greater output resulting from a more educated population, and the effects of more rapid economic development (in particular through such effects as urbanization and the education and employment of women) in inducing further declines in fertility. If these factors could be measured they would add substantially to the benefits.

Besides the omission of some effects, there are other important problems of measurement. First, as no general equilibrium model is available, a partial approach to the measurement of the economic effects (consumption, production and savings) has to be used. Second, there are difficulties in estimating the number of permanently prevented births in a family planning program as opposed to the number and time pattern of “delayed” births. And third there is the problem of substitution, or of separating the impact of a family planning program from the reduction of fertility that would have occurred anyway as a result of improvements in socio-economic conditions. These problems do not reverse the previous conclusions, but make the quantitative estimates less precise.

Even when acceptable, the benefit-cost approach is not suitable for some types of analysis. It is not suitable for ranking countries according to the degree to which population is a problem or in ranking family planning programs according to their “efficiency.” It is also not a suitable tool of analysis for measuring the economic effects of different levels of population growth. Instead, it is suitable for measuring the effects of changes in these levels, and as a method of comparing the returns of investment in family planning with those of other economic sectors.

In the final analysis, neither the benefit-cost approach nor other techniques for the economic analysis of population trends can or should be used alone to determine the desirability and extent of the reduction in fertility. Rather, economic tools should be used for presenting policy-makers with options and alternatives. The final choice will involve far more than economic considerations.
INTRODUCTION

The rapid post-war decrease in the death rates of developing countries has resulted in population growth of an unprecedented magnitude. Serious concern for the consequences of this high rate of growth was first voiced over a decade ago; today there is an increasing awareness of the gravity of this problem on the part of many governments, international organizations, private institutions and responsible citizens. Reactions aroused by this problem have varied, but they have usually been intense. As one writer stated, "Population is an emotional subject, and there has always been an inclination to attribute evil or virtuous consequences to population growth—or decline—in a slightly careless manner." This emotional response is in large measure evoked because population policies raise fundamentally moral, ethical, religious and political problems. Economists who have looked at this problem have not been immune from such fundamental considerations, though they have not always been aware of the implicit judgments being introduced in their analysis.

Modern quantitative economic analysis of the impact of population trends on economic development began in 1958 with the Coale-Hoover analysis of India which was financed by the World Bank. It noted that of the variables

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affecting population change, death rates are not subject to conscious policy manipulation (though naturally they will be affected by the extent to which health programs are pushed), and a policy of encouraging emigration, even if economically desirable and successful, is in most cases insufficient to have a sizable impact on population growth. Consequently the Coale-Hoover study assumed a reduction in fertility and then set out to measure the impact of this reduction on the growth of per capita income. More recently an alternative technique for measuring the economic implications of a reduction in the present high birth rates was introduced by S. Enke. Here the returns from investment in family planning are calculated by taking the value of the consumption stream necessary to support a person through life as a measure of the benefits of averting a birth. The benefits are then compared with the costs of averting a birth. These costs include the productive contribution to the economy that an additional person would have made through his lifetime, and the real costs of providing family planning services. To insure the comparability of the benefit and cost streams, each is reduced to its present value by means of discounting, and a measure of the economic returns (either in the form of the difference between benefits and costs or a "benefit-cost ratio") is derived. This analysis, which shows large economic returns, has been widely and uncritically accepted; most noteworthy perhaps was the now famous remark by President Johnson that investment in population control is twenty times as effective as investment in more traditional lines of economic activity.

This paper has two objectives. The first, and perhaps less important, is the extension of Enke's analysis and the consideration of the problems involved in the quantitative measurement of the various economic effects of preventing a birth. The second and more important objective is the delineation of the assumptions and limitations inherent in the use of this widely accepted technique. This objective emerges naturally as soon as it is realized that under almost all conceivable and plausible economic assumptions, this type of analysis

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4 In his address at the opening of the U.N. 20th Anniversary Commemorative Session at San Francisco (June, 1965), President Johnson said: "Let us act on the fact that less than five dollars invested in population control is worth one hundred dollars invested in economic growth." The speech is reproduced in Department of State Bulletin, Vol. LIII, No. 1360 (July 19, 1965), p. 100.
will yield high economic rates of return to investment in family planning. To many such a result appears to be suspect and it becomes imperative to spell out why this is so. It is the contention of this paper that these results follow as much from the objectives that one is implicitly trying to maximize as from the economic analysis underlying this approach. This fact has rarely been appreciated by the users of this approach.

At the outset one preliminary point should be made. Many important non-economic considerations are omitted, and while these omissions are not intended to suggest that the wider religious, moral, and political considerations are in any sense less important than the more narrowly economic ones, it is felt that the economic aspects are an important part of the large number of issues that arise in any rational discussion of this vital problem.

The discussion in this paper can be conveniently broken down into three distinct parts. The first is a description of the various effects of the reduction of fertility and the combination of these into a benefit-cost criterion. The second section appraises the advantages and limitations of using the benefit-cost approach. The third illustrates the method and studies the problems of measurement by applying the technique to the concrete case of the United Arab Republic.

5 In an accounting sense most of the resources spent on the provision of family planning services (i.e. salaries) are current costs as they are made on a recurrent (annual) basis. In an economic sense, however, all those resources are an investment since they create an asset (the averted birth) that gives rise to a stream of benefits in future years. It is in this latter sense that the term investment in family planning is used here.
The welfare effects of the prevention of a specified number of births can be divided into effects that reduce the claims on aggregate national income, and those that lead to additions to national income over and above what it would have been in the absence of the decline in fertility. The reduced claims on the aggregate national income accrue as benefits to the living population. Two such benefits are first the future consumption of the unborn child throughout his life, and secondly the social services (mainly education) that the government would have provided in addition to the child's personal consumption. As a result of these reduced claims the same national output is now divided among a smaller population, since the unborn child would not have made a productive contribution to the economy. This holds true 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; thus output may be reduced as a result of the lower fertility.

Not only are the claims on national income reduced, but the decline in fertility can also lead to additions to the national income. The reduction of the number of unproductive consumers results in a better fed and more healthy labor force, and to larger possible private and public savings. These

\(^1\) The "short run" is defined here as the length of time between birth and the average age at which persons enter the labor force.
two secondary benefits can then lead to increases in the output of the economy, making the per capita income even higher. Each of these secondary benefits is discussed below.

The effect of more consumption per worker, or the "wage productivity effect," has been analyzed by H. Leibenstein. The basis of this effect is that the increased food consumption resulting from the initial increase in per capita income leads to greater output through the following intervening links: (i) the marginal propensity to consume food, (ii) the resulting increased calorie intake, (iii) the resulting increased supply of effort, and (iv) the marginal product of effort. The greater the magnitude of each of the ratios (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 per capita consumption is below the optimum calorie requirement and that the marginal product of effort is not zero. Even when this effect is present, one must be aware that only the consumption of workers adds to output. Thus one must take into account only that proportion of the initial increase in income that goes to members of the labor force, and only in those periods of the year when there is no seasonal unemployment.

The savings effect raises much more difficult problems. If savings are increased future aggregate income will be larger than otherwise; this can make a substantial difference, particularly after a long period of time. The question arises, however, as to how these large potential benefits can be converted into a present value. This raises the difficult problem of whether both the additional investment and the income generated by this investment should be included in the benefits. If this is not done the full effect of larger savings will not be reflected in the benefits (the extent to which there are savings will not affect the size of the present value of the benefits), provided the return on investment and the discount rate are equivalent. The question of whether both the investment and the income should be included is a complicated one. The answer depends, in part, on whether the objective is to maximize consumption or income. We do not propose to pursue this discussion here, since at the empirical level both the direction and the magnitude of the savings resulting from different family sizes are uncertain; consequently this effect is

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3 See for example Coale and Hoover.
4 The theoretical relationships between savings behavior and the rate of population growth have been analyzed by P. Demeny in Demographic Aspects of Savings, Investment, Employment and Productivity, Paper No. 460, United Nations World Population Conference, Belgrade, 1965. The discussion is inconclusive and there are few empirical studies at the micro-economic level of the relationship between family size and savings in less developed countries.
not measured in this paper. The main point to bear in mind is that larger savings in some cases could lead to a national income that is larger than otherwise, and this real benefit should not be overshadowed by the difficulties arising from converting this larger income into a present value.

On the basis of the previous discussion, this study will measure the benefits of an averted birth by applying the following formula, which includes three of the effects already discussed:

\[ B = \sum_i y_i (1+r)^i + P \sum_{i} \sum_{j} \frac{x_j}{(1+r)^j} + k \cdot h \cdot \sum_{i} f_i \cdot \frac{y_i}{(1+r)^i} \]  

(1)

where \( \sum_i \) denotes summation over all years of the unborn child’s age to the end of our time horizon,

\( \sum_j \) denotes summation over all years from \( i \) to the end of our time horizon,

\[ y_i = c_i (1 - q_i), \] the anticipated consumption of an unborn child in year \( i \), allowance being made for the possibilities of the child’s death at various ages,

\[ c_i = \text{annual consumption of a child between ages } i \text{ and } (i+1), \]

\[ q_i = \text{probability that a newborn child having lived to age } i \text{ will not live to age } (i+1). \] \((1 - q_i)\) is therefore the probability of survival between ages \( i \) and \( (i+1) \),

\[ f_i = \text{marginal propensity of the labor force to consume food in year } i, \] expressed as a proportion of total income, in periods of the year when there is no seasonal unemployment,

\[ s \text{ and } S \text{ are the propensities to save before and after the reduction in fertility respectively.} \]

One other effect which we do not consider is the possibility that different fertility patterns will affect the incremental 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 to 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.
\( k \) = 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 annual (current and capital) cost of education per child between ages \( i \) and \( (i + 1) \),

\( r \) = social rate of discount,

\( P \) = average yield on investment.

The benefits of preventing a birth, estimated on the basis of equation (1), are then compared with the costs of this averted birth. These costs include first the reduced output resulting from the slower rate of growth of the labor force under conditions of declining fertility. This reduction is measured ideally by the marginal product of labor that would have prevailed at the time the unborn child would have entered the labor force. Second, the costs include the actual government expenditures and real costs to the economy of averting a birth through a family planning program. The costs can therefore be measured by the following expression:

\[
C = \sum_i \frac{MP_i}{(1 + r)^i} + E
\]

where \( MP_i \) = the marginal product of labor of the unborn child between ages \( i \) and \( (i + 1) \). Assuming the child would enter the labor force at age \( Z \), then \( \sum_0^Z MP_i = 0 \).

\( r \) = the rate of discount.

\( E \) = the real resources required to avert a birth through the provision of family planning services.

Returning to the measurement of benefits in equation (1), the first term is seen to be the discounted consumption stream of an unborn child. The second is government saving on educational expenses. The third is the wage-productivity effect.

While this expression is spelled out in terms of the total consumption of one prevented birth, it can be converted into a per capita measure once the number of births averted by a particular program is estimated. The effect of a fertility decline in per capita income can be shown with the aid of a diagram. This diagram shows the benefits arising due to the fact that the consumption of births averted in one year is now available to the population. On Part I of Figure 1 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 are measured on the horizontal axis. These savings
FIGURE 1: EFFECTS OF A DECLINE IN FERTILITY

Discounted future consumption

Increase in per capita consumption

O, Increase in present per capita consumption

O, Increase in savings per worker

Additional increase in present per capita consumption

Increase in savings per worker

Present per capita consumption

Increase in savings
result if any part of the increased resources are not consumed.\(^6\) In Part II the effect of the increased consumption per head on the increased income per head during the current period is shown. This curve takes into account many relationships already mentioned. It shows that increased consumption per head leads to progressively smaller increases in income per head since:

a) Only part of the increased consumption per head results in increased food consumption per head.

b) Not all of this increased food consumption goes to persons in the labor force.

c) Because of seasonal unemployment in agriculture, increased food consumption in some parts of the year does not lead to an increased supply of effort.

d) Because of diminishing returns to the labor 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 suitably discounted. Here, too, diminishing returns to capital are shown. Finally in Part IV we see the alternatives that are possible between income today and income in the future. Time preference will determine what proportion of the increased income is saved and what proportion is consumed. Enlarging Part IV, we can view \(O_x\) as the point at which the economy would have been if there had been no reduction in fertility. The initial effect can be thought of as providing an increase in per capita income of \(O_xO_y\) more of present income. Then this increased income could be either wholly consumed or saved. If it were all consumed, the induced increase in income would be \(O_xC\). If on the other hand it were all saved, the induced increase in future income would be \(O_xS\). As more was saved, however, the present income \(O_xO_y\) would be reduced. If it were all saved \(O_x\) would coincide with \(O_x\) and \(S\) would move to the left to lie above \(O_x\). The solid line \(CS^1\) traces out the options for income now and in the future, measured on the larger diagram.

In conclusion, it should be pointed out that underlying all these effects is the change in the age distribution of the population resulting from the lower fertility. In the short run the initial effect is a consequence of this, since it is because the size of the labor force is unchanged while the proportion of young

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\(^6\) Note that the scales are adjusted to bring out the point that a given amount of released income is being divided between consumption and saving: since \(P > L\), \(\Delta\left(\frac{C}{P}\right)\) on the vertical axis would be smaller than \(\Delta\left(\frac{K}{L}\right)\) on the horizontal axis if \(P\) and \(L\) were measured in the same units on the same scale.
people who consume but do not work decreases, that output per worker can 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 a smaller family size permits families to increase their total savings and affects in various ways their inducement to save. Finally, this changed age-distribution may influence the total amount of revenue available to the government; it allows resources that are devoted to the “consumption” of the young (such as education) to be diverted elsewhere or to be allocated between different sectors. Hence the altered age-distribution turns out to be a major factor underlying all the effects.
APPRAISAL OF THE BENEFIT-COST TECHNIQUE

The apparent simplicity of the benefit-cost criterion obscures several important difficulties. Some of those relating to difficulties of measurement will be discussed in Chapter V. Others of a more basic nature are treated below. The peculiarities of this approach force economists to state explicitly the assumptions underlying their analysis of the relationship between population growth and economic development. Many of these assumptions are non-economic; thus the discussion is carried over the blurred frontier of economics into the wide range of issues often considered in any discussion of the population problem.

Bias of the Benefit-Cost Approach

The benefit-cost approach will show large economic benefits under almost all conceivable conditions. The value of the consumption stream (first term of equation (1)) is always far larger than the discounted productive contribution of an individual plus the costs of preventing a birth—which will be seen to be small. This holds true for two reasons. The first is that the consumption and productivity streams are discounted. Since consumption starts immediately after birth, and production is delayed for at least ten to

1 See in particular Table 6.
2 Besides these, Enke lists other (minor) reasons for this bias. See "The Economic Aspect of Slowing Population Growth."

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fifteen years, even moderate discounting leads to large differences between the present values of the two streams. The rationale for using discounting is that it represents the opportunity cost of capital, or alternatively a social time preference, i.e. a preference for the present over the future. Any positive discount rate is likely to ensure that the present value of consumption exceeds that of production. The larger the discount rate, the larger the benefit-cost ratio, since the productivity stream is reduced proportionately more than the consumption stream. If, however, the absolute difference between benefits and costs is taken instead of the ratio, increasing the discount rate may reduce this difference. The second reason is that average consumption is being compared with marginal product. In the long run, average consumption and average production are identical. However, whereas an unborn child would have consumed as much as the average person through his lifetime, his marginal output falls short of the average. Insofar as the difference between the average and marginal output is a measure of the extent of the pressure of population on limited resources, this source of bias is legitimate.

For these reasons it is difficult to imagine a case in which an extra birth is shown to be “economically” desirable. The benefit-cost technique applies not only to the seventh or eighth child but also to the first or second. Adherence to this criterion thus suggests prima facie that the birthrate should be reduced to zero. Yet quite obviously the idea of a society reaching an economic optimum when it is in the process of becoming extinct does not make economic sense. By the same token, the benefit-cost approach leads to the conclusion that a reduction in fertility would be desirable on economic grounds for all countries at all periods in their history. While some cases can be found where the marginal product of labor is so high that the benefit-cost approach would show that more population is desirable (and that the “optimum” birthrate would then be higher than zero), it is difficult to think of actual examples where this is so. The general point is that there is a “bias” in this approach that leads to unpalatable results. In fact, the excess of benefits over costs is so much greater than in other economic projects that this has been used by some as an argument to justify the use of coercion and pressure in population control policies.

If the benefit-cost technique is to be at all meaningful, it should be quali-

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4 See Table 7.

5 Assuming this can be made effective. In effect, it is difficult to envisage how any kind of force or pressure can be brought to bear on a large number of couples (if an impact on the birthrate is to be made) for the greater part of their married lives. Voluntarism is thus not only desirable on the moral grounds of free choice, but also on grounds of expediency.
fied and used with care in order to ensure that conclusions which conflict with common sense are not drawn. This requires a rigorous analysis of the assumptions and limitations inherent in this approach. The benefit-cost technique implies a "welfare function." This can reasonably be justified for small changes, but becomes unreasonable and may lead to unwarranted conclusions for large ones. The technique implicitly assumes that:

a) Per capita income is the only measure of welfare that is being maximized;
b) This welfare refers only to people living today and does not take into account the welfare of the unborn; and
c) Children do not give any form of satisfaction or impose any costs other than those included in the benefit-cost approach.

These assumptions, while justifiable up to a point, show how partial and incomplete the "welfare function" of this approach actually is. A complete "welfare function" should include not only per capita income, but also income distribution, total income and the utility that children provide to their parents (such as carrying on the family name, etc.). Before an "optimum" birthrate can be approximated, it is necessary to agree on the items to be included in the welfare function, the weights to be attached to each item at each point in time, and the effect of lower fertility on each of these items. The decision as to which items to include will depend on whose welfare is being maximized. Are benefits and costs to be measured from the point of view of the family, the government or the country? This can make a substantial difference as seen from the following cases:

a) For the extended family, the cost of one less birth is the average income that an unborn child would have earned. From the point of view of a country in which unemployment is prevalent, the cost would be zero if a marginal child would have been unemployed.
b) Part of the costs of education, health and family planning services are borne by the government rather than the individual family.
c) "Externalities," such as the nuisance of other people's children and the greater concentration of persons, are a social but not a family cost.

While several welfare functions can be formulated, it would be unrealistic to expect agreement on the objectives required for the derivation of an "optimum" birthrate, or to expect that sufficient knowledge would be available for measuring many of the variables that are included (such as the "utility" of children), or finally that the impact of fertility on those variables can always be measured. While such information would be needed for the derivation of an "optimum" rate of population growth, this is neither an
attainable nor a desirable goal. A more modest and practical approach would be to analyze small changes to see whether these could be treated within the limited objectives outlined above. It can be argued that for small changes in fertility the limited welfare function does "make sense." This can best be seen with reference to the three premises underlying such a simple welfare function.

The first is that only per capita income is being maximized. Here it can be argued that this is a valid approximation for small changes. It is implicit in the analysis of most projects where the only aim is to maximize the growth of the national income. As long as the gap in per capita income between developed and developing countries is increasing, while average rates of growth of national income are approximately the same for both, it seems legitimate to treat per capita income as the predominant measure of welfare. This would hold true at least until the birthrate of a developing country reached the level prevailing in developed countries. In most countries it would require at least a decade to achieve this reduction. The most rapid declines in the birthrate resulting from family planning programs and general improvements in socioeconomic conditions have averaged 1.0 to 2.0 per thousand per year. This means that over a decade a reduction of 1.5 percent in the birthrate (and 1.0 percent in the rate of population growth) represents a considerable achievement. In most developing countries such a reduction would be required to bring the birthrate down to the level prevailing in developed countries. Beyond this point, per capita income would still be an important objective, but other components of welfare might then be given more weight. This could serve to insure that the extreme conclusions noted above would not follow. The choice of factors affecting welfare and of the weights for each of these factors is crucial for determining the "optimum" birthrate. This need not, however, be a source of immediate concern.

The second premise underlying this function is that the welfare of the unborn is excluded. This restriction is dictated partly for pragmatic reasons, but it can also be justified within certain limits. The welfare of these future generations is excluded largely because the problem of placing a value on human life would be almost insurmountable. (Is life worth nothing or is nothing worth life?) Beyond pragmatic necessity, however, this can also be justified as the conscious choice of the living for a certain quality of life, in opposition to the idea of greater numbers in the future living at a miserably low standard. The quality of life here is measured by per capita income, a value judgment which in itself raises many issues. However, these problems are not serious when one is dealing with the developing world where standards of living are at or just above subsistence levels. There it makes eminent

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sense consciously to choose quality over numbers, and then as an approximation to measure quality by per capita income. In low income countries there is a fair degree of unanimity over the uses to which higher per capita income should be put. It is felt that this should be used to provide more of the basic necessities—nutrition, health, education, etc. However, when per capita income is at a level well above subsistence, the link between welfare and per capita income is far more tenuous. The higher the per capita income, the greater the range of choice permitted by economic growth. At a higher level it becomes harder to agree whether quality should be preferred to numbers. Keeping population low will at this point give more choice, and whether or not this is desirable in effect depends on the use made of the increased potential.

The third premise is the exclusion of the utility of children from the welfare function. This exclusion is partly a matter of necessity: the utility of these children is impossible to measure. In some circumstances, however, this exclusion will not be serious. It can be argued that welfare should be measured from a national point of view, and that here the utility of children to the family has no place. Such an argument takes a rather totalitarian view of society, excluding the welfare of the families that make up society and considering only the “investment” aspects of children. Another approach is the argument that while the utility of children should be included, in many cases this utility will be marginal or nonexistent. When primitive abortion is practiced as a method of birth control, for example, there is good reason to doubt that the marginal child has a positive utility for the family. These are extreme, though not uncommon, cases. The general point is that the births averted through family planning programs are unwanted. Though there is no way of imputing a utility to such averted births, the presumption is that this utility is low. Knowledge, Attitude and Practice (KAP) surveys conducted over a wide range of developing countries show that desired or ideal family size is about three or four children. Looking at the distribution of births by birth order, it appears that about one-third of all children born are not

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7 Income distribution could also be added. This would make family planning even more desirable, since the objective of such programs is to reach low income persons.

8 The choice between quality and numbers is being viewed here on a short-run basis (i.e. less than a generation). In a long enough perspective greater numbers will reach a point where there is only “standing room.” In such a situation the economic and social costs would be such as to outweigh the private benefit.


wanted by their parents. When this is compared with the progress of successful family planning programs—where the annual reduction in the birthrate is about 1–1.5 per 1000 per year (as in the Republic of China for example)—it appears that at least a decade would be required to reduce the birthrate to the desired level.

A problem also arises when all children born are wanted by their families. The question then is whether or not this number corresponds to the number desired by society. How this number is to be determined is another consideration. This, as already noted, presents difficulties which cannot be resolved without an explicit social welfare function. The point to emphasize here, however, is that these are not problems of immediate concern. There is so much to be done to insure that only children wanted by the family are born, that the more difficult (and important) problem of a social optimum need not be tackled at this stage.

The above discussion clearly shows that careless use of the benefit-cost technique can lead to absurd results. The overall conclusion is that this criterion is valid for at least marginal changes in the birthrate—where “marginal” is the change that is feasible over a ten to fifteen year period. It is also valid particularly with respect to developing countries, where the choice of quality over numbers is clear, where quality can be identified with per capita income, and where a fairly large proportion of the children who are born are not wanted by their families.

If it is felt that, in population questions, the practice of discounting the future leads to a conclusion that does not “make sense,” it is possible to present the results of this analysis as a time stream of benefits and costs, or of the difference between benefits and costs, without any resort to discounting. The policy-maker is then able to compare this with the time stream of investments in alternative economic sectors. This procedure shifts the responsibility for attaching different weights to different time periods from the economist to the policy-maker. It does not “solve” the problem, however, since in making his choice the policy-maker will have an implicit time preference.

When the Benefit-Cost Approach is Most Suitable

The benefit-cost technique is not an effective method of ranking family planning programs in different countries according to their “economic rate of return.” Its main use is as one of a number of methods for demonstrating the superior effectiveness of a family planning program over investments in alternative projects.

The main source of benefits, especially in the short run, is the result of the same output being divided by fewer persons (the first term of equation (1)). In Table 7, we shall see that this initial effect accounts for 80–85 percent of
the total benefits in the U.A.R. Furthermore, this effect is the most certain of the effects included in the benefits as it follows almost by definition. When the initial effect is expressed as a proportion of the per capita income of a country, the ratio will be very similar for all countries. This is because average consumption is a constant proportion of per capita income in all countries. However, the costs of a family planning program will depend very largely on the level of wages. Thus the effect of the two principal terms in the benefit-cost equation will depend on the relation between per capita income and the average wage level. This relation, while it is not independent of population pressure, is influenced by it in two different ways, since surplus population both depresses wages relative to other incomes and also increases the weight given to wages in computing the average; its influence is therefore indecisive. The smaller terms in the equation (the effect on government savings, the wage-productivity effect, and the impact on costs of the declining marginal productivity of labor) are all difficult to measure, and the relation of most of them to population pressures is uncertain. Insofar as population pressure in a country increases the difference between average income and average wage level, or between average and marginal product of labor, that country will show a larger benefit in relation to cost; but quite large differences between countries in these respects may have only marginal effects on the benefit-cost ratio.

The benefit-cost criterion is not sensitive to the initial economic and demographic conditions of a country and is thus not a suitable tool of analysis of the economic effects of different levels of population growth. This can be seen because the main benefits and costs—the consumption and productivity streams—do not depend on the levels of population and economic growth. The consumption stream of an averted birth is the same whether population is growing by \(x\) percent or \((x - n)\) percent. The total benefits of a family planning program thus depend mainly on how many births are averted—on the value of \(n\) rather than \(x\). The economic effects of a given level of population growth can be important but these are not reflected within this framework.

Separation of Private and Public Benefits

Should the benefits and costs that accrue in the first instance to the family be separated from those accruing initially to the government? There are several reasons why such a separation is desirable. First, the marginal propensity to save in the government sector is different from the private pro-

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pensity to save. While this can be presumed on a priori grounds, the necessary data will not always be available. Where they are, the distinction between the private and government sectors is desirable. Second, government consumption is sometimes judged to be more socially desirable than family consumption. It is sometimes argued that the government is more likely than the family to spend the freed resources on important objectives. This proposition may be true, though the problem remains of what weight to attach to government and private consumption. Third, as a matter of policy it may be more effective to separate families from government. For example, ministers of education may be particularly concerned with the effect of fertility reduction on public expenditures. Any of these reasons may serve to justify the separation of the government from the private sectors. Both calculations should, however, be included in the benefits, since the population at large (i.e., families) are always the ultimate beneficiary. The accepted measure of welfare is the national income and not the government budget.

An Alternative Approach?

In view of the previous difficulties there may be some question as to the extent to which benefit-cost techniques should be used. Alternative methods for measuring and interpreting the effects of a reduction in the rate of population growth should also be considered. An alternative is presented in the Coale-Hoover analysis, and in other studies which introduced a number of refinements in this basic approach. Coale and Hoover assume a given decline in fertility and work out the effect of this on the aggregate and per capita income of the economy at various points in the future. There are several differences between this approach and the benefit-cost approach.

a) The results are presented in terms of a time stream. No discounting is involved and hence this approach is not subject to the criticism that discounting introduces an "unwarranted" bias.

b) Both the total income and per capita income are calculated, thus introducing more than one objective in the welfare function. No weights, however, are attached to the objectives.

c) The Coale-Hoover approach uses aggregate magnitudes. The effect of a reduction in the birthrate by \( z \) percent is calculated rather than the effect of a prevented birth. In such an emotional field as population, this has some advantage. Aggregates tend to assume an impersonality all their own. To some, the idea of reducing the rate of population growth may be commendable, while at the same time talk of "a prevented birth" would verge on infanticide.

d) The extent of the reduction in fertility is assumed and is not related to family planning efforts. Comparison of this reduction with cost esti-
mates of family planning programs is therefore not meaningful. All the problems of converting a number of new acceptors into a reduction in the birthrate would still arise if the Coale-Hoover analysis were used as a framework to calculate the economic effects of a family planning program.

While differences between the two approaches exist, they are more apparent than real. If the benefits measured by the benefit-cost technique are multiplied by a number of prevented births that is equivalent to a given reduction in the birthrate (or to one assumed to result from the program), divided by the total population, and the results presented as a time-stream of per capita income, then these results would be equivalent to what would be obtained with the Coale-Hoover approach. In fact, the similarities between the approaches are greater than the differences. In both the basic issues remain unsolved—namely what social welfare function should be used, which items should be included, from whose point of view should welfare be maximized, how is the “utility” of children to be included, etc. Furthermore neither approach is useful in separating countries according to the intensity of the population problem. The economic benefits in the Coale-Hoover approach are mainly affected by the speed with which fertility is reduced, but are not affected by the levels of the economic and demographic parameters from which one starts. A case in point is the application of this approach to both India and Mexico—countries which differ greatly with respect to economic and demographic conditions. In both, a reduction in fertility by 50 percent over 25 years was reflected in a per capita income about 40 percent higher than it would have been without the change. Finally, the problems of measuring the impact of the program on the birthrate, as already noted, are common to both approaches.
It has been shown that benefit-cost techniques are valid for assessing family planning programs only within certain restricted assumptions, that they are useful only for some specific purposes, but that nevertheless within these limits they can be used with advantage. The following pages emphasize the problems of measurement arising in the application of this method of assessing the benefits and costs of the family planning program in the U.A.R. The ensuing analysis is in terms of an averted birth and can be extended, within the constraints discussed in the last chapter, to a given reduction in the birthrate.

The application of formulas (1) and (2) requires information which can sometimes be obtained from the relevant data, and also some assumptions that must be made when the necessary data are not available. The relationship between benefits and costs will be substantially affected by these assumptions. Benefits and costs are considered separately in the following two sections. A third section compares benefits and costs and a concluding section deals with general problems of measurement.

Benefits

As already noted, the benefits can be divided into an initial effect (the consumption stream), a wage-productivity effect, and increases in private and public savings. These are discussed in the following sections with a concluding section on other benefits.
Initial effect—the consumption stream

In order to calculate the impact of this initial effect, data will be required showing the average consumption of an individual at various ages. An estimate of the probability that this individual will survive to these ages will also be required. The latter can be derived from various demographic measures, which though inaccurate do not greatly affect the magnitude of the benefits. In the measurement of consumption three problems arise. The first is the definition of the term "consumption." The second is the allocation of consumption to different age groups, and the third is the choice of a discount rate. Each of these problems will be reviewed in turn.

Measurement of consumption. In his study of India, Enke defines consumption as GNP minus gross capital formation. This is the standard definition in the national accounts, but as a measure of the benefits of a prevented birth it can be criticized on three grounds: (i) Part of what is classified as consumption is really investment from the point of view of economic growth. Included in this are expenditures on education, health and other investment in human capital. (ii) There is an element of grossness in consumption. Some government expenditures (for example those for the maintenance of law and order) can be regarded as intermediate goods rather than as final output. (iii) Finally, some consumption expenditures are made independently of the rate of population growth and are, therefore, non-marginal. An example is defense expenditures.

Adjusting for the above factors (in particular (i) and (iii)) would reduce average consumption by about 25 percent in the U.A.R.—a sizable effect. The question then remains as to how consumption should be measured within the context of this study. It is clear that non-marginal items should be excluded, and that intermediate goods should not be part of welfare (though differences of opinion will emerge regarding the definition of intermediate goods). Difficulties also arise regarding the proportion of expenditures on education and health that should be considered as investment, and the proportion that should be considered as consumption. The calculations below treat the standard and reduced definitions of consumption as the upper and lower limits of "true" consumption.

Allocation of consumption to different age groups. Once the marginal consumption of the average person has been determined, this figure is then used to derive the consumption of individuals of different ages. In his estimates Enke gives no indication as to how this was done.¹ According to his figures, persons thirty-five years old consume thirteen to fourteen times as much as infants who have not reached their first year. Thus far no empirical studies on the distribution of consumption by age have been done for underdeveloped

¹ Enke, "The Gains to India from Population Control."
countries. However, household studies of typical middle class families in developed countries have been made. Estimates of calorie requirements for persons of different ages have also been calculated. Each of these approaches indicates a ratio of adult to childhood consumption varying between 1:2 and 1:2.5. Since food is the largest item of consumption, it has been assumed that actual expenditures on food conform to the established ratios of the minimum calorie requirements of different ages. Thus if the daily calorie requirements of a seven-year-old are 1,970 calories, while those of a one-year-old are 1,120, the consumption of a seven-year-old was assumed to be 1.76 that of a one-year-old. Though actual levels of calorie intakes in the U.A.R. may be different from the ideal ones, we are chiefly concerned here with the ratios, and have assumed these to be the same as those of the required levels. The conversion of this calorie (physical) index into a monetary one is valid provided that diets remain unchanged with age. Otherwise a switch, for instance from wheat to meat, would raise monetary expenditures much more than calorie intake since the former reflects economic scarcities. The assumption of unchanged diets is reasonable in underdeveloped countries where consumption consists primarily of grains.

One final point should be made. Although calorie requirements diminish after age twenty-five, this diminution has not been reflected in the economic index. It was assumed that this index would remain at the maximum level after age twenty-five: people are unwilling to abandon accustomed living standards, and there are some expenditures (e.g. medical) that increase with age. Given these ratios, the consumption of persons in different age groups was computed by taking the economy-wide consumption figure and the age distribution of the population, and by insuring that the weighted average of the consumption of different age groups (weighted by the proportion of persons in each age bracket) equaled the national average.


3 These requirements depend on temperature, weight, sex, and especially on work done. Although they are periodically revised, the ratios between different age-groups may be expected to alter less than the absolute levels. Our figures were taken from P. V. Sukhatme, "The World's Hunger and Future Needs in Food Supplies," *Journal of the Royal Statistical Society*, Series A (General), Volume 124, Part II (1961), Table 1, p. 472. This table is based on the requirements as given in *Calorie Requirements* (Nutritional Studies, No. 15), Food and Agricultural Organization of the United Nations, Rome, 1957.


5 Formally if we use $x_i$ to denote the per capita consumption of the $i$th age group, $a_i$ to denote the percentage of the population in the $i$th age group, then we
The results show that consumption expenditures vary by a factor of 2.5—about the same as was found in studies of developed countries. This provides an alternative to Enke's approach. Since the future is heavily discounted and since our estimates show consumption to be higher than Enke's in earlier years and lower than his in later ones, the discounted consumption stream comes out larger here than in Enke's calculation (as will be seen below in Table 1).

Choice of a discount rate. In theory the discount rate should be the rate of interest determined by the forces of productivity and thrift in a free capital market. In practice the capital market is imperfect and a multitude of interest rates exist. On the one hand the central bank discount rates of 2 to 5 percent are not established with any regard to the productivity of capital and are far too low. On the other hand the rates of 25 percent or more charged in rural areas are far too high, incorporating as they do monopoly elements, high risk premiums of default and high administrative costs. Perhaps the most representative rates are those charged by banks to medium sized commercial firms—something on the order of 10 to 15 percent. Discount rates of 10 and 15 percent are used below as alternative upper and lower limits.

From the previous discussion it will be seen that taking maximum and minimum values for the level of consumption, a consumption stream allocated in two ways to different ages and alternative discount rates yields eight different possible values of the consumption stream. Table 1 summarizes these eight alternatives for mortality levels of the years 1947 and 1960. It should be noted that the per capita income was around LE58 in 1960 and that the discounted value of the consumption stream therefore ranges from 1.9 to 6.0 times the per capita income in 1960. It is also noteworthy that the main differences between 1947 and 1960 are the lower levels of mortality in the latter year. This means that an unborn child would have had a higher probability of survival to various ages in 1960, and therefore that the cost of supporting a child in 1960 would have been greater than in 1947 by about the margin shown in Table 1.

Wage-productivity effect

The second term of equation (1) shows that the wage-productivity effect is a proportion of the initial effect (first term in the equation). This proportion is determined by: (i) the percentage of the increased income that is used require that $a_kx_i = x$ where $x$ is the average national per capita consumption figure. We are also given the consumption ratios (assumed to equal the calorie requirement ratios) $x_i / x_j = b_{ij}$, where $b_{ij}$ is the ratio of the calorie requirements of age group $i$ to that of age group $j$. There are $(n - 1)$ such equations, where $n$ is the number of age brackets. Since the $a$'s and $b$'s and $x$ are all known we have $n - 1 + 1 = n$ equations that we can solve for the $n$ unknown $x$'s.
TABLE 1: The Initial Effect, Present Value of Consumption Stream

<table>
<thead>
<tr>
<th></th>
<th>10% Discount Rate</th>
<th>15% Discount Rate</th>
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<tbody>
<tr>
<td></td>
<td>Standard</td>
<td>Revised</td>
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<tr>
<td>Definition of</td>
<td>(1)</td>
<td>(2)</td>
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<td>Consumption</td>
<td>Definition of</td>
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</tr>
<tr>
<td>A. 1960 Mortality Level</td>
<td></td>
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<tr>
<td>1. Consumption allocated to different age groups as indicated in the text</td>
<td>351</td>
<td>281</td>
</tr>
<tr>
<td>2. Consumption allocated to different age groups using Enke’s ratios</td>
<td>278</td>
<td>222</td>
</tr>
<tr>
<td>B. 1947 Mortality Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Our consumption and productivity stream</td>
<td>294</td>
<td>235</td>
</tr>
<tr>
<td>2. Enke’s consumption and productivity stream</td>
<td>223</td>
<td>179</td>
</tr>
</tbody>
</table>

for food consumption by the labor force in periods when they are employed (i.e. excluding seasonal unemployment); (ii) a conversion factor translating the increased food consumption into an increased supply of effort via an increased calorie intake; and (iii) the marginal product of effort. Each of these links is reviewed below.

First, part of the increased national income per head is used for increased food consumption. We have assumed that the proportions are the same as those now prevailing. Thus only 75 percent of national income is used for private consumption expenditure (PCE) and only 65 percent of the latter is spent on food. These figures bias the benefits downward; first because all the consumption costs of the unborn child are available to the family, and secondly, the lower income groups who are the main target of a national family planning program spend more than 65 percent of their income on food. (The 65 percent figure is derived chiefly from behavior in urban areas, which are richer than the agricultural ones. For this reason the estimate below assumes a national average of 0.75.)

It should also be noted that not all the expenditure on food will result in an increase in output. Some of the increased food consumption will be used by food consumption by the labor force in periods when they are employed (i.e. excluding seasonal unemployment); (ii) a conversion factor translating the increased food consumption into an increased supply of effort via an increased calorie intake; and (iii) the marginal product of effort. Each of these links is reviewed below.

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It should also be noted that not all the expenditure on food will result in an increase in output. Some of the increased food consumption will be used by

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* M. A. Anis, "A Study in the National Income of Egypt," L’Egypte Contemporaine, No. 261-62 (November–December 1950), Table 6, p. 681. The figures are for the period 1938–45, and these were used because no more recent figures were found.
groups of the population other than the labor force, and some consumption by the labor force will occur during periods of seasonal unemployment in agriculture. Even when more food is consumed by the labor force, output is not influenced in periods of the year when the labor force is unemployed. An effort was made to take these factors into account. In the first instance it was assumed that the increased expenditure on food was evenly distributed among the whole population. Since the labor force accounts for 25 to 30 percent of the total population, this means that only 25 to 30 percent of the increased food consumption was assumed to be used by the labor force. If the higher consumption of adults is allowed for by assuming that the consumption of children aged less than 15 is half that of adults, the share of labor's expenditure on food is increased to between 31 and 37 percent of the total expenditure on food. Seasonal unemployment is allowed for by treating men in agriculture as fully employed for about four months per year, whereas no seasonal unemployment is assumed in other sectors. Using the weights of the different sectors, the total labor force is seen to be employed for 62 percent of the year.

Secondly, the increased expenditure on food has to be converted into an increased supply of effort via increased calorie intake. This is done in two steps. The increased expenditure on food is converted into an increased calorie intake at 3,280 calories per Egyptian Pound. This increased calorie intake

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7 This is the range given by B. Hansen and G. Marzouk, *Development and Economic Policy in the U.A.R.* (Amsterdam: North Holland Publishing Co., 1965), Table 2.9, p. 35. The 25% estimate is from labor force sample surveys, whereas the 30% estimate is based on the 1960 census. The authors point out that the first estimate is probably biased downward.

8 Given that the number aged 0–15 account for 40% of the total population, that 25% are in the labor force and that 35% are above 15 but not in the labor force, and assuming that a child consumes half what an adult consumes, we have \((0.5 \times 40\%) + (1 \times 25\%) + (1 \times 35\%) = 80\%\). Bringing the total to 100% gives the share of labor in food expenditure as 31.25%. Alternatively, starting with a share of labor of 30% and with the same calculations, we would have arrived at a figure of 37.25%.


10 The proportion of the labor force in agriculture is 57%. See Hansen and Marzouk, *Development and Economic Policy*, Table 2.8, p. 35. Since the agricultural labor force is employed for 4 months, or 33% of the year, whereas the non-agricultural labor force is employed full time, this gives a weighted average of \((33\% \times 57\%) + (100\% \times 43\%) = 62\%\) for the economy as a whole.

11 In 1960 the per capita annual consumption of food was 27.8 Egyptian Pounds, whereas the average calorie intake was approximately 2,500 calories per day or 91,250 per year. This means that one Pound bought 3,280 calories.
then results in an increase in the supply of effort, measured in "equivalent hours of work." Here estimates vary between 100 and 200 extra calories required to produce the equivalent of one hour's work.12

Thirdly, these extra hours of work would result in an increased output. For this we would need the marginal product of a "real" hour's work. This was computed as follows. The marginal product of labor is estimated as a maximum to be 35 Pounds per year, and the number of "real" hours worked are estimated to be 4 hours per day or about 1,200 hours per year. Thus the marginal product of a "real" hour is 3,500/1,200 = 0.03 Pounds. This, multiplied by the extra number of hours of effort, gives us the extra income induced by the initial increase in consumption through the operation of the wage productivity effect. This will be a maximum effort, since the value of the marginal product is likely to decrease.

Allowing for the various assumptions which have been made, it will be seen that a range for the wage-productivity effect can be derived. A reasonable point within this range can be established using the following figures. The initial increase in income is multiplied successively by 0.75 (proportion going into PCE), 0.75 (proportion of consumption spent on food), 0.35 (percentage of food consumed by labor force), 0.62 (percentage of the total time in a year that the labor force is employed), and 3,280 (number of calories per Pound). This figure is then divided by 150 (intermediate estimate of number of calories required to produce an extra hour's work) to give an estimate of the extra number of hours of work, and is then finally multiplied by 0.03 pounds (the product of a marginal hour) to give the expected increase in income. The wage-productivity effect under these assumptions varies between LE16.0 to LE20.8 with a 10 percent discount rate, and LE8.8 to LE14.0 with a 15 percent discount rate. This is an intermediate

12 For agriculture the last 50% increase in capacity requires 1,000 extra calories, i.e. since the last 4 hours require 1,000 calories, each hour requires 250 calories. Making similar calculations for the other sectors and weighting the results by the percentage of the labor force in each sector gives a national average of 185 calories necessary to produce the equivalent of an hour's work. If the service sector is lumped with industry (because in the less developed countries services require more effort than banking, etc.) a figure of 270 calories is obtained. Finally it is assumed that the starting point is at 75% of capacity (and not 50%), the figure that is derived is 150 because marginal requirements are not constant in the tables. Thus estimates range from 150 to 270. 200 was taken as an average.

18 The estimate of the daily effort being equivalent to a 4-hour day was deduced because the average daily calorie consumption is about 2,500, and at this level of calorie intake one is working at 50% or less of full capacity in both the industrial and agricultural sectors.
### TABLE 2: The Wage-Productivity Effect

*(Egyptian Pounds per prevented birth)*

<table>
<thead>
<tr>
<th></th>
<th>10% Discount Rate</th>
<th>15% Discount Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Allocation of consumption to different age groups as in the text</td>
<td>9.0–36.0 (16.0)</td>
<td>5.0–19.8 (8.8)</td>
</tr>
<tr>
<td>2. Allocation of consumption to different age groups using Enke's ratios</td>
<td>11.7–46.8 (20.8)</td>
<td>7.9–31.5 (14.0)</td>
</tr>
</tbody>
</table>

*a* Lower and upper estimates are shown. Figures in parentheses show a "most likely" estimate.

All values are for 1960 in constant prices.

In concluding, it is well to make three points. One is that benefits from the increased expenditure on health are not included. These are potentially substantial. The second point is that actual calorie intake is presently well below the required level. When the former equals the latter, increased food intake may no longer result in greater output. Minimum calorie requirements for the U.A.R. are estimated at around 3,000 as compared with the present level of 2,500, indicating that consumption levels must increase substantially before they reach the minimum requirement level. In addition it should be

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14 The maximum (minimum) figure is obtained by multiplying the initial increase in income by 0.90 (0.65) for the proportion of consumption spent on food, 0.37 (0.31) for the percent of food intake going to members of the labor force, 0.62 (0.62) to allow for seasonal unemployment, 32.8/100 (32.8/200) to give the increased supply of effort, and 3/100 (3/100) as the marginal product of effort in Pounds. The result for the maximum (minimum) is 18% (4.5%).

15 H. Correa, *The Economics of Human Resources* (Amsterdam: North Holland Publishing Co., 1963), pp. 43–47. The author calculates that for Egypt the slack in output due to deficient health is larger than that arising from undernutrition. Correa’s estimate of the former is biased downward because (a) 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), and (b) there is much under-registration of deaths in the U.A.R.

16 There is a vast literature on minimum calorie requirements and these are periodically revised. These requirements vary with age, sex, weight, climate, and especially type of work. Many of these data are not available for most populations, but nevertheless Shehata mentions 3,000 calories as the minimum requirements for the U.A.R. A slightly higher estimate has been derived by relying on Correa’s figures for 100% capacity in agriculture, industry, and services sectors. The requirements for each sector were then weighted by the proportion of the labor force in each sector, giving a figure of 3,156 = (3,600 times .57) + (3,000 times .12) + (2,400 times .31).
noted that not only is the total number of calories important as far as the supply of effort goes, but equally important is their distribution between carbohydrates, proteins and fats. At present the diets in the U.A.R. are far from optimal in this respect. Hence, although the precise relationship between a balanced diet and the supply of effort is unknown, there is room for such an increased supply even after the minimum calorie level has been reached.\textsuperscript{17} A study on labor productivity has shown that increased calories lead to a higher output in all countries whether developed or underdeveloped. This may be explained in part as the result of a better nutritional balance as well as of more calories. Also it must be noted that the daily per capita consumption of 2,500 is a national \textit{average} figure, which means that the poorer sections of the population likely to be affected by the lower fertility can be expected to consume far less. This makes the gap between actual and minimum requirements larger than has been indicated. The third point is that the existence of a wage-productivity effect depends on a positive marginal product. With a zero marginal product there would be no such effect. However, the costs would also be lower, since there would be no lost output resulting from a prevented birth. With a zero marginal product the difference (or ratio) between benefits and costs would be greater, since quantitatively the magnitude of the productivity stream exceeds the wage-productivity effect (compare Tables 2 and 4).

\textit{Increases in private savings}

In theory the interrelationships between population growth and savings behavior are not clear-cut. Few empirical studies of the influence of family size on actual savings are available. 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,\textsuperscript{18} which is that if the only problem in economic growth were to curb consumption, then this could be achieved at no great cost. Arithmetic examples can be constructed to demonstrate this. For instance, assume that a (linear) increase in savings ratios from 9 to 15 percent of national income over a ten-year period is needed to achieve self-sustained economic growth. With no reduction in fertility this can be achieved by a decrease in the absolute level of consumption by an average of 1.2 percent of GNP in the first seven years, and by a maximum of 2.2 percent of GNP in

\begin{itemize}
\item[\textsuperscript{17}] Shehata, "Cooperative Efforts and Food Consumption in the U.A.R." 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.
\item[\textsuperscript{18}] Kuznets, "Demographic Aspects of Economic Growth."
\end{itemize}

31
any one year. After this initial period savings ratios are increased by foregoing increases in the absolute level of consumption. Put in these terms, the increase in savings ratios can be achieved at a remarkably low sacrifice.

If fertility were reduced, it is perfectly true that no reduction in the absolute level of consumption would be necessary to raise savings proportions to an equivalent extent. However, it seems that the factors which make the raising of savings proportions so difficult even when fertility is not reduced, would also be present in the case of a fertility reduction. Thus it would be unwise to believe that a fall in fertility would automatically raise total savings. The reasons for the failure of savings proportions to rise sufficiently for economic growth are complex and will differ from country to country, but perhaps a common reason is the consumption-oriented form of economic development today. The demands of the population for higher living standards (enhanced by propaganda and an international demonstration effect) may be an explanation for the difficulties many governments face when trying to curb consumption. If this explanation is correct, it would be wrong to infer that a reduction in fertility will stimulate savings. Rather the desire for smaller families may represent a desire for more consumption. This is often the basis of mass campaigns in family planning programs.

In light of these considerations, the benefits from private savings will not be included. However, the magnitude of this effect shows the large potential benefits that can be expected if government policies (taxation etc.) are successful in mobilizing the released income resulting from lower fertility.

**Increases in public savings**

Increased public savings can be expected as a result of the diversion of government consumption which would have been needed for the education, health, etc. of the unborn children. This diverted consumption can instead be channeled into productive investment. Here only the savings in expenditures on education are treated. A goal of universal primary education has been set in the U.A.R. In the field of secondary education, about 15 percent of children are presently enrolled and no explicit targets exist. A reduction in the present birthrate can therefore be expected to reduce expenditures on primary education, and it is assumed that these resources will be invested rather than consumed. With regard to secondary education, it is harder to decide whether the unborn child would have received secondary education or not. It can be assumed that the aim of secondary education is to educate either a given absolute number of children, or alternatively a constant percentage of children in the relevant age-groups. In the first case, the effect of a lower birthrate is that the resources allocated to secondary education remain unchanged, but that a higher proportion of children receive secondary education. The benefits
### TABLE 3: Benefits from Reduced Government Expenditures on Primary Education

*(Egyptian Pounds per 100 prevented births)*

<table>
<thead>
<tr>
<th>Years from Birth</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-9</td>
<td>4,800</td>
<td>1,200</td>
<td>0.497</td>
<td>596</td>
<td>1,800</td>
<td>0.350</td>
<td>630</td>
</tr>
<tr>
<td>10-14</td>
<td>2,400</td>
<td>3,480</td>
<td>0.301</td>
<td>1,047</td>
<td>5,220</td>
<td>0.165</td>
<td>861</td>
</tr>
<tr>
<td>15-19</td>
<td>3,600</td>
<td>0.183</td>
<td>659</td>
<td>5,400</td>
<td>0.078</td>
<td>421</td>
<td></td>
</tr>
<tr>
<td>20-24</td>
<td>3,600</td>
<td>0.111</td>
<td>400</td>
<td>5,400</td>
<td>0.037</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>25-29</td>
<td>3,600</td>
<td>0.067</td>
<td>241</td>
<td>5,400</td>
<td>0.017</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>30-55</td>
<td>18,000</td>
<td>0.040</td>
<td>720</td>
<td>27,000</td>
<td>0.00823</td>
<td>222</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

**Column 1**
These are the costs of primary education that are saved per 100 prevented births. The cost of primary education is about 12 Pounds per pupil per year. See S. Wehela, “Long-Term Manpower Planning Research: A note on the first attempt at estimating expenditures on education for the period 1965-1985,” Institute of National Planning, Memo. No. 329, Cairo, May, 1963. These costs include current and capital outlays and also administrative costs which the author assumes to be 15% of the total.

**Columns 2 and 5**
These are the cumulative amounts of income that are generated when these savings are invested, and when the rate of return is 10% and 15%, respectively.

**Columns 3 and 6**
Present value of Column 1, discounted at rates of 10% and 15%, respectively.

are thus those of improvements in the quality of the labor force. However, if the object is to educate a constant percentage of children, then a lower birth-rate means that resources that were allocated to secondary education can be directed to other forms of investment. The effect would then be similar to that in primary education. Here it is assumed that no reduction in government expenditures on secondary education will result from lower fertility. This is done to insure that the benefits are a minimum estimate. Improvements in the quality of the labor force that can be expected as a result of a higher percentage of persons receiving secondary education are not included because of difficulties of measurement and the lack of necessary data. Thus the only benefits estimated here are those of government savings on primary education. These benefits are estimated in Table 3 to be between LE24 and LE27 per birth, depending on whether the discount rate is 15 percent or 10 percent. This is a substantial figure; it is larger than the wage-productivity effect (Table 2) and is also larger than the government expenditures required to prevent a birth through the provision of family planning services (see Table 7, p. 45).

**Other benefits**

In addition to the benefits analyzed in previous sections, many other benefits can be identified. These have not been included because of difficulties inherent in their measurement. Some of those benefits include:
a) Non-economic benefits resulting from smaller-sized families. Some of these benefits are not included in national income, and are therefore not captured by an index of higher per capita income. Examples of these are the improved health of mothers resulting from fewer pregnancies, the avoidance of the psychological costs of abortions or of unwanted children, the better care and education that can be given to children of smaller families, etc. The fact that these benefits cannot be measured does not imply that they are less important than the benefits that have been included. Many persons, in particular those in the medical profession in several countries, feel with some justification that family planning should be given the highest priority solely on these grounds.

b) Improvements in the health of the labor force which would result in additional increases in productivity.

c) Government expenditures on secondary and higher education would be lower in cases where educational policy is to educate a constant proportion of the relevant age groups. The resultant savings could be invested and would generate further increases in total income or they could lead to increases in government consumption.

d) Last but not least is the point that family planning programs will lead to large economic and social changes (such as better education and more employment for women, urbanization, etc.) partly as a result of this larger per capita income. This will in turn induce secondary effects on fertility and reinforce the initial decline.

Costs

The costs of a family planning program can be divided into the costs to the economy of having a labor force smaller than it would otherwise have been, and the costs of the real resources needed to avert a birth.

The production stream

A decline of the birthrate will in the long run result in a labor force that is smaller than otherwise. In order to measure the effect of this decline per averted birth, we require an estimate of the marginal product of labor, starting at the time the averted birth would have entered the labor force and extending over the whole of his productive life. The derivation of such an estimate would require a detailed projection of the economy for 60 years or more. It is not realistic to assume that reliable estimates of this type can be computed, and hence a less satisfactory partial approach is used here. The present marginal product is taken as an approximation of future productivity. Even this presents several difficulties: the first is the estimation of the economy-wide marginal product, and the second is the allocation of this product to different age groups.
Measurement of productivity. There exists a vast literature dealing with estimates of the marginal product of labor in agriculture in developing areas. This literature falls into two broad categories: one uses a combination of observation and experimentation to estimate how much, if any, labor is redundant; the other is more theoretical, and resorts to the fitting of appropriate production functions whose coefficients are used to determine the marginal product of labor.

Some experiments of the first type have been carried out on medium-sized farms outside Cairo, and several studies based on the requirements of the man-days necessary to produce various crops have also been made. Both types of study have been reviewed by Kenadjian, who concludes that they provide grossly inflated estimates of labor redundancy. An experiment to measure labor requirements on farms outside Cairo was carried out on a farm far larger than the typical farm, and no allowance was made for the labor required for capital maintenance (roads, canals, livestock care), or for differences in the fertility of the soil. Studies using an estimate of labor requirements also tend to overestimate labor redundancy. As an example we may summarize the criticisms that Kenadjian made of one of these studies. In that study the requirements were computed by multiplying the coefficient of man-days (adjusted for the proportion of women and children) required in the production of different crops, by the area which each crop occupies. The criticisms of this procedure are threefold. First, no allowance is made for some labor requirements—in particular for livestock care and capital maintenance. Second, only one coefficient of labor requirement is taken for

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20 As examples of these we may mention M. R. El Ghonemy's study, "Resource Use and Income in Egyptian Agriculture before and after the Land Reform with Particular Reference to Economic Development" (Unpublished Ph.D. thesis, North Carolina State College, 1953), and studies by S. Marei and G. Saah, quoted in C. Issawi's Egypt in Revolution: An Economic Analysis (Oxford University Press, London, 1963), p. 299. El Ghonemy estimates that 50% of the agricultural labor force is redundant, whereas Issawi concludes that after "account...is taken of seasonal peaks and of the considerable work that has to be done outside the fields such as the cleaning of canals and drains, and the construction of farm buildings,...it remains true that perhaps as much as a third of the rural population is surplus."


22 Kenadjian, p. 229. Figures show that labor requirements vary by a factor of 4.5 as size of farms vary by a factor of 50. The relationship is inverse.

23 El Ghonemy.
each crop, although this coefficient varies with method of irrigation, amount of available capital, etc. Third, no allowance is made for seasonal peak demands when requirements are greatly increased. Consequently these estimates—which estimate labor redundancy at something between 30 and 50 percent—greatly exaggerate the amount of surplus labor. The point of interest here, however, is not how much of a labor surplus there is, but whether it exists at all. What should be emphasized is the fact that even after Kenadjian adjusts for all the deficiencies mentioned above, he concludes that “disguised unemployment in Egypt . . . cannot be claimed to exceed a volume of 5 percent.” If this estimate of structural unemployment is correct then the marginal product of labor is likely to be zero and the marginal person makes little or no contribution to output.

The second group of estimates is derived from fitting Cobb-Douglas production functions; the estimated coefficient of labor is then used to calculate the marginal product. For the U.A.R. two such functions have been fitted: one for agricultural field crops, and the other for cotton and cotton grains. The labor coefficients were approximately 0.3 and 0.4 respectively. This gives a marginal product of labor of around fifteen and twenty-two Egyptian Pounds (in 1960 prices), which compares with an agricultural wage rate of around thirty-five Pounds. It should be noted that the labor coefficients are multiplied by the average output productivity to yield those figures. If the value added productivity is used instead, the figures would be increased to twenty-two to twenty-seven Pounds for field crops and to thirty or thirty-seven Pounds for cotton. This would give a marginal product approximately equal to the wage rate for field crops, and about two thirds of the wage rate for cotton. Note however that field crops and cotton accounted for only one half of the value of total agricultural production in 1960. The other half

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24 Kenadjian, pp. 233–34, cites the example of the difference in labor requirements when the water wheel (Tabout) is used or irrigation, in which two man-days can irrigate one acre, and the shadouf pail and lever combination), in which case 1/12 or at most 1/8 of an acre can be irrigated in two man-days.


26 Kenadjian, p. 243.


30 Hansen and Marzouk, pp. 73–79. It is not clear whether from a conceptual point of view the value added or the average output productivity is preferable to measure the marginal product of labor.

31 Kheir el Dine, p. 15.
was made up mainly of fodder, animal products and some vegetables and fruits. Although no estimates for the latter group have been derived, H. Kheir el Dine concludes that “it seems therefore likely that the marginal product of labor in total agriculture is of the same order of magnitude as the wage rate.”

Some comment should be made with regard to these estimates. First, both procedures are open to criticism. In the studies which rely on observation and experimentation, not only is the surplus labor grossly overestimated because of failure to allow for various factors, but there seems to be a confusion between what can be done and what actually happens. Whenever nature performs the experiment of eliminating labor with all else unchanged, (as in the influenza epidemic in India) output is reduced. However, controlled field investigations similar to those made in Egypt would probably have shown some excess labor. The use of the Cobb-Douglas function involves a built-in bias—since the function is defined in such a way that the marginal product of labor can never be zero. It only tends to zero as the quantity of labor tends to infinity.

Second, although one can feel uncomfortable about these procedures, there is some qualitative evidence that suggests that the marginal product is not likely to be zero. Three kinds of evidence can be adduced for this:

a) Landowners hire labor at positive wages, which means that in their judgment the contribution of labor is equal to the wage rate.

b) The observed differentials in agricultural wages between different seasons, men, women, and children, and different areas suggest that supply and demand conditions are a better explanation of the level of wages than minimum wage legislation or a subsistence explanation. The seasonal variation of real wages shows them to increase on average by 17 percent for the peak season (May–June to September). This is a national average, and in some villages wages for men are as much as three times higher during the peak season. Second, although the average wage rates for women and children are two-thirds and one-half respectively of those for men, during the peak season all wages

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[34] Thus writing $Q = AK^{(1-a)} L^a$ where $Q$ is output, $A$ is a constant, $K$ is capital and $L$ is labor, we have that $MP_L = dQ/dL = (1 - a) A K / L$. Thus the marginal product of labor tends to zero as $L$ tends to infinity.
[36] Hansen, pp. 385–87, Table I. These are the findings of a survey by an International Labor Organization Mission.
are identical. A probable explanation is that the demand for women's and children's labor fluctuates more widely than that for men's labor. Finally, there are geographical disparities: wages are 20 percent lower in Upper Egypt than in Lower Egypt. This can be partly explained by the fact that the density of population in cultivated areas is 15 percent higher in Upper Egypt.

c) Whenever new projects that require labor are undertaken in rural areas (as for instance in the building of the Aswan Dam), wages rise immediately.

For all these reasons it is unlikely that surplus labor exists. However, the problem of estimating the value of the marginal product still remains. The Cobb-Douglas estimates show that as a maximum the marginal product equals the wage rate. It has here been assumed equal to the wage rate. This is an upper limit, which makes our cost estimates a maximum and the net benefits of an averted birth (or the benefit-cost ratio) a minimum.

One final point should be noted. The discussion has referred only to the agricultural sector in which 75 percent of the labor force is employed. No estimates of the marginal product for industry or for the service sector were calculated. Although no quantitative estimates are available, observers note that productivity in industry is well above that in agriculture. Wages there are three to four times as high, but it is difficult to say what proportion of this difference reflects higher productivity, what proportion is due to other factors such as minimum wage legislation and trade union pressure, or finally how much is a monetary difference reflecting the higher cost of living in urban areas. In the service sector observers note that the marginal product is not far from zero. Having no reliable estimate of the magnitude of the productivity of labor in the industrial and service sectors, we arbitrarily assumed that their average would correspond to the marginal product in agriculture, and that the "national" productivity of labor would therefore be equal to the one prevailing in agriculture.

Allocation of production to different age groups. No data are available on when children start to work, nor on how much they earn or what their productivity is at different ages. We arbitrarily assumed that children would start work at age ten, even though they probably start at an earlier age in rural areas, but later in urban areas. Since agricultural work is largely a bodily effort, the marginal physical product was assumed to vary roughly with

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37 Hansen and El Tomy. The authors give an estimate of requirements of men, women, and child labor in different parts of the year.
38 Kheir el Dine.
39 Hansen and Marzouk, Table 2.8, p. 35.
40 Hansen and Marzouk, Tables 5.7 and 5.8.
41 Hansen and Marzouk.
TABLE 4: Present Value of the Productivity Stream

<table>
<thead>
<tr>
<th></th>
<th>10% Discount Rate</th>
<th>15% Discount Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Allocation of production to different age groups as in text</td>
<td>91</td>
<td>31</td>
</tr>
<tr>
<td>2. Allocation of reduction to different age groups using Enke's ratios</td>
<td>79</td>
<td>24</td>
</tr>
</tbody>
</table>

strength. Children aged ten to fourteen and fifteen to nineteen were assumed to produce one-third and two-thirds respectively of the product of men aged twenty and over. This procedure may be valid for agriculture, but in industry we assumed that productivity would increase with age (after twenty) as a result of experience. The figures used are tenuous, but they provide an alternative to Enke's estimates which vary by a factor of seven between ages ten and thirty-five. The figures used here yield a productivity stream higher than that estimated by Enke, as the marginal product is relatively higher in the earlier years which are less heavily discounted.

Two possible ways of allocating the marginal product to different age groups and two discount rates yield four possible estimates of the value of the discounted productivity stream of a prevented birth. These are summarized in Table 4.

Costs of preventing a birth in a family planning program

The discussion in this section can be clarified by breaking down the second term in equation (2) (page 10) into the following components:

\[ E_i = \frac{TC_i}{B_{t+1} + B_{t+2} + B_{t+3} \ldots B_{t+n}} \]  

\[ B_{t+1} = A_{t}m \] (4.a)

\[ B_{t+2} = A_{t+1} = RA_{t}m \] (4.b)

\[ B_{t+3} = A_{t+2} = R^2A_{t}m \] (4.c)

\[ \vdots \]

\[ B_{t+n} = A_{t+n-1} = R^{t+n-1}A_{t}m \] (4.n)

\[ B_{t+1} + B_{t+2} + B_{t+3} + \ldots + B_{t+n} = A_{t}m(1 + R + R^2 + \ldots + R^{t+n-1}) \ldots (5) \]

42 As with the consumption stream, the weighted average (weighted by the proportion of people in each age bracket) was made equal to the average national figure. This was done in a manner exactly analogous to that of the consumption stream.

43 Enke, Economics for Development, Chap. 20.
TC = Total expenditures in time $t$.
$B_{t+i}$ = Number of births averted at time $t + i$.
$A_t$ = Number of new acceptors at time $t$.
$A_{t+i}$ = Number of acceptors who joined the program at time $t$ and who are continuing to practice contraception at time $t + i$.
$m$ = The average fertility that acceptors would have had, had they not joined the program.
$R$ = The continuation rate, or the number of women in the program in period $t + 1$, in relation to those who joined the program in period $t$. This rate is assumed to be constant, though in practice it is found to be higher in the initial months. This can be handled in the computation without affecting the general principles discussed here.

Using this simplified framework it is then possible to consider problems that will arise in estimating the total expenditures and the number of averted births. One preliminary point should be made here. The time lag between total expenditures and the averted births will vary depending on the time at which a woman becomes an acceptor. For example, a woman who becomes an acceptor immediately after childbirth is not likely to have conceived a child in the first year had she not become an acceptor. The demographic impact would start only toward the end of the second year. In other cases the impact will be more immediate, the lag being just over nine months. The point to be noted here is that expenditures will occur at a given time, while the averted birth will occur after a lag which is an average of the time lag of all averted births resulting from this expenditure.

**Total costs.** These are the real resources spent on the provision of family planning services. The direct budgeted expenditures on family planning have to be adjusted to reflect the use of real resources. Adjustments particularly relevant to family planning include:

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44 Discussions with Dr. C. Chandrasekaran greatly clarified my thinking on this point, and on the "catching up" problem. These discussions underlined the nature of the difficulties arising in the measurement of these problems.

45 While several studies have calculated the number of births averted by a family planning program, none has yet dealt with the time sequence of these averted births. These studies include: R. G. Potter, "Estimating Births Averted in a Family Planning Program," Paper presented to a Fertility and Family Planning Conference: A World View, University of Michigan, November, 1967; and W. P. Mauldin, "Births Averted by Family Planning Program," *Studies in Family Planning*, No. 33 (August, 1968), pp. 1–7.

46 There are many other adjustments common to benefit-cost techniques in other sectors which are not considered here. Examples of these are the use of shadow prices, the treatment of taxes, inflation, etc.
a) Adding the imputed value of extra health resources used in family planning. Many programs are integrated with other health services and budgeted expenditures do not reflect the additional use of health resources. Salaries of medical and paramedical personnel working in family planning should be allocated to family planning. Health facilities used partly for family planning should also be allocated to the program. Finally, the administration of the family planning program is sometimes part and parcel of the administration of other health services. Rough rules of thumb should be used to impute a value to all these health resources, for example, by including a proportion of these costs that corresponds to the proportion of the time that these resources are used for family planning purposes.

b) The treatment of free services. These can be provided either by the government (as for instance free time on radio and T.V. etc.) or from foreign sources (such as contraceptive supplies, medical and training equipment, etc.). It is clear that an imputed value for the first group of items has to be included. If the items offered in the second group are “tied” to family planning, then they will not involve the use of real national resources. They are included here, however, since they are part of the international costs of preventing a birth.

Available figures do not usually make all the above adjustments. Nevertheless, the following figures give an indication of the magnitudes involved. Below are the annual budgets authorized for family planning in 1967 in a number of countries. Actual expenditures have usually been close to the authorized budgets.

Number of prevented births. The estimate of the number of prevented births, as seen from equations (4) and (5), involves several successive estimates: the number of acceptors, the number of acceptors continuing the use of contraception in successive years in the future, and finally, the number of prevented births. At each step costs can be estimated. Each of these estimates involves difficulties which increase in complexity from one level to the next.

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Budget</th>
<th>Per Capita</th>
<th>Per Woman in the Reproductive Ages</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>60,000,000</td>
<td>0.12</td>
<td>0.72</td>
</tr>
<tr>
<td>Pakistan</td>
<td>12,000,000</td>
<td>0.11</td>
<td>0.66</td>
</tr>
<tr>
<td>South Korea</td>
<td>2,150,000</td>
<td>0.07</td>
<td>0.42</td>
</tr>
<tr>
<td>Republic of China</td>
<td>425,000</td>
<td>0.035</td>
<td>0.21</td>
</tr>
<tr>
<td>U.A.R.</td>
<td>2,300,000</td>
<td>0.077</td>
<td>0.45</td>
</tr>
</tbody>
</table>

The result is that the estimates become less precise at each successive step. These difficulties are briefly reviewed:

a) **Costs per new acceptor.** Data on the number of new acceptors are available in most ongoing programs. Costs per new acceptor have been low—in South Korea and the Republic of China, for example, the cost is around US$5. Many factors can be expected to influence the cost per acceptor over time. Some of the more important are:

1. Administrative overheads, which are usually a substantial proportion of the costs, become spread over a larger number of acceptors as a program gains momentum.

2. Improvements in contraceptive technology as well as substantial reductions in the costs of production of existing contraceptives will also lower costs. Pills are produced today for much less than their cost of production in initial years.

3. The expansion of the program into rural areas can be expected to increase costs for two reasons: clinics and staff will be serving a smaller population, and more information efforts will be required to enlist a given number of new acceptors. Home visitors who are sometimes used for this purpose will be able to visit fewer homes than in urban areas.

4. Costs per acceptor can also be expected to increase as the initial highly motivated women become acceptors and more effort in terms of motivation and information is required to enlist additional acceptors.

The above a priori arguments show that in theory costs per new acceptor can either increase or decrease. In practice, the evidence we have suggests that over short periods of time (say five years), costs are constant. This will be presently shown.

b) **Cost per couple-year of protection.** A couple-year of protection is defined as a year of effective practice of contraception. A given expenditure will result in a number of new acceptors. These will practice contraception in the first year (in which the expenditure was made) and also in succeeding years. For example, a vasectomy performed in one year will lead to several years of protection in the future, depending on the average number of potentially fecund years following the operation. Similarly, whether an acceptor of an IUD or pill in a year will practice contraception in the succeeding years will depend on: the continuation rate, or how far new acceptors continue to remain in the family planning program; and what happens to those who leave the program—in particular whether they continue to practice contraception (by the method first used or another) or whether they become
again subject to the risk of pregnancy. While service statistics in some programs do provide data on the continuation rate, data on those who leave the program are rarely available except in some programs where sample surveys of “dropouts” have been made.

The number of years of protection given by different contraceptive methods can be estimated, aggregated and related to the costs of providing these methods. These costs will be a better (but less accurate) measure of the effectiveness of a program than the cost per new acceptor, since contraceptive practice is more directly related to fertility changes than is the number of new acceptors. One study which has calculated the cost per couple-year of protection in various countries shows the following results:

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Cost</th>
<th>Country</th>
<th>Year</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>1964-65</td>
<td>4.22</td>
<td>South Korea</td>
<td>1964</td>
<td>1.66</td>
</tr>
<tr>
<td></td>
<td>1965-66</td>
<td>1.95</td>
<td>1965</td>
<td>1.54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1966-67</td>
<td>2.25</td>
<td>1966</td>
<td>1.94</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1967-68</td>
<td>2.51</td>
<td>1967</td>
<td>2.48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1968-69</td>
<td>3.10</td>
<td>1968</td>
<td>6.52</td>
<td></td>
</tr>
<tr>
<td>Republic of China</td>
<td>1964</td>
<td>1.20</td>
<td>Pakistan</td>
<td>1965-66</td>
<td>6.55</td>
</tr>
<tr>
<td></td>
<td>1965</td>
<td>2.14</td>
<td>1966-67</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1966</td>
<td>1.72</td>
<td>1967-68</td>
<td>2.79</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1967</td>
<td>1.84</td>
<td>1968</td>
<td>2.21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1968</td>
<td>2.21</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: *A Cost-Effectiveness Analysis of Selected National Family Planning Programs*, p. 141.

This study also looked at the trends over a period of four years and came to the conclusion that no clear or dominant relationship between program volume and costs or couple-year of protection emerges from the data. As a rough rule, costs per unit seem more likely to be constant with program volume than to rise or fall markedly. In Pakistan costs were reduced over time, while in South Korea a rise was observed. In both India and the Republic of China costs were reduced at first and then increased.

c) **Cost per prevented birth.** Given the number of current users in successive years, it is possible to estimate the number of prevented births. For this some estimate of the number of children that acceptors would

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48 This will be an estimate of the gross number of births averted rather than those averted by the program.
have had in the absence of a family planning program is required. By
definition data on this are not available, but some indirect estimate is
necessary if the number of prevented births is to be derived. One possi-
bility here is to use data from questions to acceptors on the number
of births they had in the years prior to their joining the program, and
to assume that child-bearing would have proceeded at the same rate
after they became acceptors. Such data are not usually available, al-
though they have been collected in one or two programs. An alterna-
tive method is to assume the fertility level of acceptors to be the same
as that of the general population having the same characteristics (mar-
tal status, age, education, parity, etc.). This will usually be an under-
estimate, since acceptors of family planning services will usually be
selected for “higher than average fertility.” Data on characteristics of
acceptors that are relevant to their fertility pattern will be required.
These include age, education, parity, income levels, etc.

Simple estimates (i.e. incorporating only a few of the refinements outlined
above) of costs per prevented birth have been calculated for various countries.
These estimates show a range of US$15 to US$30 per prevented birth. For
the U.A.R. some estimates based on budgeted expenditures were made. These
show a range going from LE4 for inter-uterine devices in urban areas to
LE20 for pills in rural areas. These estimates were made using various
tentative assumptions. Though no single estimate is accurate, the point of this
and other estimates is that these costs are low in relation to the magnitude of
the benefits discussed in previous sections.

One final point should be made. Though costs per prevented birth have
been shown to be low, this does not mean that cases cannot be found or will
not occur where costs are excessively high. This, however, will probably be
due to inefficiencies in program administration—i.e. to the fact that the pro-
gram is not operating close to the “minimum cost” level. The main point in
this section is to show that costs can be low in relation to the benefits, and
that these costs over short periods of time (five years, for example) are more
likely to remain constant than to increase or decrease.

**Summary of Benefits and Costs**

Table 7 summarizes the benefits and costs discussed in previous sections.
Minimum and maximum estimates are given with ranges for the differences
and the ratio between benefits and costs. The benefit-cost difference varies
between LE91 and LE326 or between 1.6 and 5.6 times the per capita income,
while the ratio varies from 2.5 to 8.7. The ratio between benefits and costs
does not allow for the scale of a family planning program, whereas the differ-
ence between benefits and costs, when multiplied by the number of births
prevented in a program, would take this scale into account. Whichever formu-
TABLE 7: Summary of Various Effects

<table>
<thead>
<tr>
<th></th>
<th>10% Discount Rate</th>
<th>15% Discount Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Benefits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Consumption</td>
<td>222–351</td>
<td>109–206</td>
</tr>
<tr>
<td>2. Wage productivity effect</td>
<td>16–21</td>
<td>9–14</td>
</tr>
<tr>
<td>3. Public savings effect</td>
<td>37</td>
<td>24</td>
</tr>
<tr>
<td>4. Total</td>
<td>275–409</td>
<td>142–244</td>
</tr>
<tr>
<td><strong>B. Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Productivity</td>
<td>79–91</td>
<td>24–31</td>
</tr>
<tr>
<td>6. Family planning services</td>
<td>4–20</td>
<td></td>
</tr>
<tr>
<td>7. Total</td>
<td>83–111</td>
<td>28–51</td>
</tr>
</tbody>
</table>

8. Difference between benefits and costs (Row 4 minus row 7) | 164–326 | 91–216 |

9. Benefit-cost ratios (Row 4/Row 7) | 2.5–4.9 | 2.8–8.7 |

...
able. Indirect evidence and judgment will therefore have to be used. A ques-
tion to an acceptor on whether she is limiting or spacing her births is helpful.
In the former case, comparison with the fertility pattern of “similar” women
with respect to age, education, parity (i.e. number of living children), and
other characteristics related to fertility gives an indication of how many births
are permanently prevented. Assuming that the limiting of births is due to the
program, all the economic benefits can be imputed to these “permanently”
prevented births. However, an indication that a given acceptor is spacing her
births will not be sufficient to show either the extent and form of the delay
that is involved or whether the acceptor plans to have the same total number
of children. Consider the following example where the time sequence of births
with and without the practice of contraception is assumed to be known. In
the first case, assume that a child is born every year; in the second, one child
is born every two years. In both cases assume the total number of births is
three. This sequence can be illustrated as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No family planning</td>
<td>B1</td>
<td>B2</td>
<td>B3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With family planning</td>
<td>B1</td>
<td>....</td>
<td>B2</td>
<td>....</td>
<td>B3</td>
</tr>
</tbody>
</table>

In this example the economic benefits are the same as those of preventing the
birth of a child with an expected lifetime of three years, not fifty or sixty as
in the case where ceasing to bear children is involved. This extreme example
is meant to illustrate how difficult it is to derive exact estimates of economic
benefits. In actual programs where acceptors are asked whether they are limit-
ing their births or spacing, typically one-half will be limiting. Of the re-
mainder who are spacing, there will be some who are also limiting. Hence
there is usually a strong presumption that the adjusted benefits would still be
very large. However, this point demonstrates that it is unrealistic to aim for
a precise estimate of economic benefits.

The “substitution” problem

This refers to substitution between the private practice of contraception and
the practice of contraception through a family planning program. It can be

46 This can be seen by assuming that a child’s consumption is 100 units per
year. Then total consumption would be as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Family Planning</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>With Family Planning</td>
<td>100</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Difference</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
argued that many women were practicing contraception prior to the introduction of a family planning program or that as a result of improvements in general socio-economic conditions, they would have started to practice contraception even without a program. Initial acceptors are sometimes middle-class women in urban areas who switch from private to public contraception or who would have started to practice contraception even in the absence of a family planning program. How is this to be measured and how are the net prevented births (i.e. those solely due to the program) to be estimated? It is impossible to do this directly, since no data are available on “what would have happened in the absence of a program.” Indirectly, it can be done in several ways. One possibility is to study the characteristics of acceptors. In mass programs where the majority of acceptors come from rural areas and from the lowest socio-economic and educational echelons, this is prima facie evidence that substantial “substitution” is unlikely. Another possibility is the use of multiple regression analysis in which fertility differentials are related to two groups of factors: those contributed by the program (such as the number of man-hours of field work) and those related to fertility but not due to the program (such as changes in educational levels, information, the employment of women, etc.). The data for such an analysis will only rarely be available. The one case where such an analysis was made\textsuperscript{50} shows that most of the variation in fertility levels can be accounted for by program inputs. The conclusion is that substitution is not very prevalent in mass programs. However, the existence of some substitution affects the precision with which benefits and costs can be calculated.

**Indirect effects**

A program may also, through mass communication or personal and group contact, increase the practice of contraception among that part of the population that does not join the national program. It is not possible to estimate the size of this group without detailed sample surveys which are only rarely available. The likelihood that such an effect is present, and may be large, implies benefits that are larger than those derived on the basis of program statistics.

In summary, the problems of “catching-up,” “substitution” and “indirect effects,” show that the range of benefits and costs is greater than that shown in Table 7. This increase in the degree of imprecision does not generally invalidate the main conclusion, which is that the benefits are much larger in relation to the costs than in conventional economic sectors.

In summary, difficulties of measurement are not peculiar to the study of population but are also present in estimating the impact of other economic policies. The basic difficulty is a general inability to devise controlled experiments in economics. The data that are generated reflect a “before and after” situation, whereas what is needed is a “with and without” situation. The resulting problems of “substitution,” “catching up” and “indirect effect” have their counterparts in other fields. Similarly, the problem of how to allow for “qualitative” factors is common to other fields. The performance of a firm will depend crucially on the administrative ability of one or two persons at the top. But no one has yet devised a satisfactory way of measuring this quantitatively. The point to emphasize in population policy is that most qualitative variables (the health of mother and children, further induced declines in the birthrate as a result of the initial increase in per capita income, the effect of better health on output, etc.) reinforce the quantitative argument, which can be regarded as a low estimate of the benefits. Our inability to quantify some important variables should not be used as an excuse for not quantifying others, especially when the addition of the former cannot reverse but can only reinforce the conclusions drawn on the basis of a quantitative analysis.

The difficulties mentioned in Chapter IV show that the benefit-cost approach should be used with care and within prescribed limits. This approach is more acceptable the more marginal a birth (i.e. the smaller the changes
in the birthrate) and the less developed a country is. In these instances where births are not wanted by parents, changes in per capita income are a good index of changes in welfare, and these changes alone are a good approximation of the welfare of a country. As the births become less and less marginal and as the analysis is applied to countries which are not near the subsistence level, these underlying implicit assumptions, and hence this whole approach, become progressively less acceptable. Pushed to extreme limits the benefit-cost approach leads to absurd conclusions. Even when acceptable, however, this approach is not a good index of the relative efficiency of various family planning programs or of the degree to which population is a problem in various countries. If the answer to such questions is sought a different analysis would be more suitable. The main usefulness of the benefit-cost approach is as a measure of the relative effectiveness of investment in family planning as compared with other projects within the economic field.

In the final analysis it is well to emphasize that the benefit-cost technique—and the economic analysis of population trends in general—should not attempt to meet the unrealistic demands placed on it by many who are concerned with the population problem. Many non-economists (and some economists) believe that economics alone can demonstrate that population growth is undesirable. This it cannot and should not do. The economist's role is to point as precisely as possible to the "trade-off" or the price ratio between higher living standards and a greater number of persons, but not to pass judgment—as an economist—on which is "better." This is not to argue for greater numbers but only to emphasize that when higher standards of living are preferred this choice is not an economic choice but one that involves much broader and more basic considerations. Economic analysis can influence this choice to some extent, but cannot be a substitute for it. This point is not peculiar to population. Analysis of economic behavior such as maximizing profits, output or sales is based on objectives that are generally held to be worthwhile if not obvious. Such objectives are rarely questioned because they are normal and accepted as a matter of course. In the field of population, however, reactions are often emotional because there is little agreement on basic issues. This emotional response has led us to question the assumptions on which the economic analysis is based and to spell out some basic questions. Similar questions can likewise be raised about other types of economic analysis. Such questions involve basic beliefs, which are not always subject to rational discussion. The remedy for this, however, is not to forego the economic analysis of population trends, but to make a clear distinction between the economic and the broader issues—in short to use economics as one of several ingredients to be considered in the analysis of this vital problem.
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