Technical Report

7

OPTIMAL TARGETS FOR INDIAN FAMILY PLANNING PROGRAM*

by

J. K. Satia
C. Rangarajan

विद्याविनियोगाद्विकासः
IIM
AHMEDABAD

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD

OPTIMAL TARGETS FOR INDIAN FAMILY PLANNING PROGRAM*

by

J. K. Satia
C.Rangarajan

August 1973

Indian Institute of Management
Ahmedabad

No. 7

To

Chairman (Research)
IIMA

Technical Report

Title of the report OPTIMAL TARGETS FOR INDIAN FAMILY PLANNING PROGRAM

Name of the Author J. K. SATIA and C. RANGARAJAN

Under which area do you like to be classified? P&QM Area (J. K. SATIA) C. RANGARAJAN ECONOMICS (C. RANGARAJAN)

ABSTRACT (within 250 words)

(PLEASE SEE ABSTRACT WITH THE MANUSCRIPT)

Benefits of costs associated with family planning programs of under-developed countries in general, and of India in particular, have been a subject of intensive investigations. These studies have been primarily used as a means for the justification of family planning programs. In this paper, we have applied benefit-cost analysis to derive the economically justifiable targets for Indian family planning programs. The targets are defined in terms of desired declines in general fertility rates (GFR). A demographic and economic model similar to Coale-Hoover is constructed to evaluate the economic consequences of different GFR paths. The cost-equations based upon the past data are used to estimate the costs of achieving various GFR paths. Benefit-cost analysis is used to compare these paths and derive optimal targets.

The study shows that the benefit-cost analysis results are very sensitive to the type of economic benefits considered. Interest rates and horizon periods also effect the optimal targets.

The analysis is then used to discuss the interactions among per-capita-consumption distribution, measures used and suggested to achieve declining fertility rates and financing of family planning programs. It is stressed that a massive program to reduce fertility rates may not achieve credibility unless steps are taken to achieve a greater equality in per-capita-consumption distribution.

Please indicate restrictions if any that the author wishes to place upon this note ~~[illegible]~~

PRELIMINARY DRAFT

Date Aug 23, 73

Signature of the Author

JKSatia

Abstract

Benefits and costs associated with family planning programs of underdeveloped countries in general, and of India in particular, have been a subject of intensive investigations. These studies have been primarily used as a means for the justification of family planning programs. In this paper, we have applied benefit-cost analysis to derive the economically justifiable targets for Indian family planning programs. The targets are defined in terms of desired declines in general fertility rates (GFR). A demographic and economic model similar to Coale-Hoover is constructed to evaluate the economic consequences of different GFR paths. The cost-equations based upon the past data are used to estimate the costs of achieving various GFR paths. Benefit-cost analysis is used to compare these paths and derive optimal targets.

The study shows that the benefit-cost analysis results are very sensitive to the type of economic benefits considered. Interest rates and horizon periods also effect the optimal targets.

The analysis is then used to discuss the interactions among per-capita-consumption distribution, measures used and suggested to achieve declining fertility rates and financing of family planning programs. It is stressed that a massive program to reduce fertility rates may not achieve credibility unless steps are taken to achieve a greater equality in per-capita-consumption distribution.

OPTIMAL TARGETS FOR INDIAN FAMILY PLANNING PROGRAM

I. Introduction

The desirability of national birth control programs for developing countries has been established beyond doubt. India's family planning program is expected to play a crucial role in the nation's development. The benefits resulting from these programs and costs incurred by the programs have been a subject of intensive investigations.

Coale and Hoover[1], in one of the pioneering attempts, investigated the effects of different rates of fertility declines in India. They constructed a demographic and econometric model for India. Using such a model, they showed that declines in fertility rates will significantly affect the per-capita income.

The case for "Birth Control Programs" has been made by Enke[2] and he has supported the case by constructing a set of increasingly sophisticated models of a typical underdeveloped country to evaluate economic consequences of declines in fertility rates. The investments in these programs are shown by him to be superior to other investments in terms of their resulting effects on per-capita income.

Attempts have been made by Simon[3], Repetto[4], Simmons[5] and others to evaluate the discounted value of a birth averted in India[6]. These estimates range from Rs.1000 to Rs.8000 per birth averted. Such a wide variation in the estimated value of a birth averted is due to differing assumptions regarding the measurement criterion of the benefits and the parameters used in the models such as discount rates and the time horizons considered.

Myrdal[7], and Liebenstein[8], argue against the benefit-cost analysis of family planning programs. Liebenstein raises the question of whose view point should be used by benefit-cost analysis. The usual benefit-cost analysis looks at the national economic consequences whereas the actual decisions and their consequences are felt by the individual families. The possible conflict between social and privat benefits and disbenefits needs to be resolved. Discounting further complicates the issue, by linking present generations with future generations. Myrdal argues that it is very difficult to pinpoint the exact amount of benefits. The attempts to construct quantitative models were abandoned by him in favor of qualitative discussions.

The Government of India uses an estimate of Rs.1500 as the discounted value of a birth averted[9]. Past experience indicates that the average cost per birth averted is approximately Rs.125. This would imply a benefit-cost ratio of 12 at the present level of family planning programs.

While it has been established beyond doubt that the family planning programs are desirable, the optimal targets of these programs have not received much attention. We investigate, in this paper, the economically justifiable targets for the Indian family planning program using benefit-cost analysis. The targets are defined in terms of desired declines in general fertility rates.

The methodology of investigation is described in Section II. A reworked Coale-Hoover model is used to evaluate the economic consequences of different paths of declines in general fertility rates in Section III. The estimates for the births that need to be averted under these paths are derived in Section IV using a demographic model. Section V discusses the discounted economic value of a birth averted. The sensitivity of this estimate with respect to measurement criterion, interest rates and horizon length are discussed. Cost equations based upon past experience are presented in Section VI. Section VII compares the benefits and costs of different paths. The implication of the results obtained by benefit-cost analysis are discussed in Section VIII. Finally, a summary is presented in

II. Methodology of Investigation

Definition of Different Targets

The targets for a family planning program are usually defined as the desired general fertility rate (i.e., number of births per thousand of population between the ages of 15 and 44) GFR at the end of a certain period. But the benefits and costs also depend upon the path taken to reach the targets. Therefore, a targetted fertility decline path should specify GFR for each year t in the planning horizon. There are an infinity of such GFR paths. However, we limit ourselves to the GFR paths with the following characteristics:

a) The fertility rate stablizes by the year 1985.
b) The fertility decline occurs at a linear rate.

Figure 1 shows the various GFR paths that will be considered.

Method of Comparison Between Alternative Paths

Each GFR path k implies different national income projections $Y_t(k)$ and different numbers of consumers, $C_t(k)$ sharing these benefits in each year t. A lower GFR path, as is well known, leads to a higher level of income and a smaller population. In discussing the effects of family planning programs, two types can be distinguished: Those arising due to increased availability of aggregate consumption - the aggregate consumption effect; and those arising due to the increased consumption being shared by fewer consumers - the per-capita consumption effect. The measurement of these benefits would be as follows: Consider two GFR paths A and B. The national income differences between these two paths in year t is $Y_t(B) - Y_t(A)$. However, some portions of this increased wealth is reinvested and consequently only the remaining portion is available for consumption. We have estimated[10] that 25% of the national income will not be available for private consumption. Hence[11] the aggregate consumption effect in year t is $.75 [Y_t(B) - Y_t(A)]$. The per-capita consumption effect is $.75 [Y_t(B) - (Y_t(A) \times C_t(B)/C_t(A))]$.

Different GFR paths also imply different amounts of family planning program effort necessary to avert the births and consequently different expenditure levels. As it takes several years for benefits to realize after expenditures have been incurred, we have to discount benefits and costs. The discounted benefits and costs can thus be evaluated for each linear GFR path as compared to "uncontrolled fertility". Whereas investments will be justified if the benefits exceed costs, the optimum level of investment can only be determined by comparing marginal benefits and marginal costs of successive GFR paths. Marginal costs increase and marginal benefits decrease with increasing family planning program efforts. The GFR path for which marginal costs equal marginal benefits is the optimal GFR path. Figure 2 is a schematic representation of the methodology.

The discounting procedure, and the rates are controversial issues. Our attitude here is that the value of rates should be determined by "cost of capital" depending upon current borrowing costs and "opportunity-cost of money" as measured by the returns from other investments. The analysis is performed for several values of interest rates. Another issue in evaluating the benefits and costs is the planning horizon that should be considered. As the planning horizon gets longer the benefits of a GFR path also increase. Since it is difficult to pinpoint a value for this horizon, we carry out the analysis for several values ranging from 20 to 50 years.

III. Economic Model

In this section, we describe a reworked Coale-Hoover model to evaluate economic consequences of differential fertility patterns. First the Coale-Hoover model is described.[12] The model structure and parameters are then compared with the actual data for the period 1956 to 1966.[13] Based upon this comparison, new values of parameters are estimated. This reworked model in conjunction with a demographic model is then used to estimate national income and economic effects of different GFR paths.

Description of Coale-Hoover Model

The Coale-Hoover model is built on the assumption that the major cause of income growth is investment or as they call it, "equivalent growth outlays" which is a measure of total investment adjusted for the varying degrees of productivity of its components. The two major components are investments in capital goods and welfare type outlays, the former being more productive than the latter. The capital-output ratio determines the income growth given the equivalent growth outlays. The size of population and its rate of growth are introduced as two specific variables which have an impact on the composition and level of investment and therefore, rate of growth of income. A low fertility rate leads to a faster increase in income due to two factors. One, it leads to a larger volume of saving and investment; two, a greater proportion of the investment is directed to high productivity capital goods type as opposed to the welfare type expenditures.

The basic structure of the Coale-Hoover model is as follows:

Total public expenditures plus net monetized private investment (F) in any year is assumed to depend upon national income (Y) and the equivalent consumer population (C)[14]

$$F = aY - bC$$

The F - expenditures consist of two components: Direct development expenditures (D) and welfare - type - outlays (W). W outlays are assumed to contribute less directly (and hence less strongly) to raising national income as compared to D-outlays.

$$F = D + W.$$

The welfare-type outlays or W-outlays will meet the needs of both the existing population (W_C component) and the needs of current increment of population (W_I component).

$$W = W_C + W_I$$

W_I expenditures involve. setting up expenses to continue to maintain the welfare level implied by W_C expenditures. The W_I - expenditures will depend upon the ratio (p) of annual population increment to current population.

$$W_I = (10\ p\ )\ W_C.$$

Over a. long period, the demand for welfare-outlays (W_C) will be based upon what people can afford and are hypothesized to absorb a constant percentage of national income, i.e.,

$$W_C = .0725\ Y$$

The equivalent growth outlays (G) are the sum of direct development outlay (D) and the effect of W_C and W_I expenditures. Since W-outlays are shared by total population, only that portion expanded on current labor forces will cause a change in productivity and consequently an increase in Y. Therefore,

$$G = D + (e_C W_C + e_i W_i)_t L_t + (e_C W_C + e_i W_i)_{t-15} \quad (1-L)_{t-15}$$

Where e_C and e_i are respectively the weight assigned to W_C and W_I outlays. The capital-output ratio R is assumed to depend linearly on t giving

$$R = m + nt$$

where m is the initial value and n is the rate of change of capital output ratio.

Finally, $Y_{t+1} = Y_t + G/R$.

Validation of the Model

The robustness of the Coale-Hoover model was tested by comparing the actuals of the national income with the values predicted by the model for the period 1956-1967. The actual population figures and the following values of the parameters were used to predict national income,

$$e_c = .5,\ e_i = 0,\ m = 3.0, \text{ and } n = 0.02.$$

The comparison is presented in Table 1.

The comparison reveals that the actual and predicted values agree well for the first five years. But the model consistently underestimates for the subsequent years. We therefore compare actual direct developmental expenditures with the predicted developmental expenditures in Table 2. Since the actual F-outlays and D-outlays are substantially higher than the values projected by the model, the parameters need to be reestimated.

Modification of the Model

While retaining the basic structure of the Coale-Hoover model, we have made some changes in deriving the equivalent growth outlays. The F expenditures were defined by Coale and Hoover to include total public expenditures and net monetized private investment. We felt, however, that from total government expenditures we should exclude all administrative expenditures as these could be said to contribute directly to increased national income. We also follow a slightly different procedure for making an estimate of direct developmental expenditures and welfare type expenditures.

The total government expenditure and net monetized investments were estimated as a proportion of the national income.[15] An examination of these outlays during the period 1956-1971 shows that these expenditures increased to 25% of the national income. We make an assumption that it will stabilize at this level. The welfare and administrative expenses do not seem related to the national income. For instance, in the year 1966, the national income declined whereas welfare and administative expenses showed an increase. Therefore, we regressed welfare (W) and administrative expenses (A) on the equivalent consumer population (C). The equation is estimated to be

$$(W + A) = 49.11C$$

where W and A are measured in 1952 prices.

Since the direct developmental expenditures (D) are equal to the total governmental expenditures plus net monetized private investment less welfare (W) and administrative expenses (A), the equation[16] relating D to Y and C is given by

$$D = .25Y - 49.11C.$$

Since welfare expenditures are treated as purely a function of equivalent consumer population, we regress W on C to obtain the following relationship:

$$W = 18.14C.$$

Using the values of welfare outlays W and population increment p, W_C and W_I components can be calculated using Coale-Hoover relationships. The weight e_i assigned to W_I expenditures used in computing equivalent growth outlays was assumed to be zero as in the Coale-Hoover model. The predicted and actual national income was compared for several values of e_C, the weight assigned to W_C expenditures. The best value of the parameter e_C was derived as .2.

Regarding the capital output ratio,[17] we use the Coale-Hoover formulation that it will be 3.0 + .02t.

Thus, the model we used to estimate the economic benefits arising from different rates of population growth is as follows[18]

$$D_t = .25\ Y_t - 52.577\ C_t \tag{1}$$

$$W_t = 19.424\ C_t \tag{2}$$

$$W_t = (W_C)_t + (W_I)_t \tag{3}$$

$$(W_I)_t / (W_C)_t = 10p_t \tag{4}$$

$$G_t = D_t + e_C (W_C)_t\ L_t + e_C\ (W_C)_{t-15}\ (1-L)_{t-15} \tag{5}$$

$$R_t = 3.0 + .02t \tag{6}$$

$$Y_{t+1} = Y_t + G_t / R_t \tag{7}$$

IV. Population Model

Sev

In projecting the population levels under various GFR paths, we have followed the component projection method which was the basis of Coale-Hoover projections also. The life tables need to be estimated for this purpose. We have modified the life tables used by Coale-Hoover. They assume that the survival probabilities of age group 0-5 will increase and the survival probabilities of other age groups will remain constant during the period 1971-1981. This leads to an estimated mortality rate decline from 13.4 in year 1971 to 12.5 in year 1981. However, projections made by the Registrar General of India imply a decline in mortality rate from 13 to 10 during that same period. To reflect this reduction, we have assumed that this decline will occur by a proportionate increase in survival probabilities for all age groups and have modified the Coale-Hoover life tables accordingly. The 1971 census estimates the population in year 1971 to be 546 million and we have used this as an estimate of the initial population.

Table 3 shows the projections made by using the model. It can be noted from this table that even a high fertility reduction from GFR of 179 to 80 will lead to an increase in population from 546 million in 1971 to 694 million in 1986. The reduction in GFR to 40 by year 1985 is necessary to stabilize the population at 650 million by that time.

Births to Be Averted

Undoubtedly an increasing number of births must be averted as a higher decline in fertility rate is desired. However, the number of births to be averted in a year between any two GFR paths is not obtained by taking simply the difference between the population levels in that year according to the two paths. The calculations of births averted in each year between two GFR paths involves three steps. First, the age-sex composition of the population at the beginning of the year for lower GFR paths is estimated. Second, the number of births with the higher GFR and lower GFR is estimated for this population. Third, the births averted is the difference between these two estimates of the number of births. Figure 3 shows the comparison between two GFR paths.

Following the above procedure, we have indicated in Table 4 the number of births that will have to be averted by the family planning program in India for various GFR paths.

V. Benefits

In this section, the economic benefits of different GFR paths is examined. The basis for estimating the benefits is the model already outlined in Section III.

Income Projections for GFR Paths

The national and per-capita income for different GFR paths are presented in Tables 5 thru 8. Figure 4 is a graph of national income and per-capita income over time for present fertility rate (GFR path 179-179) and very low fertility rate (GFR path 179-80).

The difference in national income between the highest and the lowest fertility paths is only Rs.2.5 billion by the year 1981. This difference increases to Rs.23 billion or 5% of the national income by year 1991. Thus, the effect of family planning programs on the national income is not significant for the next 20 years. These effects become significant only at the end of 40 years.

However, the impact of a successful family planning program on per-capita income is striking. The per-capita income due to a fertility decline of 55% over the next 15 years (i.e., GFR path 179-80) is higher by 12% in the year 1981, 50% in the year 1991 and 90% by the year 2001 over the per-capita for uncontrolled fertility rate. Whereas, in the absence of any further decline in fertility rate, the per-capita income only increases by 85% during the period 1971-2001 a successful family planning program will increase it by 200% during the same period.[19]

Benefits Per Birth Averted

Several estimates have been made of the benefits or value of a birth averted in the Indian context. (S. Enke and R. Zind[20], Repetto[21], Simon[22], Simmons[23]). These estimates range from Rs.1000 to Rs.8000.[24] Obviously, benefits per birth averted depend upon the GFR path, the discount rates and the time horizon chosen. Further, these benefits can be measured either by using the increase in aggregate consumption or income or the increase in per-capita consumption or income. There is no consensus either on the procedure used for measurement of the benefits or the value of parameters used such as interest rates and horizon. These differences largely explain the wide variations in the estimates of the value of a birth averted. While the justification of the family planning programs can be achieved by comparing the lowest of these benefit estimates with the present cost estimates, a more rational allocation of funds will require a precise estimation of the total and marginal benefits of GFR paths. Indeed, as we shall see later, the justification of schemes such as monetary incentives, designed to increase the participation in family planning programs depends upon how the benefits are measured.

Given two GFR paths, A and B, the aggregate consumption effect and per-capita consumption effect can be measured as given in Section II. The births that need to be averted can be computed by the procedure described in Section IV. The benefit per birth averted due to the GFR path B over A is given by the ratio of discounted present value of the benefit in each year t to the discounted present value of the births averted in each year t i.e.:

$$\frac{\sum_{t=1}^{N} (\text{benefit (B)} - \text{benefit (A)})_t (1+i)^{-t}}{\sum_{t=1}^{N} (\text{births to be averted(B)} - \text{births to be averted(A)})(1+i)^{-t}}$$

Tables 9 and 12 present the estimate of benefits per birth averted for various combinations of interest rates and horizons. From these tables several observations can be made.

1. The per-capita consumption benefits per birth averted at 10% discount rate and 30 year horizon are Rs.2500 (at 1961 prices), or Rs.3900 (at 1970 prices). But the effect of horizon and discount rates are significant. This estimated value increases by 80% when a 50 year horizon is considered. For a time horizon of 30 years, the estimated benefits are only half of its value at 20% as they are at 10% interest rate, Figure 5 is a graphical representation of the phenomenon.

2. At 30% interest rate, the per-capita consumption benefits stabilize at Rs.750 at a 30 year horizon. A consideration of longer periods has a negligible effect.

3. As is generally agreed, the per-capita consumption benefits are higher than aggregate-consumption-benefits. It is worth mentioning, however, that these differences are very significant. For a discount rate of 10% and a horizon of 30 years, the per-capita-consumption benefits are approximately 5 times the aggregate consumption benefits. If we consider a time horizon of 20 years, the difference is even higher. In other words, of the total benefits received due to the family planning program, only about 20% are due to the faster growth of the economy. The other 80% arise because there are fewer people to share this income.

VI. Costs of GFR Paths

The procedure for estimating the expenditures necessary to achieve a particular GFR path is as follows. We first estimate the cost of averting a given number of births in any year. Since the number of births that need to be averted can be calculated by the procedure given earlier in Section IV, the cost of a GFR path for each year can be derived. The discounted present value of these costs, then is the cost of achieving a GFR path.

Cost of Births Averted in a Year

There are two components of the total cost of a family planning program: direct cost of providing services and non-direct costs of education and motivation.

lan-
ing

The difficulty in estimating direct costs stems from their dependence on the type of method used to avert births.[25] The methods used depend upon the demographic characteristics of the population and the availability of services. The non-direct cost of motivation will increase as the family/program increases in scope.[26] The cost of a birth averted in India has increased from Rs.40 in year 1968 to Rs.100 in year 1970. (Table 13).

We shall use two procedures for estimating the cost functions using historical data. In the first procedure, we directly relate the total cost to the number of births averted. The second procedure considers the direct and non-direct motivational costs separately.

First Procedure

The past cost performance of the Indian family planning program is shown in Table 13. Figure 6 is a graph b of births averted[27] vs. total expenditures during a year. An examination of the graph leads us to believe that a quadratic function would best express the relationship between births averted and cost. Three points (.35, 20), (2.0, 88) and (3.25, 2.55) were chosen to fit a quadratic function.

$$T = 29.8 - 42.5 X + 35.8 X^2$$

where T = total cost at 1961 prices, Rs. Million.

X = number of births averted in millions. The marginal cost of a birth averted is given as $dT/dx = -42.5 + 71.6 X$, which implies that the marginal cost of a birth averted after 7 million births have already been averted is Rs.458.

Second Procedure

Assuming that the direct cost is Rs.20 per acceptor,[28] the non-direct costs of motivation, etc., are related to the number of acceptors. Table 14 and Figure 7 show the past data in terms of number of acceptors and the non-direct costs. Once again a quadratic curve is fitted using the three points (.4, 12), (1.5, 40) and 3.4, 195). The relationship[29] is estimated as

$$TND = 13.04 - 10.09Y + 18.70\ Y^2$$

where TND = total non-direct cost at 1961 prices, Rs. Million.

Y = number of acceptors, Million.

To estimate the total cost, it is necessary to evaluate the number of acceptors needed to avert a desired number of births We assume that the ratio of acceptors to births averted as in 1970 will continue to hold in the future. (i.e., 3.125 births will be averted by 3.5 acceptors).[30]

Hence:

$$T = 20.0Y + 13.04 - 10.09Y + 18.70Y^2$$

$$Y = (3.5/3.125)\ X.$$

Under this procedure the marginal cost of averting a birth after 7 million births have been averted is Rs.380. The cost estimates derived by both procedures are compared in Figure 8. Up to 5 million births averted, the first procedure results in a lower average cost estimate than the second procedure. Beyond this range, the average cost estimates using the first procedure are higher. As will be seen later, the choice of the cost procedure does not significantly affect optimal targets.

Estimating Costs of GFR Paths to Government

It is perhaps worthwhile to examine the annual expenditures to be borne by the Government of India for various target GFR paths. These are presented in Table 15. The fourth five-year plan aims at reducing the birth rate from 39 per thousand (in year 1969) to 25 per thousand by year 1981. This would imply a GFR path of 179-80. The envisaged fourth five-year plan expenditure of Rs.3150 million tallies well with our cost estimates for the same period. However, to ensure this rate of fertility decline (i.e., GFR path of 179-80), the total amount of expenditure called for during the fifth five-year plan is Rs.16000 million.

VII. Benefit-Cost Analysis

In Section III, we constructed an economic model to derive the economic benefits by different GFR paths. In the subsequent sections we outlined the procedures for deriving the costs attached to different GFR paths. Now we make a comparison of the benefits and costs for different GFR paths with a view to choosing the optimal path. For choosing the optimal path, we need to look not only at the total benefits and costs of each path but also at the additional or marginal costs and benefits of each path compared to the previous path of smaller declines in fertility. Table 16 to 23 list these benefits and costs using both aggregate consumption and per-capita consumption effect for interest rates of 10 and 20% and time horizons of 30 and 40 years. The most desirable GFR path is the one at which the marginal benefits and marginal costs are equal. Assuming that other developmental outlays can be made to yield a given rate of return equating marginal benefit with marginal cost will maximize the net present value. Any further expenditures beyond this level will not give that return. Table 24 shows the most desirable paths for different interest rates and horizons.

We observe from this table that using the aggregate-consumption effect, the present national targets of a GFR path 179-80 are economically justified only if an interest rate of 10% and a horizon of 40 years is used. At higher interest rates and/or smaller horizon periods, such an effort is not warranted. At 20% interest rate, the horizon values of 30 years or beyond do not affect the analysis. However, this value seems high.[31] At interest rates of 10% to 15%, a GFR path of 179-120 will perhaps be most desirable. However, using per-capita consumption effects, a massive reduction in fertility rates can be justified.

when the aggregate consumption effect is used, the benefit-cost ratio at optimum GFR path is approximately two. This implies that approximately 50% of the higher benefits due to family planning will have to be spent on the family planning program. When the per-capita consumption effect is used, the present targets imply a benefit-cost ratio in the range of four to six. A major consideration that emerges is which of the two effects - aggregate consumption effect or per-capita consumption effect should be used to measure benefits. Many writers have chosen the latter. The choice of this criterion however, raises other issues which we discuss in the next section. If the aggregate consumption effect is treated as the appropriate criterion, then the choice of the values of interest rates and horizons becomes an important issue.

VIII. Implications of the Study

The benefit-cost analysis carried out here is not intended to directly compare family planning program outlays with the other developmental outlays. One of the principal difficulties in making such a comparison is that different types of benefits are desired from these investments. The family planning program outlays are made to decrease the population growth so that the consumption thus freed up could be directed towards increased developmental outlays which would subsequently increase the consumption level of the population. The developmental investments on the other hand are made to increase the output directly. Also, many non-economic considerations are involved. Since both these types of outlays complement each other in a nation's goal of economic development, a much larger analysis incorporating many dimensions of economic development will be necessary to study the trade-offs between these two investments. Our analysis by using a discount factor, implicitly assumes that other opportunities are available for investments earning a return equal to the discount rate used.

This study was intended to answer a specific question--what family planning program targets are economically desirable for India. Our study shows that there is no unique answer. As already stressed, the benefits and costs depend upon the interest rates, length of the planning horizon and the criterion used to measure benefits.

A major consideration that arises in this context is the criterion used to measure benefits. The benefits using per-capita-consumption effects are about 5 times the benefits using aggregate-consumption benefits. The use of aggregate-consumption benefits as a criterion causes no particular problem. However, the use of per-capita-consumption benefits to justify massive family planning program efforts needs further examination. There are two issues involved: The distribution of per-capita consumption and the identification of the types of expenditures. The latter issue becomes pertinent even when aggregate consumption effects are used.

It is only under conditions when the benefits flowing from family planning program efforts are distributed equitably, there is a justification for using the criterion of per-capita-consumption effects. There is no evidence to indicate that this has been the case so far. Thus, while the per-capita increase in consumption due to family planning programs will be realized, the benefits are unlikely to be equitably distributed over all income groups unless specific steps are taken towards such a redistribution of increased income. In the absence of such steps, it is questionable if per-capita-consumption benefits can be used.

It has been argued[32] that since a portion of the expenditures involved in the family planning program are transfer payments, they should not be considered as part of costs in the benefit-cost analysis. To examine this contention, we need to identify the measures suggested for enlarging the scope of family planning programms and the related expenditures.

The costs of family planning program expenditures can be analyzed in terms of three components: expenditures that reduce the available consumption, expenditures that distribute the released aggregate consumption and the expenditures that redistribute increased per-capita-consumption.

Most of the direct costs of the family planning program reduce available consumption. Some of the non-direct costs for purposes of education and motivation also fall in this category. A significant portion of the present family planning program efforts are of these two types. It is expected that these costs will rise at a faster rate as the number of births that need to be averted increase. Since our cost estimates were an extrapolation of the past experiences, we have compared these types of costs to the increase in aggregate consumption benefits. These are real costs (opportunity costs), and our analysis has indicated that at the optimal level of operation of family planning programs, this type of expenditure will approximately be 50% of the aggregate consumption effects, thus making it possible to use the other 50% for transfer payments. A portion of the non-direct costs distributes the aggregate consumption released by family planning programs. Many financial incentive schemes[33] that involve payments at the time of birth prevention fall into this category. It is interesting to note that such a proposal made by Sirageldin and Hopkins[34] agrees with the results of our study. They suggest cash payments on an ongoing basis with frequent examinations of women participating in the birth control program. The cost of such a scheme is estimated to be approximately 50% of the benefits. Therefore, these types of measures may be used to distribute the other half of the aggregate benefits.

It may be recalled that the increased per-capita-consumption results due to two factors: increased availability of aggregate-consumption and fewer consumers sharing it. The latter accounts for approximately 80% of the total effect. These benefits can be used to justify the incentive schemes resulting in delayed payments of a large magnitude. Several such proposals have been made such as issue of bonds. A weakness of these proposals is that they do not include explicitly how such a measure would help redistribute the increased consumption due to a smaller population equitably. This study points out why such an equitable redistribution is essential. It should be noted that by year 2001, the magnitude of the amount of consumption to be redistributed is approximately one-third of the total consumption in that year. Also a more detailed analysis of the ways of raising money for these schemes without causing more inequities in the per-capita consumption is required. Further research is needed in this direction.

If per-capita consumption effect is used to justify a massive family planning program measures for redistributing such benefits must be instituted. Unless these are done, the family planning program may not achieve credibility.

IX. Summary

In this paper, the benefit-cost analysis is used to investigate the optimal targets for Indian family planning program. An economic and demographic model similar to that of Coale-Hoover is constructed and validated to measure the benefits of fertility declines. Two types of effects are used to estimate benefits: aggregate-consumption effects and per-capita-consumption effects. The costs of achieving the fertility declines are estimated using equations based upon the past data. The benefits and costs of successive higher declines in fertility are compared to derive optimal targets.

The analysis points out that the benefits and costs are sensitive to interest rates and horizons of analysis. Therefore the optimal targets depend upon the values selected for these parameters. But the most significant factor is the type of effect used to measure benefits. The aggregate-consumption effects are estimated to be only 20% of the per-capita-consumption effects. It is concluded that a decline in general fertility rates from 179 to 120 (approximately 30%) by 1985 is justified based upon aggregate-consumption effects. However, a much higher decline in fertility is indicated if the per-capita-consumption effects are used to measure benefits.

The study, therefore, reveals the interactions among per-capita-consumption distribution, measures suggested for fertility declines, and the financing of these measures.

Footnotes

*A part of this work was performed when the first author was visiting the Indian Institute of Management, Ahmedabad, India, during the summer, 1971.

[1]Coale, A.J., and Hoover, E.M., Population Growth and Economic Development in Low Income Countries - A Case Study of India's Prospects, Princeton University Press, 1958.

[2]Enke, S., "The Economic Aspects of Slowing Population Growth, The Economic Journal, March 1966, Vol. LXXVI, No.301 Enke, S., "Raising Per-Capita Income Through Fewer Births", 68 TMP9, General Electric Company, Tempo, Santa-Barbara, California; Enke, S., "Sensitivity Analysis of the Economic Demographic Model", 69 TMP-52 General Electric Company, Tempo, Santa-Barbara, California.

[3]Simon, J.L., "The Value of Avoided Births to Under-developed Countries", Population Studies, March 1969, Vol. XXIII, No.1, pp.61-68.

[4]Repetto, R., (Ph.D. diss., Harvard University, Cambridge, Mass. 1967).

[5]Simmons, G.B., The Indian Investment in Family Planning, The Population Council, New York, 1971.

[6]For a comprehensive review, see Robinson, W.C., and Horlacher, D.E., "Population Growth and Economic Welfare", Reports on Population/Family Planning, February 1971, No.6

[7]Myrdal, G., An Approach to the Asian Drama, Vintage Books, 1970.

[8]Liebenstein, H., "Pitfalls in Benefit-Cost Analysis of Birth Prevention", Population Studies, July 1969, Vol. XXIII, No.2, pp. 161-171.

[9]Government of India, Mimeo.

[10]See Section III.

[11] We are ignoring the effect of different welfare outlays of the government on the aggregate consumption. This effect is given by $W_t(B) - W_t(A)$. Since welfare outlays are assumed to be proportional to the equivalent consumer population and the consumer population is smaller under GFR path B, we are slightly overestimating the aggregate consumption effect. However, the per-capita-consumption effect remains unaffected.

[12] For a detailed discussion of the arguments leading to this model see Coale-Hoover.

[13] The comparison is limited to 1966 because of the economic disturbances in 1967 and 1968. This period covers the second and third five-year plans and is therefore expected to be representative of the economic situation beyond 1970.

[14] The population is adjusted by assigning children of under 10 years a weight of 0.5, females 10 and older a weight of 0.9, and males 10 and older a weight of 1.0, to arrive at the equivalent consumer population.

[15] Our efforts to directly relate F-outlays to the national income and equivalent consumer population had to be abandoned as national income and equivalent consumer population are collinear during this period.

[16] These relationships can be compared to the relationships used by Coale-Hoover. According to them, $D = F - W_C - W_I = .30Y - 49.27C - .0725Y - (.0725)Y\,(10p)$, for a population increment of $p = .02$, $D = .226Y - 27C$. Thus for the same equivalent consumer population C, our model will predict higher direct developmental outlays.

[17] Some authors have estimated this ratio to be around 2.7. For instance, see, "Estimates of Incremental Capital Output Ratio for the Indian Economy, 1950-51 to 1973-74", Planning Commission, Perspective Planning Division, Sept. 1969, Government of India. Using a higher capital output ratio underestimates the benefits of the fertility declines.

[18] The initial conditions for year 1971 are set as follows:

$Y_0 = 179.55$ Rs. Billions.

The values of L_t and (W_C) expenditures at 5 year intervals for the period 1956 -1971 are given by .398, .392, .385, .38 and 6.42, 7.07, 6.84 and 7.66 Rs. Billions respectively. In equation 1 and 2, the coefficients of C_t are higher than the figures cited earlier because they have been adjusted from 1952 prices to 1961 prices.

[19]The effect of fertility decline is still significant when a correction is made for the age-distribution of the population. Per-equivalent consumer income increase by 180% during the period 1971-2001 for a GFR path 179-80.

[20]Enke, S., and Zind, R., "Effect of Fewer Births on Average Income", Journal of Biosocial Science, January 1969, No.1, pp. 41-56.

[21]Op. Cit.

[22]Op. Cit.

[23]Op. Cit.

[24]Simmons felt the best estimate of the current marginal value of a birth prevented due to a 20 percent to 30 percent reduction in fertility was Rs.7800 or about 14 times India's per-capita income in 1967-1968.

[25]These costs vary considerably. For instance, Enke, S., The Economic Aspect of Slowing Population Growth, gives the following estimates of direct cost:

Method	Cost $	Method	Cost $
Zero Control	0.00	Foam Tablet	12.00
Withdrawal	0.25	Diaphragm	4.50
Rythm	0.50	Pills	90.00
Condom	12.00	Vasectomies	3.00

These estimates may need to be revised.

All of these costs are not borne by the Indian family planning program. For instance, condoms are subsidized by foreign aid.

[26]There is almost unanimous agreement that these costs will rise. It was observed in a recent report on the national family planning program of Korea and Tiawan that, "Both countries have become increasingly aware, that to keep the birth rate going down, they must invest more money than before", Ross, J.A., Dee Woo Han, Keeny, S.M., and Cernada,G., "Korea/Tiawan 1969: Report on the National Family Planning Programs", Studies in Family Planning, June 1970, 1, No.54, 15. The monetary incentive schemes suggested by several persons have costs ranging from Rs.200 to Rs.600. See Ridker, R. G., "Synopsis of a Proposal for a Family Planning Bond", Studies in Family Planning, June 1969, 1, No.43, pp.11-16. Sirageldin, I., and Hopkins, S., "Family Planning Programs: An Economic Approach", Studies in Family Planning, February 1972, Vol. 3, No.2.; Rogers, E.M., "Incentives in the Diffusion of Family Planning Innovations", Studies in Family Planning, December 1971, Vol. 2, No.12.

[27]It has been assumed that a sterilization averts 1.7 births. However, these births are averted on an average over ten years. By assuming that all these births are averted in the same year, we are overestimating the births averted and consequently underestimating costs. This effect is partially offset by ignoring the number of births already averted due to sterilization performed in the previous years.

[28]The direct cost is estimated as Rs. 30 per vasectomy, Rs.11 per IUCD and Rs.8.5 per conventional contraceptive acceptor. A weighted average of these costs gives us the direct cost per acceptor.

[29]This and the earlier fit are subjective and can be questioned. Unfortunately, better base for cost estimation is not available. As noted earlier, costs are expected to rise as the scope of family planning increases. Micro comparison of various experimental studies have been carried out by Mack, Newell B., "The Cost of Control", Mass Communication and Family Planning, Ed. Bogue, Chicago University Press, 1967. He postulates an S-curve relating births averted to the cost. Since we are approximately only in the range where marginal costs are increasing, a quadratic curve fit agrees with the postulates.

30 Another possible assumption is that the sterilization and IUCD acceptors will stabilize at 1.3 million and .5 million level of 1970. The remaining number of births will be averted by acceptors of "conventional contraceptive couple years of protection". This will result in an increase in the acceptors per birth averted.

31 Chakravarthy, P.S., Capital Formation and Economic Development, Rosenstein - Rodan (Ed.), Cambridge, Mass., MIT Press, 1964), pp.66, estimates shadow rate of interest to be between 8% and 12% with a mean of 10%.

32 Pohlman, E., How To Kill Population, The Westminister Press, 1972.

33 See Rogers (Note 26 above) for a typology and the general effect of incentives.

34 Op.Cit.

Table 1 Comparison of actual and predicted national income

1952-53 Prices

Rs Billion

Year I	Actual Y[1] II	Predicted Y using Coale-Hoover model[2] III	Estimated Y - Actual Y III-II
1956	108.000	108.000	0.000
1957	113.359	111.359	-2.000
1958	112.225	114.848	+1.623
1959	120.057	118.475	-2.418
1960	122.221	122.249	+0.028
1961	131.187	126.178	-5.009
1962	134.588	130.157	-4.431
1963	137.061	134.375	-2.786
1964	143.760	138.538	-5.222
1965	154.374	142.955	-11.419
1966	151.489	147.535	-3.954
1967	154.374[p]	152.268	-2.106

1 Source: Economic Survey, Govt. of India, 1970-71

p Plan estimates

2 The population projections are based upon the "Population Projection of India 1957-1976", National Council of Applied Economic Research, New Delhi, India, 1960.

Table 2 A Comparison of actual and predicted values* of D and F outlays

52-53 Prices
Rs. Billions

Year	Estimated F-Outlays	Actual F-Outlays	Estimated D-Outlays	Actual D-Outlays
1954	16.13	13.58	6.82	6.92
1955	16.82	18.31	7.21	8.83
1956	17.54	20.45	7.64	10.50
1957	18.31	22.91	8.09	12.06
1958	19.12	25.88	8.57	12.53
1959	19.20	26.29	8.74	12.61
1960	20.69	27.92	9.18	11.49
1961	21.52	30.93	9.65	13.12
1962	22.40	32.95	10.15	14.04
1963	23.33	38.54	10.68	13.31
1964	24.18	45.15	11.43	18.75
1965	25.08	45.66	11.62	18.57
1966	26.03	49.90	12.13	19.76

Table 3 – Population estimates for year 1986 to 2001.

GFR Path		Birth Rate Per Thousand 1971	1986	Total Population in Year 1986 mil	2001 mil	Equivalent Consumer Population 1986	2001
195–195	Uncontrolled Fertility	41	40	836	1299	682	1059
179–179	Present Rate	38	37	804	1202	661	987
179–160	Very High Fertility	38	34	783	1117	648	927
179–142	High Fertility	37	31	763	1039	637	871
179–120	Medium Fertility	37	27	738	948	622	805
179–100	Low Fertility	37	23	716	867	608	747
179–80	Very Low Fertility	37	19	694	790	595	690

NOTES: 1. The uncontrolled fertility level is assumed to be 195 per thousand and the available evidence indicates that the GFR has declined to 179 per thousand by year 1971.

2. The Registrar General has also made population projections but these projections were made prior to 1971 census and use a higher figure of 561 million as the initial population in 1971. Besides, we need population projections for each year for several GFR paths. Hence, we constructed this model. The projections made by this model and the comparable projections made by the Registrar General agree closely after providing for the initial peopulation correction.

Table 4 - Births averted in millions for various GFR paths

GFR paths/year	1971	1976	1981	1986	1991	1996	2001
179-179	1.9	2.1	2.4	2.7	3.1	3.5	4.0
179-160	2.0	3.1	4.4	5.9	6.6	7.4	8.3
179-142	2.2	4.0	6.4	8.8	9.9	10.9	12.0
179-120	2.3	5.2	8.7	12.4	13.7	14.9	15.9
179-100	2.5	6.2	10.9	15.6	17.1	18.2	19.0
179-80	2.6	7.3	13.1	18.1	20.4	21.3	21.6

Table 5 National Income Projections at 1961 Prices, Rs. Billion

GFR Path \ Year	1971	1976	1981	1991	2001
195-195 Uncontrolled Fertility	187.0	231.8	289.1	457.4	731.4
179-179 Present Rate	187.0	232.0	290.1	463.0	754.2
179-160 Very High Fertility	187.0	232.0	290.3	466.1	768.2
179-142 High Fertility	187.0	232.0	290.7	469.1	781.4
179-120 Medium Fertility	187.0	232.1	291.0	472.8	797.3
179-100 Low Fertility	187.0	232.1	291.3	476.2	811.6
179-80 Very Low Fertility	187.0	232.1	291.6	479.9	825.8

Table 6 National Income Indices Projections, 1971=100

GFR Path \ Year	1971	1976	1981	1991	2001
195-195 Uncontrolled Fertility	100	123	155	244	331
179-179 Present Rate	100	124	155	247	403
179-160 Very High Fertility	100	124	155	249	410
179-142 High Fertility	100	124	155	251	417
179-120 Medium Fertility	100	124	155	252	426
179-100 Low Fertility	100	124	156	255	434
179-80 Very Low Fertility	100	124	156	257	441

Table 7 Per Capita Income Projections at 1961 Prices

GFR Path \ Year	1971	1976	1981	1991	2001
195-195 Uncontrolled Fertility	341	368	400	471	462
179-179 Present Rate	341	374	412	502	628
179-160 Very High Fertility	341	376	418	528	688
179-142 High Fertility	341	378	423	554	752
179-120 Medium Fertility	341	379	430	588	841
179-100 Low Fertility	341	381	437	623	936
179-80 Very Low Fertility	341	382	444	660	1045

Table 8 Per Capita Income Indices Projections

GFR Path \ Year	1971	1976	1981	1991	2001
195-195 Uncontrolled Fertility	100	108	117	138	164
179-179 Present Rate	100	109	120	147	184
179-160 Very High Fertility	100	110	122	154	201
179-142 High Fertility	100	110	124	162	220
179-120 Medium Fertility	100	111	126	172	246
179-100 Low Fertility	100	111	128	182	274
179-80 Very Low Fertility	100	112	130	193	306

Table 9 Aggregate-Consumption-Benefits Per Birth Averted at 10% Discount Rate, Rs.1961 Prices

GFR Path	Average Benefit over Uncontrolled Fertility(195-195) Per Birth Averted for a Horizon of 10	20	30	40	50 Years
179-179	70	290	600	960	1300
179-160	60	245	530	865	1200
179-142	57	225	500	830	1170
179-120	54	210	485	820	1160
179-100	52	205	475	810	1160
179-80	50	200	470	810	1160

Table 10 Per-Capita-Consumption-Benefit Per Birth Averted at 10% Discount Rate, Rs.1961 Prices

GFR Path	Average Benefit over Uncontrolled Fertility Path (195-195) Per Birth Averted for a Horizon of 10	20	30	40	50 Years
179-179	710	1660	2700	3680	4560
179-160	650	1510	2500	3560	4490
179-142	620	1450	2470	3520	4470
179-120	600	1400	2430	3500	4480
179-100	580	1380	2420	3500	4490
179-80	570	1370	2420	3520	4500

Table 11 Aggregate-Consumption-Benefit Per Birth Averted at 20% Discount Rate, Rs. 1961 Prices

GFR Path	Average Benefit over Uncontrolled Fertility Rate (195-195) Per Birth Averted for a Horison of					
	10	20	30	40	50	Years
179-179	55	160	230	270	290	
179-160	50	140	220	260	280	
179-142	45	135	215	260	280	
179-120	40	130	210	260	270	
179-100	40	130	210	260	270	
179-80	40	130	210	260	270	

Table 12 Per-Capita-Consumption-Benefit Per Birth Averted at 20% Discount Rate. Rs. 1961 Prices

GFR Path	Average Benefit over Uncontrolled Fertility Rate (195-195) Per Birth Averted for a Horizon of					
	10	20	30	40	50	Years
179-179	580	1050	1300	1420	1460	
179-160	540	1000	1300	1430	1480	
179-142	525	1000	1290	1440	1500	
179-120	510	970	1290	1440	1500	
179-100	500	970	1290	1440	1500	

Table 13

Cost Performance of Family Planning Program

Year	Expenditure Million		Acceptors of			Births Averted	Cost/Birth Averted
	Current Prices	1961 Prices	Ster-ilization	IUCD	Con-ven-tion-al Contra	Million	Rs.
1961	9.8	9.8	0.80	0	0.16	0.160	61.25
1962	13.9	13.65	0.16	0	0.24	0.308	44.31
1963	27.7	26.50	0.20	0	0.25	0.378	70.10
1964	21.7	18.80	0.22	0	0.27	0.415	45.30
1965	65.2	51.70	0.32	0	0.42	0.607	85.17
1966	120.0	88.00	0.70	0.68	0.62	1.760	50.00
1967	133.8	86.00	0.90	0.92	0.50	2.250	38.22
1968	265.3	158.00	1.84	0.80	0.40	3.746	42.17
1969	387.0	230.00	1.74	0.44	1.00	3.416	67.33
1970	520.00	300.00	1.48	0.48	1.52	3.08	97.40

NOTES: 1 Sterilization = 1.7 births prevented over 10 years
1 IUCD = 0.7 births prevented over 5 years
1 conventional contraceptive couple year of protection = 0.15 births averted

Table 14 Data on Number of Acceptors and Nondirect Costs of Family Planning Program

Year	Acceptors of			Total Acceptors	Direct Cost Rs. Million	Nondirect Cost Rs. Million
	Sterilization	IUCD	Conventional			
1961	0.08	0	0.16	.24	4.80	5.00
1962	0.16	0	0.24	.40	8.00	5.65
1963	0.20	0	0.25	.45	9.00	17.50
1964	0.22	0	0.27	.49	9.80	9.00
1965	0.32	0	0.42	.74	14.80	36.90
1966	0.70	0.68	0.62	2.00	40.00	48.00
1967	0.90	0.92	0.50	2.32	46.40	39.60
1968	1.84	0.80	0.40	3.04	60.78	97.22
1969	1.74	0.44	1.00	3.18	63.60	166.40
1970	1.48	0.48	1.52	3.48	68.60	231.40

Table 15 Annual Costs of GFR Paths using Cost Pattern 1.

Rs. Billion,
1970 prices

GFR Path \ Year	1971	1976	1981	1986	1991	1996	2001
179-179	0.13	0.17	0.23	0.30	0.42	0.55	0.75
179-160	0.15	0.42	0.93	1.80	2.30	2.90	3.70
179-142	0.19	0.75	2.10	4.20	5.40	6.60	8.10
179-120	0.21	1.30	4.10	8.70	10.70	12.80	14.60
179-100	0.25	2.00	6.60	14.00	17.00	19.00	21.00
179-80	0.28	2.80	9.80	19.00	24.00	26.00	27.00

Table 16 Benefits and Costs of GFR Paths, Rs. Billion

Aggregate Consumption Benefits, Cost Procedure 1, Discount Rate 10%

GFR Path	30 Year Horizon				40 Year Horizon			
	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost
179-179	13.2	1.6	13.2	1.6	22.4	1.8	22.4	1.8
179-160	19.5	4.6	6.3	3.0	34.8	5.3	12.4	3.5
179-142	25.5	8.9	6.0	4.3	46.3	10.3	11.5	5.0
179-120	32.8	16.0	7.3	7.1	60.3	18.4	14.0	8.1
179-100	39.4	24.2	6.6	8.2	72.9	27.4	12.6	9.0
179-80	45.9	33.8	6.5	9.6	85.4	37.7	12.5	10.3

Table 17 Benefits and Costs of GFR Paths, Rs. Billion

Aggregate Consumption Benefit and Costs of GFR Paths, Rs. Billion

GFR Path	30 Year Horizon				40 Year Horizon			
	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost
179-179	2.4	0.7	2.4	0.7	2.9	0.7	2.9	0.7
179-160	3.4	1.6	1.0	0.9	4.2	1.6	1.3	0.9
179-142	4.4	2.8	1.0	1.2	5.4	2.8	1.2	1.2
179-120	5.5	4.8	1.1	2.0	6.8	4.9	1.4	2.1
179-100	6.6	7.0	1.1	2.2	8.1	7.2	1.3	2.3
179-80	7.6	9.7	1.0	2.7	9.5	9.9	1.4	2.7

Table 18 Benefit and Cost of GFR Paths, Rs.Billion

GFR Path	Aggregate Consumption Benefits, Cost Procedure 2, Discount Rate 10%							
	30 Year Horizon				40 Year Horizon			
	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost
179-179	13.3	1.2	13.3	1.2	22.4	1.4	22.4	1.4
179-160	19.6	4.8	6.3	3.6	30.7	5.8	12.3	4.4
179-142	25.5	10.6	5.9	5.8	46.3	12.5	11.6	6.7
179-120	32.8	20.5	7.3	9.9	60.3	23.8	14.0	11.3
179-100	39.4	32.0	6.6	11.5	72.9	36.6	12.6	12.8
179-80	45.9	45.8	6.5	13.8	85.4	51.3	12.5	14.7

Table 19 Benefit and Cost of GFR Path, Rs. Billion

GFR Path	Aggregate Consumption Benefits, Cost Procedure 2, Discount Rate 20%							
	30 Year Horizon				40 Year Horizon			
	Total	Discounted	Marginal	Discounted	Total	Discounted	Marginal	Discounted
179-179	2.4	0.5	2.4	0.5	2.9	0.5	2.9	0.5
179-160	3.4	1.5	1.0	1.0	4.1	1.6	1.2	1.1
179-142	4.4	3.1	1.0	1.6	5.4	3.1	1.3	1.5
179-120	5.5	5.7	1.1	2.6	6.8	5.9	1.4	2.8
179-100	6.6	8.9	1.1	3.2	8.1	9.1	1.3	3.2
179-80	7.6	12.6	1.0	3.7	9.5	12.9	1.4	3.8

Table 20 Benefits and Costs of GFR Paths, Rs. Billion

Per-Capita Consumption Benefits, Cost Procedure 1, Discount Rate 10%

GFR Path	30 Year Horizon				40 Year Horizon			
	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost
179-179	58.8	1.6	58.8	1.6	86.3	1.8	86.3	1.8
179-160	93.4	4.6	34.6	3.0	142.8	5.3	56.5	3.5
179-142	125.9	8.9	32.5	4.3	195.3	10.3	52.5	5.0
179-120	165.3	16.0	39.4	7.1	258.3	18.4	63.0	8.1
179-100	200.7	24.2	35.4	8.2	314.4	27.4	56.1	9.0
179-80	235.8	33.7	35.1	9.5	369.5	37.7	45.0	10.3

Table 21 Benefits and Costs of GFR Paths, Rs. Billion

Per-Capita Consumption Benefits, Cost Procedure 1, Discount Rate 20%

GFR Path	30 Year Horizon				40 Year Horizon			
	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost
179-179	13.8	0.7	13.8	0.7	15.1	0.7	15.1	0.7
179-160	20.3	1.6	6.5	0.9	22.6	1.6	7.5	0.9
179-142	26.4	2.8	6.1	1.2	29.7	2.8	7.1	1.2
179-120	33.9	4.7	7.5	2.0	38.3	4.9	8.6	2.0
179-100	40.6	7.0	6.7	1.3	46.0	7.2	7.7	2.3
179-80	47.3	9.7	6.7	2.7	53.6	9.9	7.6	2.7

Table 22 Benefits and Costs of GFR Path, Rs. Billion

Per-Capita Consumption Benefits, Cost Procedure 2, Discount Rate 10%

GFR Path	30 Year Horizon				40 Year Horizon			
	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost
179-179	58.8	1.2	58.8	1.2	86.3	1.4	86.3	1.4
179-160	93.4	4.8	34.6	3.6	142.8	5.8	56.5	4.3
179-142	125.9	10.6	32.5	5.8	195.3	12.5	52.5	6.7
179-120	165.3	20.5	39.4	9.9	258.3	23.8	63.0	11.3
179-100	200.7	32.1	35.4	11.6	314.4	36.6	56.1	12.8
179-80	235.8	45.7	35.1	13.6	369.5	51.3	55.1	14.7

Table 23 Benefits and Costs of GFR Paths, Rs. Bil ion

Per-Capita Consumption Benefits, Cost Procedure 2, Discount Rate 20%

GFR Path	30 Year Horizon				40 Year Horizon			
	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost	Total Benefit	Discounted Cost	Marginal Benefit	Discounted Cost
179-179	13.8	0.5	13.8	0.5	15.1	0.5	15.1	0.5
179-160	20.3	1.5	6.5	1.0	22.6	1.6	7.5	1.1
179-142	26.4	3.1	6.1	1.6	29.7	3.2	7.9	1.6
179-120	33.9	5.[illegible]	7.5	2.6	38.3	6.0	8.6	2.8
179-100	40.6	8.9	6.7	3.2	46.0	9.1	7.7	3.1
179-80	47.3	12.6	6.7	3.7	53.6	12.9	7.6	3.8

Aggregate Consumption Effect				Per-Capita Consumption Effect			
Horizon 30 Yrs		Horizon 40 Yrs.		Horizon 30 Yrs.		Horizon 40 Yrs.	
Cost Procedure I	Cost Procedure II	Cost Procedure I	Cost Procedure II	Cost Procedure I	Cost Procedure II	Cost Procedure I	Cost Procedure II
179-120	179-142	179-60	179-60	Massive Reduction	Massive Reduction	Massive Reduction	Massive Reduction
179-160	179-160	179-142	179-150	Massive Reduction	Massive Reduction	Massive Reduction	Massive Reduction

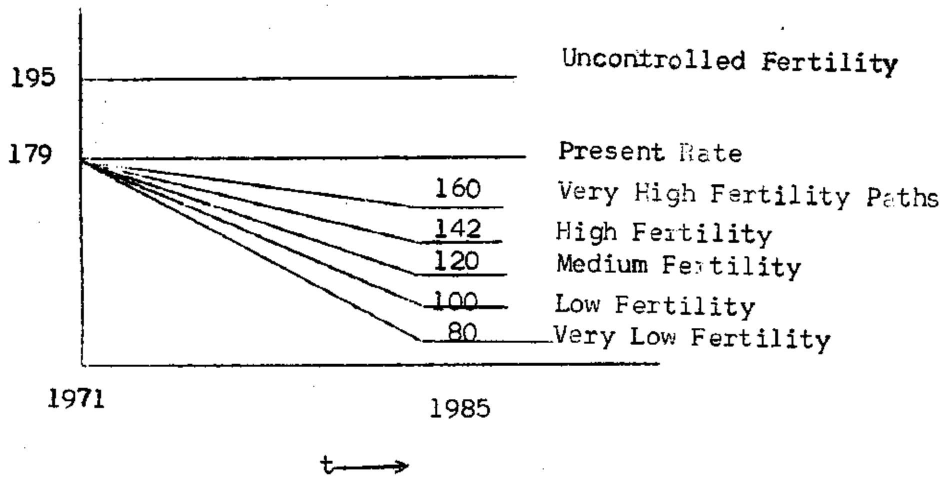


Figure 1 Various GFR Paths

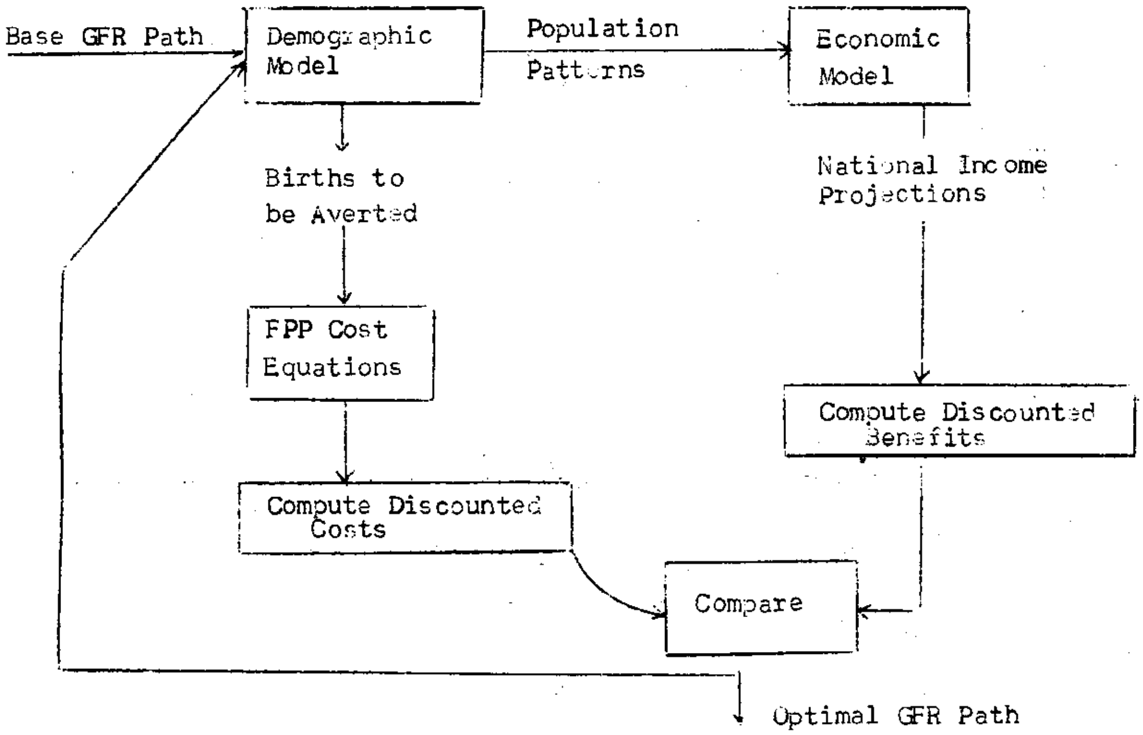


Figure 2 Schematic Representation of Analysis Procedure

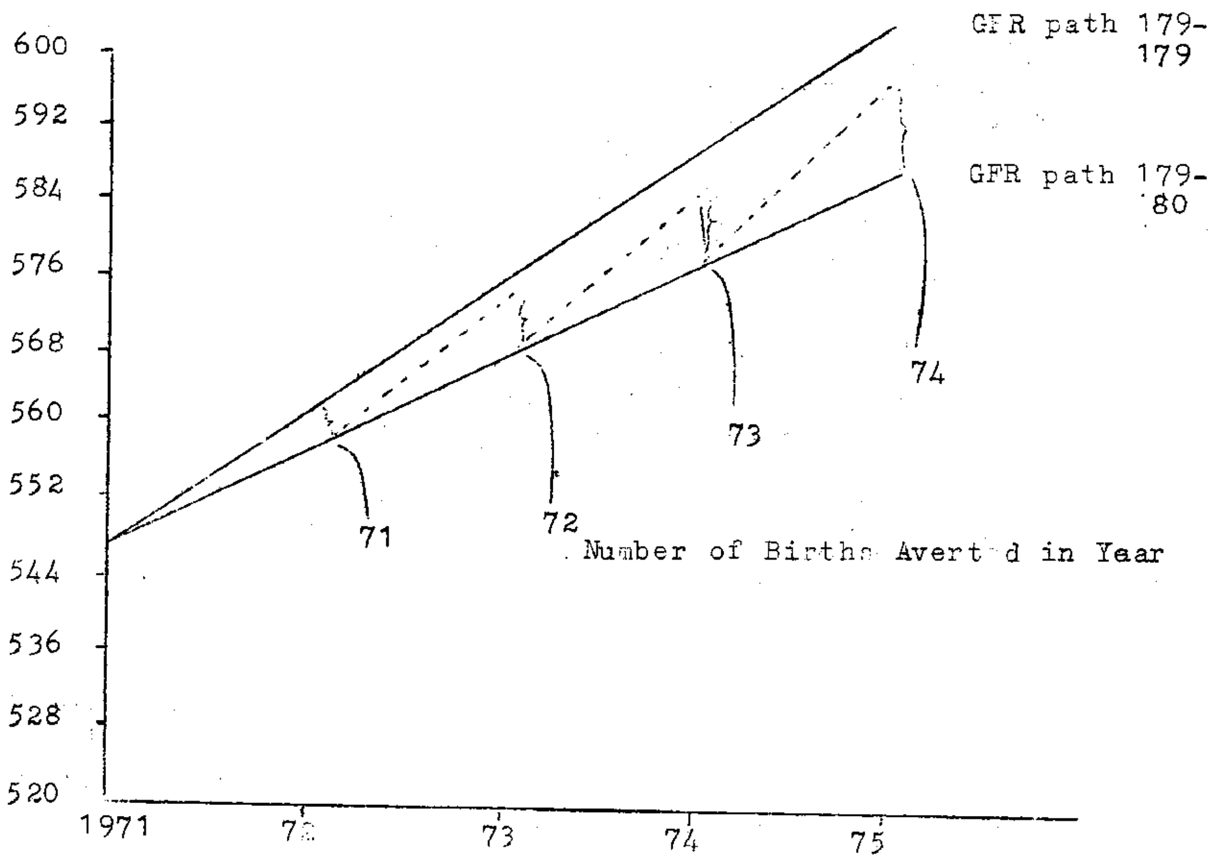
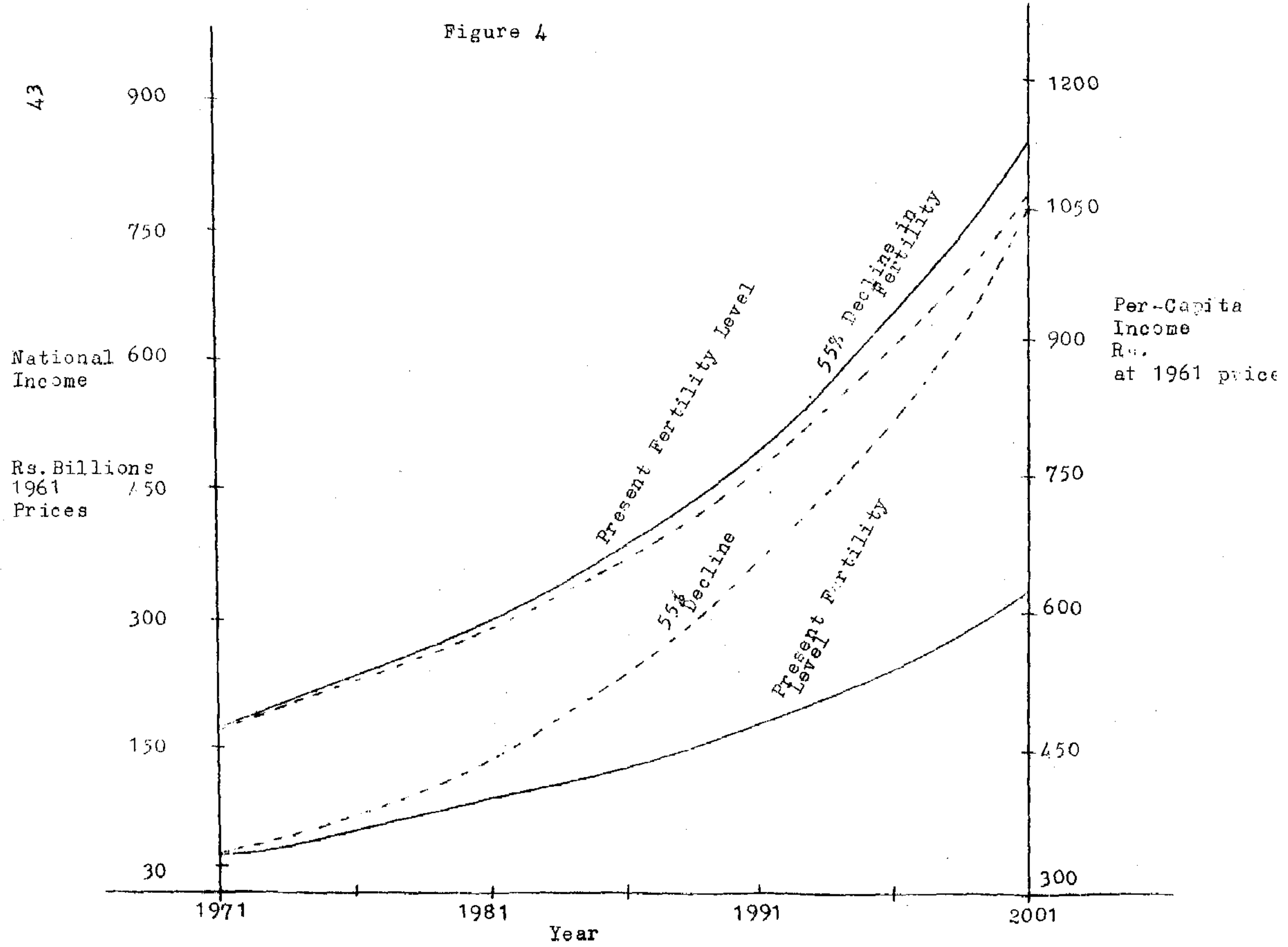

GFR path 179-179
GFR path 179-80
600
592
584
576
568
560
552
544
536
528
520
71
72
73
74
Number of Births Avert d in Year
1971
73
74
75

Figure 3

Figure 4


National Income
Rs. Billions 1961 Prices
900
750
600
450
300
150
30
1971
1981
1991
2001
Year
Per-Capita Income Rs. at 1961 price
1200
1050
900
750
600
450
300
Present Fertility Level
55% Decline in Fertility
55% Decline
Present Fertility Level

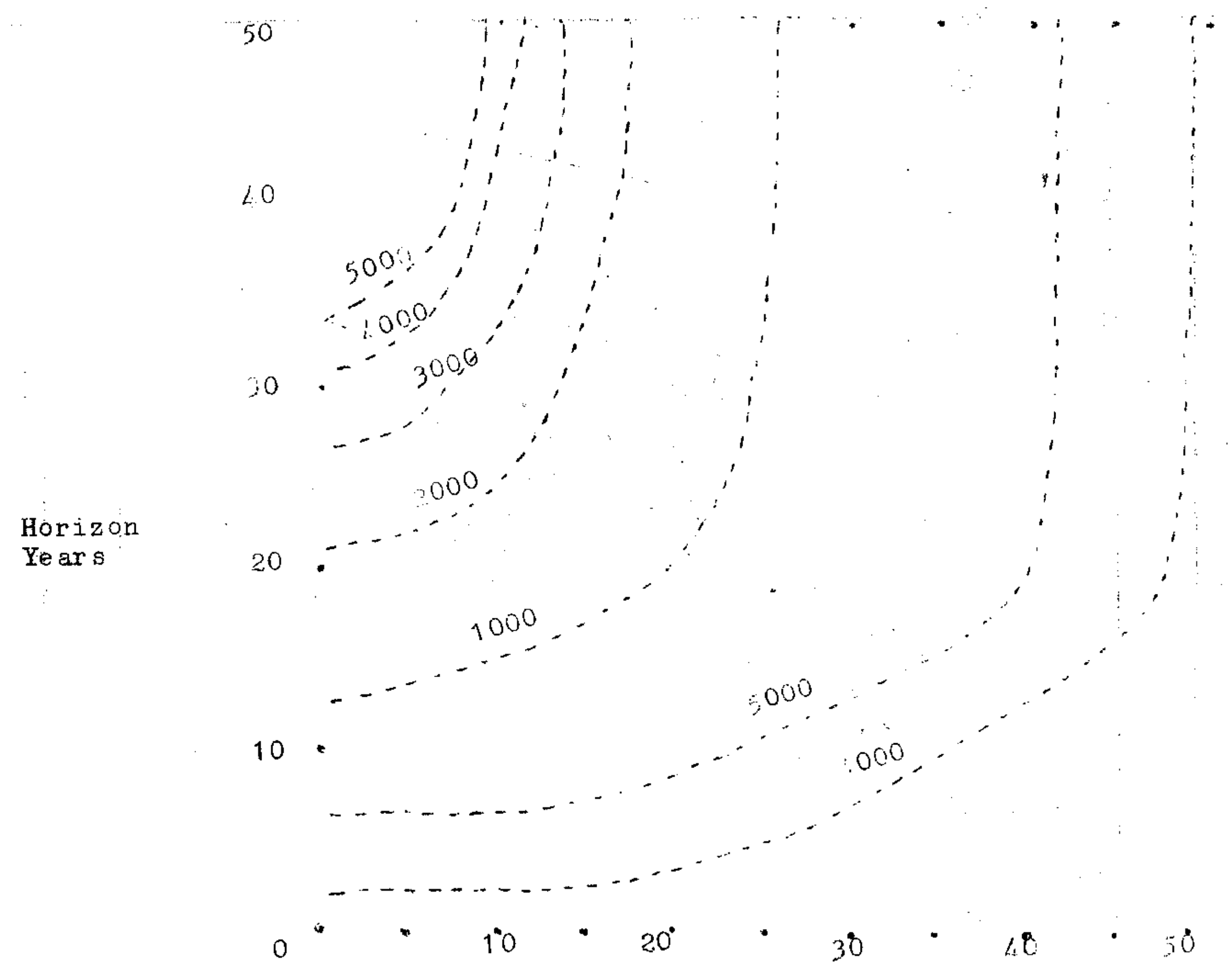


Figure 5 Contours of Per-Capita Interest Rate % Benefits per Birth Averted at 1961 Prices for GFR Path 179-142

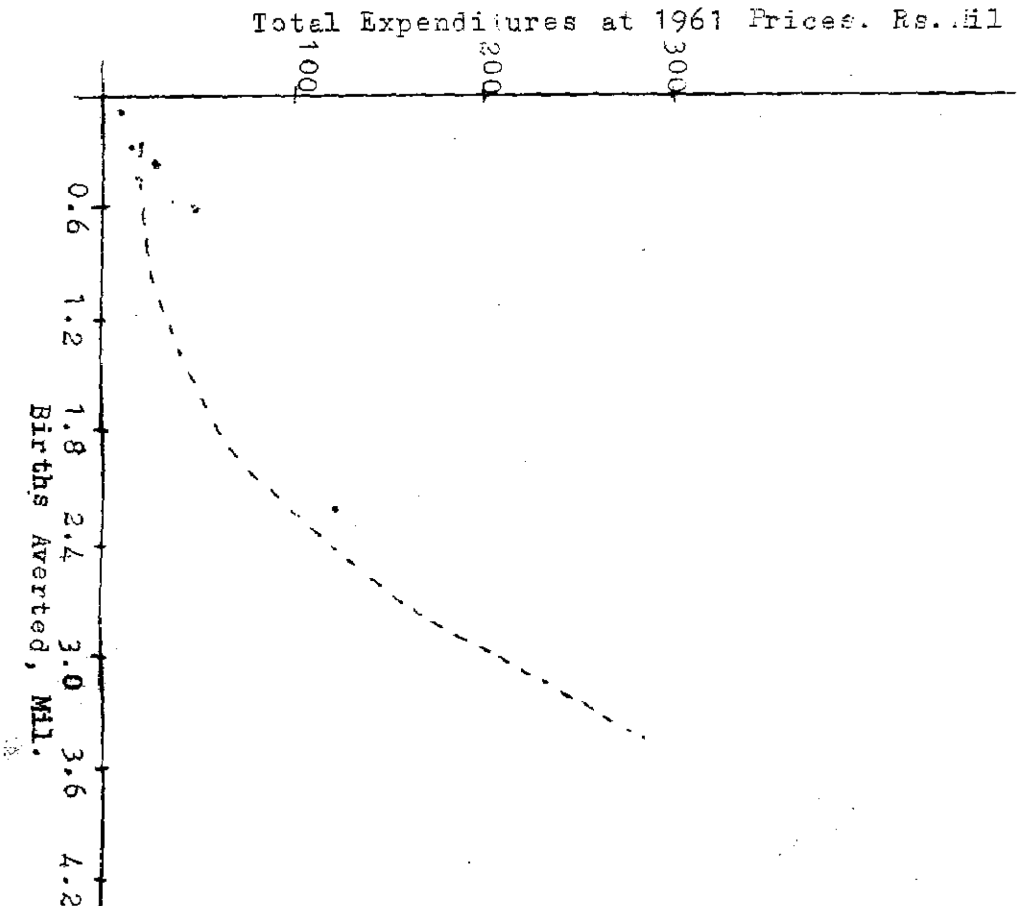


Figure 6

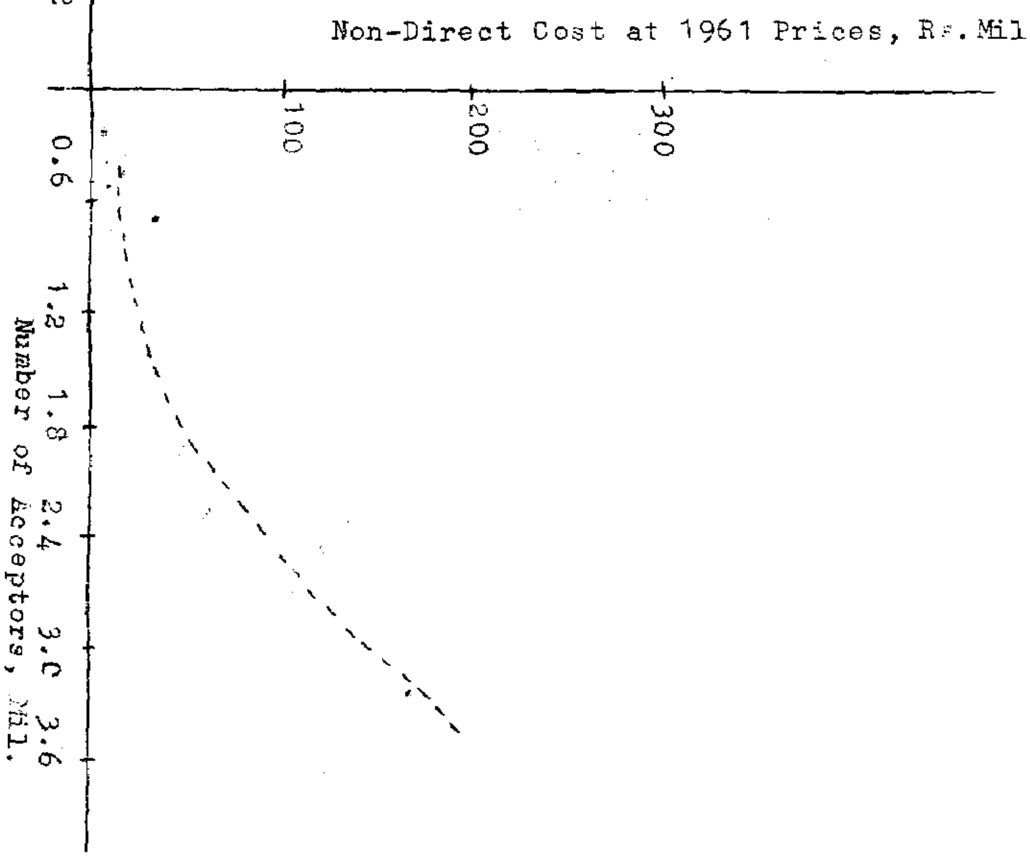


Figure 7

Figure 8 Comparison of Two Cost Procedures