Measuring the Effects of Population Control on Economic Development: A Case Study of Pakistan

by

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OBJECT OF THIS STUDY

The terms of reference of this report are to indicate the "impact of alternative foreseeable population trends upon economic development prospects and assistance needs of less developed countries". In it we consider the effects of varying the rate of natural increase of population on a "less developed" country's efforts to improve its general economic well being. Pakistan, for the period 1965-85, is the specific case examined.

In the context of Pakistan's development constraints and plans, we have attempted to measure what difference it would make in prospects for progress if mortality and/or fertility rates were changed.

The demographic contingencies to be considered include *i*) a progressive reduction of mortality through improved environmental, medical, and nutritional conditions; and *ii*) a progressive reduction in fertility through government-sponsored family-planning efforts.

There are obviously many aspects of the development process that depend upon how population is growing. We have focussed on evaluating the population impact in terms of selected characteristics of the national economy including aggregate and per capita income, savings, and consumption, the composition of output and employment by major productive sectors, and the degree of dependence on import of capital.

Such evaluations are basic to judgments about the desirability of programmes affecting fertility or mortality and the degree of priority to be attached to them at various stages of development. They are also useful as a step toward

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foreseeing assistance needs in such areas as investment funds, housing and public services, and educational facilities. At the conclusion of this paper, we suggest some lines on which further analysis might fruitfully be pursued.

OUTLINE OF PROCEDURE

Our task is not to appraise in any absolute sense the prospects for economic development in Pakistan, but merely to give an indication of the extent to which the course of development might be *altered by shifts in fertility and mortality rates* during the next two decades. We have drawn upon the work of the planners and economic experts for their data and estimates regarding the present and future national economy, and have constructed a "growth model" consistent with that information and what appears to be consensus regarding the main economic determinants of growth over the next twenty years. What has been lacking in previous analysis, and what we have tried to supply, is a role for the demographic factor in such an analytical scheme.

The Population Assumptions

Our projections model has been designed to work with alternative population projections such as the four recently prepared by the United States Bureau of the Census [1].

Since these four "demographic cases" will be referred to throughout this report, it is convenient to refer to them by abbreviation:

Cf-Dm: Constant fertility and declining mortality
Cf-Cm: Both fertility and mortality constant
Df-Dm: Both fertility and mortality declining
Df-Cm: Declining fertility and constant mortality

We shall use the abbreviated designations henceforth. The cases are arranged above in descending order of rate of net population growth—Cf-Dm gives the highest projected population trend rising to 240.7 million in 1985, and Df-Cm gives the lowest trend with 201.2 million in 1985.

Our projections are made in sets of four, reflecting these four different demographic cases. For each *set* of projections a different combination of non-demographic assumptions (*e.g.*, regarding the propensity to save) is adopted. Within any set, comparisons between cases serve to evaluate the impacts of fertility and mortality changes separately or in combination. For convenience, we have related each of the other three cases to the *Cf-Dm* (highest population growth) case. Thus,

Cf-Cm vs. Cf-Dm shows the impact of mortality.
Df-Dm vs. Cf-Dm shows the impact of fertility.
Df-Cm vs. Cf-Dm shows the impact of both fertility and mortality.

The projected rate of economic progress (under any specified set of economic assumptions regarding parameters like the propensity to save) is inversely related to the pace of population growth in our analysis. Thus, Cf-Dm (the maximum population growth case which is used as the standard for comparisons) shows the lowest economic progress of the four in each set of projections. Cf-Cm comes out somewhat better; Df-Dm better still; and the rather unrealistic case Df-Cm gives the highest rates of progress of the four.

Key Economic Factors

In order to analyse the effect of different demographic trends on the growth of the Pakistani economy, our scheme must take account of at least those main determinants of economic growth that are themselves sensitive to demographic factors. This last limitation is important. In determining the growth outlook for a country like Pakistan, it may well be that the international political and military situation, or new technological breakthroughs or resources discovered, will be more crucial than the amount of domestic and foreign funds that can be channelled into development. But if these former factors are essentially unaffected by the Pakistani rate of population growth while the supply of funds is significantly affected by population growth, we are justified in ignoring them in the present analysis of the differential growth effect of population *per se*.

From our necessarily sketchy examination of recent analyses of Pakistani development prospects, we conclude *i*) that the supply of investment funds should indeed be included as a key factor in our procedure; *ii*) that a substantial part of those funds will have to come from abroad; *iii*) that the generation of domestic funds for investment will depend on the degree to which per capita income rises; and *iv*) that the extent to which investment and development resources can be allocated between uses with different impacts on productivity will depend both on income levels and on the numbers of additional people to be provided for.

It is not clear that there is any very direct link between population growth and the availability of capital from abroad that needs to be incorporated in our simplified model, though indirect links certainly will exist. Our procedure handles capital import ("external resources") in two ways, as will be described fully later:

a) Assuming a specified trend of external resources (such as that recently envisioned in the Pakistan Perspective Plan), uniform for all projections, and then working out the different trends of income growth attainable under various demographic and economic assumptions.

b) Assuming for all projections the attainment of some specified growth target, and then working out the external resources that would be required to attain that target under the various demographic and economic assumptions.

The emphasis which the consensus seems to place on capital as the leading growth factor implies that natural resources and labour inputs are less decisive "handles" for determining growth. From the standpoint of our problem, we feel justified in ignoring both on the grounds that neither will depend substantially, in the period under consideration, on the fertility and mortality changes envisioned. In this connection it should be noted that fertility changes (much more important than mortality in affecting the growth and structure of the population over the next twenty years) have no direct effect upon the labour force for ten to fifteen years, and that in consequence the assumed slowly widening gap between alternative projected fertility rates could hardly have a significant effect on the productive labour supply before the very end of the period under consideration here. Moreover, the consensus seems to be that, for most if not all of this period, labour should be regarded as a redundant factor in quantitative terms.

Qualitatively, of course, in terms of skills and productivity, labour input is indeed crucial to Pakistan's growth. But the rate at which productivity can be raised depends on population growth only indirectly, via effects *i*) on the level of individual income, and *ii*) on the supply of investment and other development funds and the extent to which these can be channelled into uses that boost productivity (such as better training or better capital equipment) as against merely providing for additional consumers or workers at current levels of welfare or equipment.

Consequently, our procedure does not introduce manpower input as a determinant of output. It does, however, make some allowance for the indirect effects just mentioned; and also, generates projections of employment in various sectors of the economy which should be useful in any further manpower utilization studies.

Our Economic Growth Projections

With the above considerations in mind regarding the selection of relevant variables, we constructed a computer programme for projections over the period 1965-85, using *i*) the four alternative population series projected by the United States Bureau of the Census [1], *ii*) the most recent available estimates for initial (fiscal 1965) data on income, savings, investment, *etc.*, and *iii*) indications from recent documents on the Pakistan Perspective Plan as to reasonable "consensus" values for such variables as the marginal savings ratio, the output/capital ratio, the availability of external resources at various dates through the period, and the relation of sector growth to overall national growth.

Eight sets of four projections each were calculated, running by 2.5-year intervals from 1965 through 1985 and showing GNP, savings, consumption, and sector breakdowns of output and nonagricultural employment to 1985.

The first step was to translate each of the four population projections into "equivalent adult consumers" by weighting children under 10 years at 0.5 and women of 10 years and older at 0.9. Projected GNP and other magnitudes are shown in per capita and per consumer terms as well as in aggregates.

Each set of four projections represents the four demographic cases (Cf-Dm, Cf-Cm, Df-Dm, and Df-Cm) already identified. Each set of projections involves a different selection of assumptions regarding such parameters as the marginal savings ratio, as will be described specifically later.

In addition, sixteen more sets of four projections each were constructed on an alternative basis (following a suggestion from Professors Robert Dorfman and Alfred Conrad of the Harvard University Pakistan Group) under which growth of the agricultural sector is viewed as the primary determinant of total growth.

The Appendix describes the construction and operation of the projections model in further detail.

WHAT THE PROJECTIONS SHOW

The 96 different 1965-1985 projections calculated for this report represent a sizeable mass of numbers. In the present report only highlights will be given, focussing on the middle and end of the twenty-year period and on aggregate rather than sector-by-sector results.

Demographic Impacts

Table I shows the levels of per consumer GNP and per consumer consumption (GNP minus saving) in 1985 in eight sets of four projections each. (For comparison, the initial 1965 values of these two variables were Rs. 464 and Rs. 421 respectively.) These projections all assume the same time series of external resources use, which is derived from a recent version of the Pakistan Perspective Plan and runs as follows:

Fiscal year	*Crores per annum*
1965	650
1970	610
1975	390
1980	240
1985	110

Reading across the rows of Table I, we see that the level reached in 1985 is in all cases strongly affected by the choice of populaton trends. The mortality-reduction impact is of the order of 5 per cent (that is, per consumer income or consumption in 1985 is about 5 per cent lower if mortality declines than if it does not, *ceteris paribus*). The gain from reduced fertility is much larger—of the order of 16 per cent. Comparing the various rows of the table, we see that quite

similar differentials among demographic cases appear under the various combinations of parametric assumptions that have been introduced to test the stability of the results. Some more specific attention will be given later to this question of sensitivity to the economic parameters.

In no case, however, should any significance be attached to vertical comparisons among the figures in any one column of the table. Our analysis is designed to measure only the differential effects of population trends, and (as described fully in the Appendix) procedural adjustments have been made which partly cancel out the impact of changes in an economic parameter under any given assumption about population growth.

TABLE I

COMPARISON OF 32 PROJECTIONS OF GNP PER CONSUMER AND CONSUMPTION PER CONSUMER IN 1985

(all figures in rupees per annum)

Assumptions	GNP per consumer				Consumption per consumer			
	Cf-Dm	Cf-Cm	Df-Dm	Df-Cm	Cf-Dm	Cf-Cm	Df-Dm	Df-Cm
No autonomous GNP growth								
Investment drain factor 0.10								
Marginal savings ratio 0.36	883	939	1,038	1,095	689	725	788	825
Marginal savings ratio 0.20	685	721	785	822	598	627	678	707
Investment. drain factor 0.25								
Marginal savings ratio 0.36	788	844	946	1,005	629	665	729	767
Marginal savings ratio 0.20	625	662	728	768	550	580	632	662
2% annual autonomous GNP growth								
Investment drain factor 0.10								
Marginal savings ratio 0.36	909	960	1,051	1,104	706	739	797	831
Marginal savings ratio 0.20	754	791	857	895	653	683	735	766
Investment drain factor 0.25								
Marginal savings ratio 0.36	842	894	986	1,041	663	696	755	790
Marginal savings ratio 0.20	706	744	811	850	614	645	699	730

Our "investment drain factor" does *not* represent the fraction of total investment that is assumed to have no effect upon the next increment to gross national product. As described more fully in the Appendix, the "no-growth" component of investment funds is calculated as the product of (1) the investment drain factor cimes (2) the level of per consumer GNP times (3) the next 2.5 years' increment to number of consumer. As a rough guide to the interpretation of the numbers, it may be useful to know that generally in our projections an "investment drain factor" of 0.10 implies a drain of 3 to 4 per cent of total investment funds and a factor of 0.25 implies a drain of 8 to 10 per cent of such funds—the exact relationship of course varies among projections and among time periods.

Table II measures the economic effect of alternative population trends in another way. Within each set of four projections, the growth trend of per consumer GNP under the "least favourable" demographic case (Cf-Dm) is taken as the "target" to be matched under each of the other three demographic cases[1].

TABLE II

Comparison of Annual External Resources Requirements in 1976 and in 1982/83 under Alternative Fertility-Mortality Conditions in order to Match Growth of Per Consumer GNP with the Constant Fertility-Declining Mortality Case

(all figures in crores per annum)

Assumptions	1975				1982/83			
	Cf-Dm	Cf-Cm	Df-Dm	Df-Cm	Cf-Dm	Cf-Cm	Df-Dm	Df-Cm
No, autonomous GNP growth								
Investment drain factor 0·10								
Marginal savings ratio 0.36	390	311	192	127	175	—11	—205	—347
Marginal savings ratio 0.20	390	318	209	150	175	29	—124	—236
Investment drain factor 0,25								
Marginal savings ratio 0.36	390	308	183	116	175	—9	—202	—344
Marginal savings ratio 0.20	390	314	199	137	175	26	—130	—244
2% annual autonomous GNP growth								
Investment drain factor 0.10								
Marginal savings ratio 0.36	390	287	132	47	175	—75	—334	—526
Marginal savings ratio 0.20	390	293	149	70	175	—34	—251	—411
Investment drain factor 0.25								
Marginal savings ratio 0.36	390	283	122	35	175	—75	—336	—527
Marginal savings ratio 0.20	390	289	139	56	175	—37	—258	—421

The required external resources (per annum levels at the middle and end[2] of the projections period) are then calculated for each case. Thus in Table II the costs and benefits of mortality and fertility reduction are evaluated in terms of reduced capital import. It may be noted that in every one of the eight sets of cases, the external-resources requirement actually becomes negative by 1982/83

[1] Matching of per consumer income levels also implies (within a set of projections involving the same assumed marginal savings rate) matching of per consumer consumption and of per consumer saving.

[2] The latest date shown is "1982/83" because our growth projections run only to 1985 and the growth during the last 2.5 years of that period is assumed dependent on external resources and saving levels at the beginning of that last 2.5-year interval.

if fertility is reduced (assuming that the same progress is made in raising per consumer income as could be made under Cf-Dm with continued external resources, still running at an annual rate of 175 crores in the Sixth Plan period).

How Much Are the Demographic Impacts Influenced by the Choice of Economic Parameters?

Table III is designed primarily to test the sensitivity of the indicated population impacts to alterations in three economic parameters. There is a substantial

TABLE III

SENSITIVITY OF POPULATION-GROWTH IMPACTS TO CHANGES IN ASSUMED ECONOMIC PARAMETERS

(evaluated in terms of 1985 figures)

Initial set of assumptions, varied as specified in stubs of table:

Marginal savings ratio	0.36
Investment drain factor	0.10
Autonomous GNP growth	0.00

	1985 Pop.	1985 Consumers	1985 Aggregate (*crores*)		1985 per consumer *rupees*			External resources to match Cf-Dm growth (1982/83) in per consumer GNP
	(*millions*)		GNP	Saving	GNP	Consumption	Saving	(*crores*)
Demographic case								
Cf-Dm	241	189	16,668	3,659	883	689	194	175
Cf-Cm	229	181	16,996	3,872	939	725	214	—11
Df-Dm	211	169	17,560	4,222	1,037	788	250	—205
Df-Cm	201	163	17,850	4,404	1,095	825	270	—347
Ratio to Cf-Dm case								(Absolute difference from Cf-Dm case)
Cf-Cm	.950	.957	1.019	1.058	1.063	1.052	1.103	—186
Df-Dm	.875	.894	1.053	1.153	1.175	1.143	1.288	—380
Df-Cm	.834	.862	1.070	1.203	1.240	1.197	1.391	—522
Changes in above ratios								(Changes in differentials) (*crores*)
— if marginal savings ratio reduced to 20%								
Cf-Cm			—.010	—.020	—.010	—.003	—.020	+40
Df-Dm			—.026	—.052	—.029	—.010	—.059	+81
Df-Cm			—.035	—.069	—.040	—.014	—.078	+111
— if investment drain factor raised to 25%								
Cf-Cm			+.008	+.022	+.008	+.005	+.024	+ 2
Df-Dm			+.022	+.061	+.025	+.017	+.067	+ 3
Df-Cm			+.030	+.081	+.034	+.023	+.096	+ 2
— if autonomous GNP growth is 2%								
Cf-Cm			—.006	—.012	—.006	—.004	—.012	—64
Df-Dm			—.016	—.030	—.018	—.014	—.036	—129
Df-Cm			—.021	—.041	—.025	—.020	—.045	—179

range of uncertainty about the way in which savings will, in fact, respond to higher levels of individual income, and about the weight that ought to be attached to what we have called the "investment drain". Moreover, we might be biasing our results by attributing all growth effects to investment if in reality some growth has arisen and will arise independently of investment, through technological improvements in capital goods, qualitative improvement in manpower, or shifts in the production function. As more fully justified in the Appendix, we attempt to recognize this last consideration by letting some GNP growth be "autonomous" in half of our projections (with the assumed growth effect of investment compensatingly reduced).

The question faced in Table III is whether the adoption of different assumptions under any of the above heads will greatly alter the essential conclusion about the growth impact of fertility and mortality differentials.

In Table III, we first take one initial set of projections and put the (1958) results all in terms of ratios to those of the Cf-Dm case. To illustrate: per consumer consumption in 1985 is 14.3 per cent higher under Df-Dm then it is under Cf-Dm in this initial set of projections.

Then we change each of the economic parameters and see how much that affects the various ratios. For example, the 14.3 per cent fertility-reduction impact just cited would be lowered by a percentage point (*i.e.*, to 13.3 per cent) if we assumed a marginal savings ratio of 0.20 instead of 0.36 and left everything else the same. If we raise the investment drain factor from 0.10 to 0.25, this fertility-reduction impact would rise to 16.0 per cent. If we introduce an autonomous GNP growth rate of 2 per cent per annum, it would fall to 12.9 per cent. None of these revisions of the impact is very large—the advantage of reduced fertility in terms of level of per consumer GNP in 1985 remains within a range of 12.9 and 16.0 per cent no matter which parameter we change. Large changes would, of course, sometimes occur if we altered two or three parameters at once, but it is impracticable to explore this in full detail in this summary report. We should only note that, without exception, the reduction of the marginal savings ratio *weakens* the impact of population-growth differences, as does the introduction of an autonomous element of growth. Giving more weight to the "investment drain", by contrast, *accentuates* the impact of population-growth differences. But none of these parametric adjustments comes close to wiping out the impacts.

In Table III we measure also the sensitivity of the calculated external resources-saving impact. These figures run in terms of absolute differences rather than ratios. Again, the sensitivity is quite moderate in relation to the initial "demographic impacts". It is noteworthy that the effects of parameter change

are not all in the same direction here as in the case of the per consumer GNP test. Introduction of an autonomous growth rate *accentuates* the external resources-saving impact of population, while reducing the marginal savings ratio *weakens* that impact, and raising the "investment drain factor" scarcely affects it at all.

Sector Projections

We shall not take space in this report to present the results of projections of output and employment by specific sectors of the economy. Time did not permit any attempt to feed back these results into a deeper analysis of population impacts, but we believe the sector projections should be of substantial use to any further work on the development of the economy under various conditions. They are a step, for example, toward stipulation of consistent relationships between investment, domestic levels of activity in the investment goods manufacturing industries, and imports of such goods. They could also be useful in foreseeing the manpower supply/demand balance and indicated shifts of manpower and resources between sectors.

The construction of the sector projections is fully described in the Appendix.

Projections Assuming Agricultural Growth Exogenous

It was suggested to us by Professors Robert Dorfman and Alfred Conrad at Harvard that as a supplementary exercise we might develop and use an alternative projections model in which agriculture is assigned a dominant role in determining the pace of development, rather than merely being derived from overall growth in total and per capita income.

The construction of this model is described more fully in the Appendix. Here it is sufficient to say that we used two alternative assumed trends of agricultural output growth over the 20-year period: 6 per cent and 4 per cent per annum. From these we derived alternative trends of gross national product, by simply inverting the relationship which, in our sector-breakdown calculation, had been used to derive agricultural growth from population and GNP growth. Then from the projected levels of GNP (under each of the various assumptions regarding population growth and the key economic parameters) we derived domestic savings and the "investment drain", and finally the amounts of external resources needed to support the projected growth of GNP in each case.

With this "agriculture-exogenous" approach, there were sixteen sets of four projections rather than eight sets as in the initial approach—since we used two alternative rates of agricultural growth and retained all of the parametric and demographic variants of the initial approach.

It should be noted that in the agriculture-exogenous projections, the impact of demographic trends shows up *both in different levels of projected income and consumption and in different external-resources requirements.* In evaluating the costs or benefits of fertility or mortality reduction, we have to look at the combined "income effect" and "capital-import-reduction effect"—these effects are additive, not alternative as they were in the original model that is the basis of the results shown in Tables I, II and III.

For example, we see in the first row of Table IV that the impact of fertility reduction (Df-Dm compared with Cf-Dm) in one set of projections is to raise the 1985 per consumer GNP by 14 per cent; and that this *higher* level of income is attained with 217 crores *less* external resources use in 1982/83.

Here as in the earlier sets of projections (Tables I, II, III), the fertility impact is roughly three times the size of the mortality impact, and is in all cases favourable in terms of the improvement of income and consumption levels.

In regard to sensitivity of the population impacts to choice of economic parameter assumptions, we note that in this agriculture-exogenous model the projected levels of GNP in the aggregate and per consumer depend solely on which of the two levels of agricultural growth and on which of the four demographic cases we assume. The impact of population trends in terms of *income* differentials among the four population cases is accordingly insensitive to variation in the other economic parameters.

In terms of consumption and savings, the choice of savings ratios does affect the population impact, but only to a very slight degree, and there is no sensitivity at all to variation in the investment drain factor or the autonomous GNP growth rate.

The measurement of the population impact in terms of external resources differentials, on the other hand, is sensitive to all four of the economic parameters we are varying. In the first 12 of the 16 sets of projections, the "fertility impact" (next to last column in Table IV) is favourable, indicating a benefit from fertility reduction in terms of lower external resources apart from the benefit of a higher 1985 per consumer consumption level. In the other four sets of projections, however (the last four rows of the table, where there is a fast growth of agriculture and hence of GNP, but a low propensity to save), slower population growth actually increases the external resources requirement because it means that the GNP is going up faster in relation to savings that can be generated at the low marginal rate assumed.

TABLE IV

PROJECTIONS WITH AGRICULTURAL GROWTH EXOGENOUS: COMPARISON OF RESULTS FOR CONSUMPTION PER CONSUMER AND FOR EXTERNAL RESOURCES REQUIREMENT

Economic parameter assumption (see key below table)				Consumption per consumer, 1985				External resources (*crores 1982/83*)			
				Cf-Dm (*Rs.*)	Percentage difference from Cf-Dm			Cf-Dm (*Rs.*)	Difference from Cf-Dm		
A	S	F	G		Cf-Cm	Df-Dm	Df-Cm		Cf-Cm	Df-Dm	Df-Cm
4	36	10	0	469	+5	+14	+19	147	—59	—217	—260
4	36	10	2					—179	—46	—202	—232
4	36	25	0					287	—69	—238	—292
4	36	25	2					—39	—57	—224	—264
4	20	10	0	481	+6	+17	+23	338	+9	—25	—9
4	20	10	2					12	+22	—10	+20
4	20	25	0					478	—1	—47	—41
4	20	25	2					152	11	—32	—12
6	36	10	0	745	+6	+16	+21	386	—16	—139	—139
6	36	10	2					376	+17	—80	—45
6	36	25	0					620	—34	—175	—192
6	36	25	2					611	—1	—116	—99
6	20	10	0	826	+6	+18	+24	1,562	+69	+108	+185
6	20	10	2					1,552	+103	+167	+279
6	20	25	0					1,797	+52	+72	+131
6	20	25	2					1,787	+85	+131	+225

Key to parameters:

A = Agricultural growth rate (per cent per annum) S = Marginal savings ratio (per cent)

F = Investment drain factor (per cent) G = Autonomous GNP growth (per cent per annum).

QUALIFICATIONS AND CAVEATS

As we are not Pakistani area specialists, we have accepted uncritically a variety of data and assumptions coming from what we take to be the most reliable sources. We do not presume to evaluate the consistency, feasibility, or other merits of the Pakistan development plans. Nor do we pass judgment on the population projections we have used.

Our model is a very simple one, taking into account what seem to us the economic magnitudes and relationships most clearly affected by population growth. A great many aspects of the problem have been passed over because of the limitations of our time and our knowledge.

For example, there is no consideration here of the fact that mortality and fertility rates are affected by, as well as affecting, the rate at which individual incomes and well-being rise. This feedback must, of course, be recognised in development planning.

Again, we have not made explicit allowance in our calculations for the costs of the public health and other programmes that would be entailed in reducing either mortality or fertility or both, as assumed in the population projections. It would not appear, however, that such programmes will in any event represent any considerable fraction of the total development or investment outlays.

Nor have we made any allowance for possible effects of different rates of population growth and income levels upon labour force participation or labour productivity. There are certainly such effects, though they are perhaps not significantly large and the direction of their net effect is somewhat conjectural. It has been argued by some that pride in large families and the dependency burden of children are important spurs to productive effort. But it has also been argued that a rising level of individual income is a more effective invigorator. The bearing and rearing of fewer children may well have an effect on the work capability of mothers. Health improvements that reduce mortality are likely at the same time to reduce morbidity, and thereby to increase manpower energy and effectiveness. Fewer funerals might reduce what is perhaps a significant drain on private savings. All these factors we have had to ignore.

Nor have we explicitly introduced into our model the important growth constraint that is imposed by deficiency of skills and training. There is, however, some implicit recognition of this factor built into our model. It seems reasonable to assume that, insofar as the rate of development of skills will be affected by the rate of population increase, this impact will work through the supply of investment funds in relation to the rate at which facilities have to be supplied for additions to the population. And these are relations which our model does explicitly use.

Our analytical scheme has not been sufficiently detailed to take any account of certain further constraints which might play a substantial part in shaping growth over the next two decades. Here might be mentioned the important national objective of reducing income differences between the eastern and western parts of the country; limitations on markets for Pakistani exports; the rate of urbanization of population and its implications for housing and public service requirements; shortage of qualified teachers; the need to maintain a large military defence force; and many more.

Finally, our results give a substantial range of variation in showing the economic impact of alternative mortality and fertility trends. The tables in this report adequately portray this range, which of course reflects the absence of any certainty about such matters as the savings ratio and the degree to which output growth depends on the supply of investment funds, the way in which such funds are allocated, the rate of agricultural growth, or other factors independent of overall investment. Under the circumstances, we have deemed it appropriate to provide a gamut of projection results embracing what seem to be sufficiently high and low extreme values assumed for the different economic parameters. Those more conversant with the actual planning picture in Pakistan will doubtless be able to narrow considerably the range of uncertainty of results by excluding our more far-fetched cases.

APPLICABILITY OF THIS APPROACH TO OTHER COUNTRIES

We believe that our approach has the merits of simplicity and of relying on relatively few data inputs. It should, therefore, be generally useful for planning in similar national economies. Specifically, it suggests a measure which planners could show regarding the cost of not having a population growth control programme or of having an inadequate one, or even one of the "wrong" kind.

It should also be useful for those interested in allocating foreign aid among applicant countries. It might be employed as a rationing instrument for the allocation of the scarce public health personnel interested in, and capable of, developing local fertility clinics.

When we were asked to undertake this assignment, we were directed to identify the kind of countries for which our analysis would be applicable. It is appropriate here to identify the principal characteristics of the Pakistan situation which make this report a possible demonstration example for other countries. We feel that what we have done is generally applicable to countries *i*) receiving foreign aid, *ii*) willing and able to implement population control programmes with regard to fertility and mortality, *iii*) suffering from foreign exchange shortages, *iv*) suffering from a population "surplus" (low real income), *v*) suffering

more from a shortage of development funds (external as well as internal) and an inability to maintain high rates of domestic saving than from an immediately apparent shortage of human skills relevant to operate her economy, and *vi*) willing and able to entertain the bold aspirations of a national economic plan. Even though we have used Pakistani data, we have abstracted from two conditions which typify that country and do not typify most other countries like her. We have not explicitly considered the effects of a bifurcated national territory, nor have we explicitly taken into account the cost to the Pakistani economy of maintaining her defence posture.

On the other hand, our approach would in general *not* be appropriate in economically advanced countries. Nor is it likely that it would have much use in an underdeveloped country which is "underpopulated". It would not be particularly useful in any country having large economically important skilled industries. It would obviously have no relevance in countries where the resistance to fertility control and mortality control programmes was so strong that any discussion of either was impossible. Nor would it have much use in those few areas and countries of the world where the natural increase rate is negative or close to zero.

But in the many low-income countries where foreign exchange is scarce, where investment funds have largely to come from outside, where labour is redundant and the absence of skilled manpower is low on the list of "crucials", and where the productivity of the agricultural sector is the key to immediate survival, we have confidence in the usefulness of our analytical method.

SUGGESTIONS FOR FURTHER RESEARCH

Our work has brought to light a number of questions that we can suggest for further exploration. On each of these questions, we believe, the present study has provided some useful points of departure and progress toward answers.

1. *Unemployment.* What is the prospect for productive absorption of the present large fraction of the labour force that is unemployed or underemployed? What sectors of the economy will play the most active part in the creation of additional job opportunities? Will employability depend increasingly on education, and decreasingly on sex? How much shift from farms to nonfarm employment do foreseeable manpower needs imply under varying assumptions about population change and progress? Our sector-by-sector projections of output and employment should be useful as material for this area of inquiry, in conjunction with analysis of the population projections by functional age groups.

2. *Foreign trade and the balance of payments.* Our model (and of course others which have been developed) include consideration of consumption levels, domestic industry output by sectors, and net use of external resources. The

consistent interrelation among these variables could be traced much more explicitly as affected by alternative trends of population growth.

3. *Human resources investment.* An important question is how much of the nation's development funds should optimally be allocated to domestic welfare services? With how long a lag and to what degree does investment in human resources begin to affect production? To what extent, typically, does the investment in human capital rise as income rises and as populations improve their production capabilities?

4. *Special manpower requirements.* Our model could be amplified to determine how many teachers and how many physicians (to cite but two examples) would be needed at various times under alternative population and growth trends. Even more interesting are the possibilities of determining the degree to which investment in this kind of welfare activity can replace reliance upon external resources.

5. *Economic benefits per prevented birth.* Our model, or a variant thereof, could fairly readily be adapted to yield estimates of the value (in terms of income and/or reduced external resources requirements) of a birth prevented or deferred at any time in the projection period. This kind of estimate should be useful for guidance as to the scale and direction of family planning efforts in relation to the costs thereof, and in consideration of policies of fertility-control incentives under which some of the national benefits of birth prevention would be shared with cooperating parents.

REFERENCES

1. Brackett, James W. and Donald S. Akers, *Projections of the Populations of Pakistan by Age and Sex, 1965-1986.* (Washington, D.C.: U.S. Bureau of the Census, June 1965).

2. Chenery, Hollis B., "Patterns of Industrial Growth", *American Economic Review,* September 1960.

Appendix

The analytical scheme and projections programme used for generating our various projections were described in the text of this report with a bare minimum of detail.

This appendix provides more complete information on those aspects of the procedure.

The way in which the model "simulates" growth under various conditions is described below:

1. *The increase in real GNP* from each date to the next is basically a function of the level of investment at the beginning of the interval in question. Since the projections proceed by intervals of 2.5 years, there is an assumed lag of GNP-increase behind investment.

The incremental output/investment ratio is *not* taken as constant. Initially for our projections the values for this ratio were derived from the investment and GNP series in the Pakistan Perspective Plan—the ratio falls fairly rapidly in the earlier part of the twenty-year period and then flattens out, reflecting the judgment of the authors of the Plan.

We seek in our projections to allow for the fact that some investment may be essentially geared to the welfare needs of an expanding population and not as directly related to worker productivity as would be, for example, investment in irrigation works or industrial equipment. Accordingly, we assign a zero growth effect to a portion of total investment (which for convenience we can call the "investment drain"). We make this drain depend on *i*) the level of per consumer income, as indicative of welfare standards, and *ii*) the size of the next 2.5-year increment of consumers, as indicative of quantitative growth of the consumer population.

Thus, our formula for Y (the gross national product) looks like this:

$$Y_{t+1} = Y_t + R_t [I_t - By_t (C_{t+1} - C_t)]$$

where R is the incremental output/investment ratio, I is gross investment, y the level of per consumer GNP, C the number of consumers, and B a weighting factor for the investment drain, to which alternative values may be assigned. In our projections we have used alternative values of 0.10 and 0.25 for B.

2. *Investment* (*gross*) is the sum of "external resources" and domestic savings. External resources in each time period are assumed in some of our projections as will be described below; at the levels set forth in the Perspective Plan

which involve progressively lower levels through the period. In other projections, we derive external resources as a "requirement" for meeting various stipulated growth standards.

Investment in the formula previously stated is, then, broken down into two components for projection purposes:

$$I = S + E$$

where E is external resources measured as an annual rate of flow, and S is domestic saving.

3. *Domestic saving* (S) is, in turn, derived as the number of consumers times per consumer saving, and per consumer saving as a linear function of per consumer GNP. The saving formula is therefore:

$$S = C\ (ay - b)$$

where a is the marginal propensity to save. Alternative values for a are taken—a "high" of 36 per cent corresponding closely to what the Prespective Plan assumes, and a more conservative "low" of 20 per cent.

When we shift to a different value of a, we make an adjustment in b at the same time, so that the computed S for 1965 is left in conformity with current estimates. Graphically speaking, this involves the pivoting of the line showing the relation of per consumer saving to per consumer income around that point on the line that represents the present situation[1].

4. The model as described so far incorporates two "adjustable" features—the marginal savings ratio and the "investment drain". Acting on a suggestion from Dr. Stephen Enke, we added a third adjustable feature: an "autonomous" component of GNP, growth assumed to be altogether independent of investment. This feature is designed to meet the argument that an output/investment ratio based simply on historically observed or envisaged relationships between GNP growth and the level of investment implicitly ascribes all growth to the enlargement of the capital stock, and none to such other factors as increase labour supply

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[1] *The assumed savings function*

The projections GNP and savings for the Perspective Plan very closely fit the following linear relationship:

$$S = 0.3614\ Y - 124.7 \text{ (Rs.)}$$

where both S and Y are *per consumer*.

When we decided to incorporate a different marginal savings rate as alternative to the 36 per cent in the above fitted equation, we wanted to leave the computed per consumer saving in 1965 *unchanged*. Taking the 1965 per consumer income as Rs. 464.75 and the 1965 per consumer saving as Rs. 43.25 and inserting these as constants in the above formula with the marginal ratio and the intercept as variables, we have:

$$43.25 = 464.75a - b$$

or

$$b = 464.75a - 43.25$$

The per consumer savings may then be calculated as:

$$S = aY - (464.75a - 43.25)$$

where a is the marginal savings ratio.

This simplifies to

$$S = a(Y - 464.75) + 43.25 \text{ (Rs.)}$$

or enhancement of productivity through technical progress aside from the *quantity* of capital or labour inputs.

We are not prepared to admit that the simple output/investment ratio model is quite as naive as the abovestated argument might imply. In the first place, our data on investment are gross rather than net—no attempt has been made to estimate the capital stock or net accretions to it. Using gross investment implicitly assigns some productivity-raising effect to "capital replacement" and thus does allow for some of the influence of technical progress via *qualitative* changes in the stock of capital. Secondly, the consensus seems to be that during the period of projection considered, manpower can be safely assumed a redundant factor—so that even if higher fertility meant a faster growth of the labour force, we could still not assign any positive GNP growth effect to that difference. In fact, of course, the difference in the projected labour force under the four demographic cases is quite small and appears late in the period.

Nonetheless, we have introduced into our projections procedure a set of cases in which an arbitrarily assumed GNP growth rate of 2 per cent per annum is assured regardless of investment. Investment-induced GNP growth is assumed to be superimposed on that 2 per cent rate. Here as in the case of the varying of the marginal savings ratio, however, it seemed to us more useful to make a counterbalancing adjustment so as to keep the projections of growth roughly the same as before—rather than simply adding 2 per cent annual growth to all of them. Our reasoning on this is that if we assign some growth to noninvestment factors, we should assign a *smaller* growth effect to each rupee of investment. We do this by reducing the output/investment ratio by a multiple of the assumed annual percentage rate of autonomous GNP growth[2]. The compensation for introducing a

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[2] *Adjustment of Output/Investment Ratio for Autonomous GNP Growth*

The purpose of this adjustment is to scale down the growth impact attributed to investment in recognition of the fact that some growth has been attributed to factors independent of investment.

We can express this stipulation as follows, considering the rise in GNP in any 2.5-year time interval:

$$RI = R^*I + YA$$

where R is the incremental output/investment ratio without any autonomous GNP growth, R^* is the ratio assuming an annual autonomous growth at AY per 2.5 years, Y is GNP at the beginning of the 2.5-year interval, and I is the level of investment at the beginning of the interval.

The above expression yields

$$R^* = R - \left(\frac{Y}{I}\right) A$$

The value of Y/I is reasonably stable over the projections period, varying generally between 4.0 and 4.5. For our adjustment, we assign it a constant value of 4.2. This means that instead of using a simple output/invesment ratio R in our projections calculation, we substitute:

$$R - 4.2A$$

Since A is approximately .025 times the assumed annual percentage rate of autonomous GNP growth, an assumed 2 per cent annual autonomous growth means A = 0.05 and has the effect of reducing the output/investment ratio by about a quarter.

2 per cent annual autonomous growth rate is to cut out output/investment ratio by about a quarter.

5. *External resources as a requirement.* All of the projections described thus far assume external resources as given, and the same for all projections. The various projections then measure how rapidly the income per consumer (and other economic indicia) could rise with these resources.

It is equally pertinent to turn the problem around and ask what external resources would be required, under each of our sets of assumed conditions, in order to achieve a specified path of per consumer income growth. To approach the problem in this way, we have to specify that path. This has been handled as follows:

For each of eight sets of assumptions about economic parameters, we have four "demographic cases" representing the four census projections of population [1]. We take the "least favourable" of these four cases (constant fertility, declining mortality) as the standard. The trend of per consumer GNP growth achieved in that demographic case with the external resources suggested in the Pakistan Perspective Plan could, of course, be matched under any of the three more favourable demographic cases with a smaller amount of external resources in each time period. How much smaller? We have calculated this, to measure the advantages of reduced fertility (and/or sustained mortality) in terms of reduced dependence on external resources and earlier attainment of the stated goal of nondependence in that regard.

These evaluations in terms of "external resources required to match the GNP-per-consumer growth of the constant-fertility/declining mortality case" have been carried out for all of the projections, with the eight different combinations of the marginal savings ratio, investment drain factor, and autonomous growth rate already described.

It would, of course, have been just as appropriate to take the most favourable rather than the least favourable demographic case as the standard, or to establish the "target" trend of per consumer GNP by applying some time trend of external resources other than that suggested in the Pakistan Perspective Plan. That would have yielded somewhat different numbers but we see no reason to believe that it would substantially alter the character of the findings regarding the impact of fertility and mortality reductions *per se* on external resources requirements.

6. *Projections by sectors.* Each of our projections has been carried a further stage, breaking down the total gross national product by major productive sectors

and translating output into employment for each sector except agriculture. These sector breakdowns are byproducts of our effort in the sense that we did not attempt to have them feed back into the determination of projected overall growth.

To derive the projections of output by sectors, we used the "elasticities" shown in the April 1964 mimeographed Perspective Plan paper on "Long Term Perspectives."[9] These sector elasticities were originally developed by Hollis Chenery [2] and we understand that they have been subsequently modified and adapted more specifically to the Pakistan situation. Each one relates the percentage growth of a specific sector of the economy (starting with the base year, fiscal 1965) to the percentage growth of *i*) population and *ii*) per capita income. Consequently, the projected level of output of any sector in any year depends, in our model, on the population that the census has projected for that year and on the GNP that we have projected for that year.

In symbols, the calculation is as follows:

$$Q_t = Q_1 \times (P_t/P_1)^{EP} \times (y_t/y_1)^{EY}$$

where Q represents output of a particular sector, P is population, y is per capita GNP, and EP and Ey are the "Chenery elasticities" specified for that sector.

It is obvious from the form of this equation that the sector outputs thus calculated will not (except by coincidence) add exactly to the GNP total from which they are calculated. Accordingly, our calculation includes a reconciliation adjustment to make them add up. The adjustment necessary was quite small—ordinarily of the order of 1 per cent.

To derive the employment projections from these sector-output projections, a further set of elasticities is used, which is presented in the same April 1964 document and stated to have been derived from an unpublished document of the European Coal and Steel Community in Luxembourg. These elasticities (in the form we have used them) relate sector employment in any year to sector output in that year as follows:

$$E_t = E_1 \times (Q_t/Q_1)^{EE}$$

where E is employment and EE is the "employment elasticity" specified for that sector.

7. *Projections with agricultural growth exogenous.* We have also made projections on the basis of a quite different conception of what will determine the growth of the Pakistani economy. Specifically, this alternative model starts with