EMPLOYMENT MAXIMIZATION IN A LABOUR-SURPLUS ECONOMY: AN APPLICATION TO BANGLADESH

EMPLOYMENT MAXIMIZATION IN A LABOUR-SURPLUS ECONOMY: AN APPLICATION TO BANGLADESH

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ABSTRACT

The so called "Labour Surplus" economies represent a subset of the less developed countries of the world that have failed to overcome the Malthusian barrier of a population explosion. The economic and demographic history of this group of countries seems to indicate that in the peculiar circumstances of these countries, the traditional "GNP maximization" approach to development cannot spontaneously generate a socially acceptable rate of growth of employment. The concern, in this thesis, toward the allocative consequences of an "employment maximizing" development strategy arose from the massive backlog of unemployed human resources in one such labour-surplus economy, namely Bangladesh. The static and dynamic consequences for resource allocation of an employment maximizing development policy are studied within the framework of a dynamic, multi-sectoral, linear programming planning model.

Since an employment-oriented development strategy is likely to lower the overall growth of the economy, implying a possible conflict between employment and other social goals, a major part of the effort in this thesis is devoted to the study of the optimal patterns of

allocation under alternative social goals and under alternative forms of specification of these goals. The conflict between the employment and the consumption objectives are explicitly brought out by using the model to generate possible trade-off paths between these two long-run development goals. The model is also used to study the production and distributional consequences of alternative assumptions regarding labour market distortions that are reflected in wide wage-differentials between the agricultural and the non-agricultural sectors of the economy.

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INTRODUCTION

Economic and technological dualisms are common characteristics of most less developed countries. But "surplus labour" is a feature of only some of them. At the risk of some error, one way to separate the labour surplus countries from the rest of the less developed world is to view them from the Malthusian perspective. That is, to treat them as a class of countries that have failed to solve the problems of a 'population explosion.' That is to treat them as a class of countries that have failed to solve the problems of a "population explosion". Typically this group of countries displays much higher rates of "unemployment" than is observed in other developing countries despite the fact that historically their performance in terms of the growth of GNP is comparable to those realized in other developed nations.

Until recently, the major policy objective which the governments of all less developed countries have assiduously pursued has been the growth of per-capita national income. It was believed that rapid growth of GNP would ensure a rising standard of living and would also automatically result in high employment. This goal was also believed to be compatible with a more equal distribution of income. The prevailing logic was that the

the size of the pie must be increased first, after which appropriate fiscal and monetary policies could be designed to redistribute the larger pie (output) in any socially desirable way. In short, with the traditional development strategy, GNP maximization was viewed as synonymous with social welfare maximization.

The history of almost two decades of unbridled growthmanship, however, has brought disappointing results in terms of employment and income distribution. The large amounts of data compiled in the mid-60s reflect the effects of past policies and indicate that in spite of impressive growth of GNP, not only have rates of unemployment swelled in many countries, but also that in some, the level of "absolute poverty" has increased overtime (Griffin and Khan, ILO, 1976, Morawetz D., 1974). To emphasize this point Dudley Seers (1970, p. 80) wrote that to "accelerate growth" is not enough. To quote him,

> "Perhaps the hardest step for those who have worked for many years in the development field is to realize the limited relevance in itself of the rate of economic growth. Even those who accept employment as a specific objective often fall back on the argument that the way to achieve the necessary increase in employment is to accelerate the rate of economic growth. Yet it is clear, by now, that fast economic growth is not sufficient to raise employment at a fast pace; moreover, our common result is that part of the population is left behind and inequalities become even greater. In fact, if growth is concentrated in a few capital-intensive industries, as it tends to be when it is

> really fast, the effect may be to raise productivity rather than employment, and also to lift wages to levels higher than other industries can pay, especially agriculture, thus reducing the employment they provide."

The discovery that large segments of the population in some parts of the world are not only deprived of the fruits of economic growth but they are actually robbed of their "initial" subsistence (income) by the growth process itself have had a dramatic effect on thinking among researchers and policy makers concerned with the growth-distribution debate. Not only has the intellectual climate changed in favour of a more egalitarian distribution but the very foundations of the GNP maximization strategy have been questioned[1]. (Lecaillon and Germidis, 1970, W.R. Cline, 1971, pp. 9-23, ILO, 1970, Pankert and Others, ILO, 1974).

The "disillusionment" with the old strategy has given birth to a "New Development Economics" (Eric Thorbecke, 1973, Harry T. Oshima, 1976).

The new approach explicitly recognizes that "social welfare" is determined not only by the rate of growth of GNP but also by a host of other variables including the distribution of the fruits of growth, employment and consumption, some of which may be mutually incompatible

goals in the development process. At the practical policy level, it focuses on employment creation as the means to achieve increased equity, advocating it rather than income redistribution for several reasons. To a large extent, the political power balance is related to the pre-tax income distribution so that the established power groups which reflect existing inequalities oppose policies that would allow redistribution of increased output and income. Even in countries where there is a political will to use fiscal and other instruments to improve distribution, administrative costs of implementing these policies make them unfeasible. Finally, prolonged unemployment is associated with loss of human dignity and therefore employment creation deserves special attention.

The proposed strategy is necessarily a labour-intensive strategy and therefore is likely to be more suitable for labour-surplus under-developed countries. However, the introduction of employment (or equity) as a major independent policy goal raises the old question of a possible conflict between the employment (equity) objective and the output (growth) objective. In the case of a conflict, the replacement of the old strategy by a more employment-oriented one will increase aggregate employment but decrease total output. The rise in

employment will improve the relative share of labour provided the "average" wage rate does not decline at even a faster rate than the rise in employment. The improvement in the relative share of labour reduces the skewness in the distribution of income but it does not ensure an improvement in equity or social welfare. For if the employment-oriented investment policy lowers total output at a faster pace than it improves the relative share of labour, the net effect will be a decrease in the "absolute income" of labour, in which case everyone will be worse off. A sufficient condition for the labour intensive strategy to improve both absolute and relative incomes at the lower end of the income scale is that it must not cause output to fall at a faster rate than it improves the relative share of these groups. Since output nonetheless declines, the improvement in the relative share of the poor in this case is necessarily at the cost of upper income groups. Thus, to comment on the net effect on social welfare in this situation would require additional distributional value judgements.

But is there a necessary conflict between increasing employment and increasing output? There seems to be no such logical necessity. The answer would seem to depend on the structural characteristics of individual countries. If, for example, the relatively labour-intensive agricultural sector in a particular developing country adds

more to value added per unit of scarce resources than the manufacturing sector, then there need be no such conflict between employment and output. In this case the adoption of the proposed employment-oriented development strategy would unambiguously improve equity and also social welfare.

There is also the question of an intertemporal conflict between employment and output. That is, will more employment creation now mean less unemployment in the future? Again, there is no such logical necessity. For such a conflict to exist, the relatively more capital-oriented investment strategy must result in a higher aggregate saving than the less capital-oriented investment strategy.

The study in this thesis seeks to explore the static and dynamic implications for resource allocation of alternative development strategies, namely an employment and a consumption maximization strategy, based on a specific application of these policies to a particular labour surplus economy. It recognizes that given the macroeconomic interrelationships between investment, output, consumption and employment, if resources are allocated to achieve the employment objective, this might involve an 'opportunity cost' to the society in terms of the sacrifice of potential output and other social goals. However, the question of the existence of an opportunity cost of policy induced expansions in employment is an empirical matter. Will the costs of such policies be unduly high? or, are there policy instruments available to the governments of labour surplus countries that can be used to increase both employment and output simultaneously? The answers to such questions can be given only with reference to specific applications of the proposed employment oriented investment strategy to particular labour surplus countries.

In this thesis, the answers to the questions raised above are sought within the framework of a dynamic, multisectoral planning model and with reference to the economy of Bangladesh. Since the concept of "opportunity

cost" of achieving one social objective in terms of the potential sacrifice of other objectives presupposes efficiency in the allocation of resources under each goal, the entire study in the thesis is cast within the framework of an explicit (linear programming) optimization model.

The planning model is defined over 9 sectors and 4 periods. It is specified in incremental terms. The 9 sectors in the model resemble the input-output structure of the Bangladesh economy. Other resource constraints in the model, which include foreign exchange constraints, noncompetitive import constraints, working capital requirement constraints, and capacity constraints, are not unique to this model. These constraints are fairly standard in most planning models. However, in view of the assumed consumption-productivity link in a labour surplus economy, the model in the thesis makes explicit provision for at least a minimum consumption basket to each newly employed worker during each period. The aggregate domestic savings (constraint) is determined endogenously in the model, by 'sectoral saving ratios' which are implicit in the structure of the primal. Such a savings behaviour assumes that aggregate savings depends not only on aggregate income but also on other things, such as different social and occupational groups and hence on different sectors of the economy. Domestic

savings plus foreign capital inflow, impose an upper limit to domestic investment during each period in the model.

ORGANIZATION OF THE STUDY:

The planning model developed in this thesis is used for employment projections in a labour-surplus economy. The concern, in the thesis, toward the allocative consequences of an employment maximizing development strategy arose from the massive backlog of unemployed human resources in Bangladesh. Thus, a general review of the extent, nature and a diagnosis of the probable causes of unemployment in Bangladesh was considered to be a logical starting point for this study. Such a review is to be found in Chapter two of the thesis. The discussion in this chapter helps to indicate what the priorities of future planning in Bnagladesh should be.

Chapter three of the thesis is concerned with the techniques of employment projection and the prospects of employment generation for a labour surplus economy. The appropriateness of the projection technique for the purposes of any particular study depends both on the

nature of the study and also on the relative data requirements of the alternative techniques. On these considerations, a linear programming optimization model was selected as the most suitable technique for the realization of the goals set for this study. The evaluation of the prospects for employment generation is based on a brief survey of a cross-section of employment-oriented planning models.

In Chapter four , the structure of the dynamic multisectoral planning model is outlined. As a test on "primal feasibility", an "abridged" version of the model was first run. The nature of solution to this initial optimization is briefly analysed with the expressed purpose of detecting possible inconsistencies and shortcomings in the composition of the primal model.

In the light of the results of the abridged version of the model a few modifications are introduced in the structure of the full-scale model in Chapter five. In this chapter of the thesis, the 'enlarged' allocation model is studied in both its primal and dual forms. An attempt is made to give an economic interpretation to the dual to the employment maximization problem. A preliminary optimization with a purely 'supply constrained' version of the enlarged primal is performed in order to examine how the model uses the freedom it is

given. The results of this exercise has been termed as the "Naive Solution". These results are interpreted in the light of the scarcity prices of the dual solution. The specialization tendency under the so called "Naive Solution" is a reflection of the economy's comparative advantage. With employment as the maximand the directions of the economy's comparative advantage during any period is made the basis for defining sectoral priority for incremental employment generation.

The numerical values of variables under the liberal assumptions of the "Naive Solution" assume unrealistic values that cannot be realized in practice. In order to ensure that the optimal values of variables remain within a more or less realistic set of outcomes, restrictions are introduced on the demand side of the model. The results of this demand-supply constrained version of the model is termed as the "Basic Solution". The "Basic Solution" is made the basis for comparison of the results of all policy experiments that are conducted in Chapter six. Four sets of policy experiments are conducted. The first set explores the consequences of the introduction of upper bounds on net sectoral exports. The second set is designed to explore the sensitivity of the optimal allocation strategies to the choice of the long-term development goal and to alternative forms of specification of the

development goal. The third set of experiments examines the production and distributional consequences of alternative assumptions regarding labour market distortions that are reflected in wide wage-differentials between the agricultural and the non-agricultural sectors of the economy. The final set of optimizations is used for deriving trade-off relationships between employment and consumption under alternative sets of assumptions regarding the form of the two goals.

Finally, in Chapter seven, the conclusions which emerge from the study are drawn and their policy implications are analysed.

FOOTNOTE

Introduction

1. Inasmuch as there is a positive correlation between the marginal propensity to save and the level of income, a less eglitarian distribution was viewed as necessary for rapid mobilization of saving, investment and hence the potential for economic growth. Some recent studies, however, suggest that the presumed association between savings and inequality may not be as for developing countries as was originally thought. Concentration of material and human capital encourages investment in modern urban sectors and away from agriculture accentuating economic dualism. To the extent that consumption patterns in urban centers are influenced by western consumption standards (demonstration effect), economic dualism not only tends to promote consumption at a rapid rate, but at the same time, diverts increased porportions of consumer spending from goods produced in the traditional sectors to goods that are imported. Such spending creates little employment and is a further source of inequality.

Reliance on income inequality for raising aggregate savings has also been questioned by those who argue that in low income underdeveloped countries one important cause for low labour productivity is low consumption. According to this view significant gains in productivity can be made through a more eglitarian distribution of income.

Futhermore, to the extent that "social welfare" and not GNP ought to be the appropriate goal of economic development, the latter approach puts too much weight on savings and too little on employment and income distribution.

CHAPTER 2

SURVEY OF UNEMPLOYMENT IN BANGLADESH

More than a hundred and eighty-five years ago, Malthus had warned that a country must by forethought, institutions, customs, and practices, solve the problems of a population explosion, otherwise, he predicted, population would grow faster than production, per capita real income would fall to a level of "subsistence" where domestic saving fails to cover the "demographic investment" plus necessary replacements (A. Robinson, 1974). Capital per head and labour productivity falls, pushing a larger proportion of the population below subsistence income and an equilibrium at subsistence is eventually restored by an increase in sickness, death rates and other factors which he subsumed under the name of "misery".

The Malthusian mechanism of "misery" with changes in the rates of growth of population acting as an equilibrating force has not been borne out by subsequent developments of history[1]. But the main thrust of his argument that population, if uncontrolled, would frustrate all attempts at raising the standard of

living, is borne out by the experience of many LDCs which in the popular terminology of development economics have come to be called as the "labour surplus" economies. Bangladesh is a leading example of such a labour surplus economy[2].

The economic and demographic history of Bangladesh over the last several decades is an illuminating story of the Malthusian processes at work in the twentieth century.

Table (2.T.1) summarizes the growth of gross domestic product, population and the per capita gross domestic product in Bangladesh over the period 1949/50 to 1969/70. This table helps to demonstrate that in spite of the fact that real GDP has grown, in intermittent periods, at exponential rates of over 5 percent, its growth rate of only 3 percent over the entire period has not exceeded the rate of growth of population over the same period. Consequently, the long-run per capita gross domestic product of Bangladesh has at best remained stationary around the incredibly low level of only Taka 297 per annum[3]. The highest per capita income achieved by the country in recent years was TK. 315 per annum, which at the prevailing exchange rate amounted to less than 50 U.S. dollars.

TABLE (2.T.1)

GROWTH OF GDP, POPULATION AND PER CAPITA GDP FROM 1949/50 TO 1969/70

(Values at Constant 1959/60 prices)

Year	GDP (Million Takas)	Population (Millions)	GDP per Capita (Takas)	Exponential Growth Rate (%) GDP	Population	GDP per Capita
1949-50	12,374	42.25	293			
1954-55	13,816	47.70	290	2.2	2.5	-0.21
1960-61	15,310	55.25	277	1.7	2.5	-0.76
1963-64	17,855	60.37	304	5.2	3.0	+1.93
1966-67	18,734	65.96	290	1.6	3.2	-1.55
1969-70	22,317	72.07	315	6.0	3.1	+2.79

The trend in the indices of real wages which may be taken as an alternative indicator of changes in the standard of living seem to confirm the results of the per capita GDP indicator[4]. Table (2.T.2) which is reproduced from Khan (1972) shows that there has been no upward trend at all in either the urban or the rural real wage rates. In fact, Khan believes and there are other studies[5] which seem to support the view, that all real wages in Bangladesh have declined steadily. The intertemporal trend of real wages also shows that the real wages of the lowest of the income groups which mainly consist of landless rural workers and the urban unemployed, have declined relative to the average.

Declining real wages combined with the long-run constancy of per capita income suggests that stagnation of the average standard of living has been accompanied by widening inequality in the distribution of income with the result that the unemployed and other social groups at the lower end of the income scale have been pushed into deeper poverty.

TABLE (2.T.2)

REAL WAGES OF URBAN AND RURAL WORKERS

Year	Index of Real Wages in Urban Industries	Year	Index of Rural Real Wages
1954	100.0	1949	100.0
1955	88.4	1950	94.8
1957	91.4	1951	77.7
1958	93.6	1955	92.8
1959/60	92.8	1959	88.5
1962/63	96.4	1960	88.0
1967/68	101.1	1961	100.5
		1965	96.9
		1966	82.3

SOURCE: A.R. Khan (1972)

EXTENT OF UNEMPLOYMENT AND UNDEREMPLOYMENT

There exists no systemmatic time series data on employment in Bangladesh either at the aggregate or the sectoral level. However, in a country where production has failed to grow faster than population over several decades (Table 2.T.1)it may not be unsafe to infer that unemployment both in an absolute sense and possibly as a proportion of the labour force has increased over time. A more clear picture on this may be formed from a comparison of realized savings rates with the savings rates warranted for the full employment of yearly additions to the labour force. Such a comparison can be based on an applied planning version of the aggregate Harrod-Domar growth model .

Let us assume,as many other authors on Bangladesh have done, that the incremental capital-output ratio is 3, a modest depreciation rate of only 3 percent, a labour force growth rate of 3 percent and no growth in labour productivity (Khan, 1972, p.13 ; Robinson, 1974, p. 653). Under this set of assumptions, the savings rate required to equip the yearly additions to the labour force with the existing capital per head is 12 per cent of total output. This is the rate of investment required just to stand still in terms of the existing subsistence income per head and

existing capital per employee. On the other hand, the rate of investment actually realized in the 1960s, during which decade, the country achieved its highest rate of growth (see Table 2.T.1) comprised between 10 per cent and 11 per cent of GNP; of this, the rate of internal domestic saving was no more than 6 to 7 per cent of GNP (Nural Islam, 1974, p. 2).

While available statistics on employment are inadequate, there is no disagreement among researchers on Bangladesh that a substantial percentage of the available labour force remains effectively unemployed on a long-term basis. In the view of Professor Warren Robinson (1968), "Based on the conditions that generally are assumed to generate or at least to be associated with 'disguised' unemployment, one would expect to find 'surplus' labour in Bangladesh if it is to be found anywhere in the developing world."

Since in a peasant economy like Bangladesh, unemployment predominantly takes the form of less than "fully-employed" workers due to work-sharing practised within the extended family system, it is intrinsically more difficult to obtain accurate measures of its magnitude. The usual census method of measuring unemployment based on the criterion of "looking for work" or on whether one is "gainfully employed" for a number of days a year is geared to measuring open

unemployment. This method is too simplistic and too restrictive in the face of the complexity of the issues of rural unemployment[6]. This has led many researchers to use alternative methodologies. Utilizing information based upon sample surveys and farm studies these authors have made brave attempts at guessing the true extent of unemployment and underemployment in different sectors of the Bangladesh economy. Some of these estimates are presented below.

UNEMPLOYMENT EQUIVALENT IN AGRICULTURE:

Agriculture contributes over 65 per cent of GDP and provides employment to more than 75 percent of the country's active population. Nearly 90 per cent of the population live in the rural areas.

Despite the fact that both the "Food" (rice) and the "Non-Food" (Jute) crops use relatively labour-intensive methods of production, the pressure of the growth of population, the failure of the economy to generate employment opportunities away from agriculture, and inadequate investment in agriculture itself have resulted in massive unemployment and underemployment of labour in this sector.

Table (2.T.3) brings together various estimates of the 'unemployment equivalent' in agriculture based upon some of the important existing studies on the subject. These studies show that during the last few decades, as much as 30 to 40 percent of the human resources in agriculture have remained unemployed on a "full time" basis. In terms of number of workers this amounts to between 7 and 8 million farm workers.

NON-AGRICULTURAL UNEMPLOYMENT

Outside of agriculture there are, at a conservative guess about another 1.6 million workers either openly unemployed or seriously underemployed. (Austin Robinson, 1974, p. 655).

Underemployment in non-agricultural activities is mainly concentrated in the services sector which provides employment to nearly 18% of the total labour force and contributes over 20% of GDP. Underemployment in this sector is usually 'disguised' in the form of street vendors, hawkers, pedlars, "professional beggars", and such other low productivity or completely unproductive workers. It is believed that this sector performs the role of mopping up the residual labour force in non-agricultural activities.

TABLE (2.T.3)

VARIOUS ESTIMATES OF FULL-TIME UNEMPLOYMENT EQUIVALENT IN AGRICULTURE*

Source	Method Used	Percentage of Unemployed 1964/66	1969/70	1974/75
Bangladesh Planning Commission	Surplus Labour[1]			37.0
FAO	Surplus Labour	32.5	32.5	35.7
Muqtada, M.	Surplus Labour		39.8	35.7
Prof. W. Robinson	Productivity Criterion[2]			
Rabbani, M.G.	Productivity Criterion	40.0		
BIDS Survey	Time Criterion[3]			28.0

* Part of the information in this table is directly taken from R.I. Rahman (1978).

1 The surplus labour approach calculates the difference between supply of labour and the estiamted demand for it.

2 The productivity approach computes the excess of labour force over the level that equates the marginal product of labour with the real wage rate.

3 The 'Time Criterion' assumes as unemployed those who worked less than 290 days during a given year.

The manufacturing sector in Bangladesh is relatively new and small in size. It contributes less than 10% of GDP and provides employment to no more than 9% of the total labour force.

Judging by the relative factor endowments and the opportunity cost principle, Bangladesh clearly has a comparative advantage in labour-intensive production activities. However, cross-country comparison of industrial capital intensities show that almost all manufacturing industries in Bangladesh are more capital intensive than the corresponding industries in Japan and the paper industries in BD are more capital intensive than the corresponding industries in the U.S.[7] (Khan, 1972, p. 66).

Besides being highly capital intensive, 'technological dualism' is another characteristic feature of the Bangladesh manufacturing industries. There exist, side by side, production units of different sizes which supply similar products using vastly different technologies. This is particularly true in textile manufacturing, where the output is supplied by modern "large scale" firms using highly capital intensive techniques, "small scale" firms using 'intermediate' technologies and by 'cottage industries' which are mainly handicraft and household industries using highly labour-intensive 'traditional' technologies.

In terms of productive efficiency, a study by Khan (1972) reveals the interesting result that more than seven times higher capital intensity in large-scale industries as compared to small scale industries is associated with only a less than two-and-a-half times higher labour productivity. As a consequence, the capital-output ratio in large scale is more than three times as high as that in small scale industry (Khan, 1972, p. 60-1).

In terms of employment, it is the small-scale and cottage industries which provide the bulk of industrial employment, at least as much as, six to seven times the total volume of employment provided by the large scale industries, for a given amount of capital. Cottage industries, however, are highly inefficient, in terms of productivity per worker or output per unit of capital..

The above survey of the unemployment picture in Bangladesh suggests that agricultural and nonagricultural unemployment combined, there are about 9 million workers comprising about one third of the total active population of the country who remain effectively unutilized. However, because of the extreme seasonality of agricultural employment, it is still debatable as to what percentage of agricultural unemployment is truly 'surplus' in the sense that it can be

withdrawn for alternative employment without adversely affecting farm output. Although such a concept of "withdrawable surplus" may not be of any direct concern for the purposes of the present study, it is still interesting to note that Professor Masum (1979), in his doctoral thesis, has done a thorough investigation into the structure of unemployment and underemployment in Bangladesh and has found that the "withdrawable surplus" of labour, defined as the degree of unemployment in the busiest season, amounts to no less than 20% of the labour force. That is, about 20% of farm labour force remains totally unemployed on a year to year basis, and can therefore be permanently removed from the agricultural sector without affecting farm output.

On top of this enormous arrear in employment, population is growing at an explosive exponential rate of 3 percent per annum despite government family planning programmes. Assuming a participation rate of 33 percent this means that nearly a million additional people will be seeking work each year.

DESIGN OF DEVELOPMENT STRATEGY

Given the enormity of the size of accumulated unemployment and underemployment, development in Bangladesh

cannot be viewed only as a matter of growth and of vertical movement in the standard of living. In this study we propose to take the view that in planning the future development of Bangladesh, highest priority must be given to an 'employment oriented investment strategy'. To solve the problem of abject poverty which the unemployed and the underemployed have to suffer year after year, sensible planning must arrange available investment resources so that 125 people can actually earn as good a living in the near future as do 100 at present.

The literature on the choice of technique teaches that in the decision regarding the nature of allocation of <u>new</u> investment there can be a conflict between the two social objectives of output and employment. The conflict arises because new employment usually requires scarce complementary inputs (capital, foreign exchange, administrative skills, etc.) which may be more productive in alternative uses. Professor Nurkse in his "Problems of Capital Formation in Underdeveloped Countries", has pointed out that if the non-employed can make their own tools from local materials that are not scarce and if their employment does not require the diversion of scarce administrative personnel, then their employment will actually enhance

output rather than reduce it[8] . Even if there is a reduction, the essential point of Nurkse's argument is that the opportunity cost of employment in a situation of large scale underemployment need not very high

In planning the future development of Bangladesh not only must employment creation be given the highest priority, the newly employed workers must also be ensured at least a 'basic needs' consumption bundle. Although from the point of view of economic growth current consumption should be discouraged, too low a rate of consumption leads to undernourishment, malnutrition and diseases with inevitable adverse effects on the productivity of labour[9] .

According to Gunner Myrdal (Asian Drama, 1968):

> "The main cause of undernourishment and malnutrition in South Asia is, of course, poverty and, in particular, the low productivity of man and land in agriculture. The remedy is development, but the way will not be easy, partly because the dietary deficiencies themselves have reduced people's ability to work. On the other hand, as the nutritional deficiencies tend to lower labour input and efficiency and to decrease vitality in general, they themselves constitute one of the obstacles standing in the way of development, particularly in agriculture."

Although at present there exists no authoritative empirical work establishing the precise extent to which low levels of consumption, particularly low food consumption and poor housing conditions, have lead to low productivity

in Bangladesh, the fact that literally millions of people remain unemployed and underemployed year after year, with no social services worth its name to protect them, with the lower 20 percent of the population on the income scale earning no more than 15 to 18 U.S. dollars (1969) per head per annum, should leave no doubt that low consumption must be a fairly strong cause of low labour productivity in Bangladesh.

FOOTNOTES

Chapter 2

1. Death rates in particular the child mortality rates, have declined significantly since the days of Malthus, due to the 'miraculous' developments, unforeseen by Malthus, of twentieth century medical science. Decline in death rates, it may be noted, reinforces the argument for surplus labour.

2. The problems of surplus labour are common to India, Sri Lanka, Indonesia, Pakistan and other countries of south-east Asia.

3. In the regression of log Y = a + bt, where y = per capita GDP and t is time, Khan (1972) found that the estimated value of the coefficient b(= .0027) is statistically insignificant. Khan argues that there are strong reasons to believe that even this estimate is biased upward, so that it is likely that per capita GDP in Bangladesh has declined over time.

4. Khan's study (1972) also suggests that per-capita consumption of rice and cereals which are the staples in Bangladesh have declined over time.

5. Among other studies which also lead to the same conclusion of declining real wages include: (a) "Trend of Real Income of the Rural Poor", by S.R. Bose, PDR, aut. 1968; (b) "Institutional Change and Agricultural Wages in Bangladesh" by E.J. Clay, BDS (1976) and, (c) "What has Been happening to Real Wages in Pakistan", by A.R. Khan PDR, autumn 1967.

6. It has been argued that cultivators do not regard themselves as unemployed if their families own land and they are supported by the general activity of the household even if they are working only a few hours a week.

7. High capital-intensity of production, in spite of relative abundance of labour, may be the reflection of the lack of any possibilities of factor substitution in production or it may be explained by 'distorted' factor prices leading to the substitution of capital for labour.

8. It is this type of employment in the context of which Nurkse considered the underemployed as a source of domestic savings.

9. That low consumption causes low productivity is a well established hypothesis in the economics of underdevelopment. A significant amount of theoretical as well as empirical work on this hypothesis is to be found in the works of Bliss and Stern (1975), Myrdal (1968), and Lebenstein (1957).

CHAPTER 3

EMPLOYMENT GENERATION IN LABOUR-SURPLUS ECONOMIES - TECHNIQUES AND PROSPECTS

INTRODUCTION:

There are few modern theories of growth and development that are specifically employment-oriented. Most growth theories are concerned with the maximization of the rate of growth of national income, rather than attainment of full-employment. The purpose of this chapter is first, to examine the various techniques that are employed to forecast employment, second, to examine a cross-section of employment oriented growth theories so that we may better appreciate the prospects for employment expansion in a labour surplus economy. Special attention is paid to the role of the government in situations where the market mechanism fails to ensure a socially satisfactory level of employment.

TECHNIQUES OF EMPLOYMENT PROJECTION

1. Econometric Technique

In this method, employment projections are based on estimated labour demand functions.

One way of deriving a labour demand function is to first estimate a production function from quantity data and then proceed to infer a labour demand function by assuming profit maximizing behaviour.

An alternative approach to the estimation of a labour demand function is to treat the demand for labour as part of a system of output supply and factor demand equations that are derived by solving the necessary conditions for profit maximization. This approach is usually more demanding of (time-series) data as compared with the former approach.

2. Projections Based on Harrod-Domar Models

Aggregate employment projections have also been based upon macro-economic growth models of the Harrod-Domar type. This is done by first independently projecting output growth based on one version of this model and then tying demand for a homogenous type of

labour to the output projection with a fixed coefficient. Although unsophisticated, this methodology has been applied for 'deriving' employment projections in more than one national planning document[1].

With the introduction of the input-output technique to the formulation of development programmes a natural extension of the crude manpower projection approach has been to put both the sectoral output and employment projections into a more elaborate and consistent forecasting framework. However, basing output projection on the Leontief inverse matrix has not altered the essential one-way linkage between output and employment; given final demands, gross outputs are determined, which in turn automatically determine employment.

In some recent planning models (e.g., Adelman, (1966) , Almagir (1971)) of the fully consistent optimizing type, attempts have been made to incorporate employment by tying demands for different types of skilled labour to the output levels of each production activity through fixed coefficients labour-output ratios and by putting upper bound constraints on the supply of each labour category. When binding, these labour constraints limit the primal solution and the significance

(in terms of the objective function) of each of these constraints is indicated by their respective "shadow wages" in the solution to the "dual".

The linear programming technique provides a much more flexible framework for employment generation than its earlier counterparts. It is also the least demanding of data. This technique provides greater scope for employment generation than the input-output technique because there may be wide variation in the labour-output ratios within an aggregate sector corresponding to different production techniques and the programming formulation allows one to introduce, at least, theoretically, a different activity for each production technique. This introduces limited scope for direct factor substitution into the model.

Although the programming formulation is undoubtedly the most flexible and is potentially the most powerful technique known which can be used to compute the 'maximum' labour absorptive capacity of an economy under prespecified conditions, the actual employment generation indicated in the solution to the 'primal' of any programming problem will depend on the objective function which is maximized and also on the nature of the data used in implementing the model.

PROSPECTS FOR EMPLOYMENT GENERATION AND THE ROLE OF THE GOVERNMENT

As stated in the introduction, most growth theories are output-oriented. But given the macro-economic interrelationship between consumption, output, employment and investment, if a country chooses to maximize its GNP, and decides upon a certain volume and pattern of investment to achieve this objective, the inevitable result would be that employment would have to be left free to find its own level, depending on the capital-labour ratio implied by the investment program.

An output-oriented allocation policy may be justifiable in those countries where this policy automatically ensures a high level of employment, but it may be highly inappropriate in the so called labour surplus economies particularly if the structures of these economies imply a strong conflict between the employment and output objectives.

If the traditional GNP maximization approach to development is incapable of spontaneously generating an acceptable rate of growth of employment in the peculiar circumstances of a labour-surplus country, it is then natural to ask what are the different deliberate policy options open to the governments in these countries,

that might be used to alleviate the existing intolerable levels of unemployment. Would these deliberate policy induced increases in employment be unduly costly in terms of the sacrifices of other objectives which the society might have to make? Or would it be possible for the governments in these countries to use the available policy instruments in ways that may simultaneously increase employment and also output?

In what follows an attempt is made to answer the questions raised above in the light of some existing theories on growth and development.

At the risk of oversimplification we may distinguish three different, sometimes overlapping schools of thought that emphasize three different employment creating strategies.

MAXIMIZATION OF RATE OF GROWTH:

The first group emphasizes the role of growth of the economy for the generation of additional work places. Growth of output is primarily a function of capital formation. Thus, diversion of income toward investment rather than consumption is recommended.

Planning models by Chakravarty and Lefeber (1966)

and Lefeber (1968) come to the above conclusion. These models assume: (1) binding capital constraint, (2) non-binding labour constraint ('unlimited' supplies of labour), (3) an exogenously determined industrial wage rate, and (4) that all wages are spent on consumer goods and all profits on capital goods. Under this set of assumptions the authors demonstrate that maximization of investment out of a given income will lead to the highest rate of growth of output and also the highest rate of growth of employment but at the cost of current employment and current consumption. Thus, in the opinion of these authors there exists a conflict between the short-run and the long-run goals of employment. Because of this conflict, the authors see a role for government intervention in the free market, preferably in the form a payroll subsidy to employers in situations where current employment and current consumption are important social goals.

While Lefeber sees a conflict the models of Nurkse (1953), Lewis (1954) and Ranis and Fei (1964) promise simultaneous fulfilment of growth and employment objectives. However, both sets of theories emphasize capital formation, as the main source of employment generation.

These models disaggregate the economy in

terms of agricultural and industrial activities. Their assumptions of technological dualism between agriculture and industry and the existence of surplus labour in agriculture imply that the marginal productivity of labour in industry is much higher than its marginal productivity in agriculture.

The differential in marginal productivities is taken to mean that the opportunity cost of industrial employment is lower than the marginal product from such employment. This, in turn, means that a process of transferring labour from agriculture to industry will result in the accumulation of a social surplus. Thus, economic development in these theories is seen as a process of absorption of the 'labour surplus' through the reinvestment of the 'social surplus' in the industrial sector of the economy.

According to these theories then output and employment can be simulataneously expanded in a labour surplus economy. Indeed these theories do not see surplus labour as an obstacle to economic development rather recognize it as a potential source for domestic savings (Nurkse 1953).

However, the authors recognize that additional employment generation will require complementary resources which may be scarce but they argue that certain simple

types of capital can be produced by labour alone and hence the opportunity cost of employment generation in a situation surplus labour should not be high.

A second group of development models (e.g., Reynolds (1965, 1969), Galenson (1963), Taira (1966), and Miller (1971) emphasize the possibility of 'direct' substitution of labour for capital to generate additional employment from given investment funds. This strategy may be attributed to the neoclassical school of thought.

Under the neoclassical theory of production and distribution, actual employment is determined by technological possibility of substitution between labour and capital and by the relative prices of those factors. Perfectly competitive neoclassical markets ensure that all market prices of factors (and commodities) equal their respective 'shadow prices'. Thus, neither on the production side, where all homogenous machines allow infinite possibilities of factor substitution, nor on the distribution side, where factor prices equal their 'shadow' prices, can there arise any possibility of a conflict between the objectives of output and employment in the neoclassical world.

In the real world, however, such conflicts may arise because both the neoclassical assumptions of 'homogeneity' of capital and 'perfection' of markets

are violated. If 'imperfect' factor markets establish prices which are 'distorted', (from the 'shadow prices' of the factors), socially less efficient techniques may be preferred over socially more efficient techniques because they are privately more profitable. In particular, if the wage-rental ratio is kept arbitrarily high, as is true in many UDCs, using more labour-intensive techniques of production may appear to conflict with increasing output, whereas it is possible that no such conflict would exist if goods and factors were priced at their 'true' scarcity values. Thus, low employment generation (unemployment) is blamed on artificially low interest rates in the labour surplus economies.

The remedies prescribed by the neoclassical school to the problems of unemployment in UDCs are all related to different kinds of 'price-incentive schemes' (tax-subsidy) which are meant to bring the market prices of goods and factors of production more in alignment with their 'true' scarcity prices. The right factor prices, it is believed, will automatically induce firms to select appropriate (generally more labour-intensive) techniques of production, and utilize scarce factors as efficiently as possible.

A third group of models (e.g., Eckaus (1955), Navarette and Navarette (1953), and Fukuoka (1955)), assume that 'direct' factor substitution, through changes in relative factor prices, is technologically impossible because most production relations are of the fixed-coefficient type[2]. Thus, only when capital and labour are available in proportions exactly equal to this fixed ratio, is it possible that both factors can be fully used simultaneously. Since in less developed economies, the available capital is much less than what would be required to absorb available labour with such techniques, in practice an excess supply of labour will result[3].

Planning models that are based on the assumption of fixed coefficient technologies emphasize 'indirect' substitution between labour and capital through allocation strategies that emphasize the relatively labour intensive sectors of the economy to generate additional employment from given availabilities of scarce resources. The proponents of this view have been called the 'interventionist' school of thought.

According to this school, an economy with access to international markets has considerable freedom to concentrate on the manufacture of labour intensive goods. The structure of domestic

production need not correspond to the structure of domestic consumption and investment. Productive employment can be increased both by changing the composition of domestic demand in favour of labour intensive goods and also by exporting goods that require more unskilled labour and importing goods that require more capital and more skilled labour (S. Marglin, 1982, and E. Lee (ed.), 1981).

Stated formally, the basic investment criterion underlying this strategy involves maximizing the aggregate labour-output ratio through the reallocation of investment funds more towards goods and processes that have higher labour-coefficients and away from products or processes that have lower labour coefficients.

Suppose, between Good 1 and Good 2, the labour output ratio for Good 1 is greater than the corresponding ratio for Good 2, i.e.,

$$\frac{L_1}{X_1} > \frac{L_2}{X_2}$$

or

$$\frac{L_1}{K_1} \cdot \frac{K_1}{X_1} > \frac{L_2}{K_2} \cdot \frac{K_2}{X_2}$$

This inequality is satisfied under the following cases:

Case (a).

$$\frac{L_1}{K_1} > \frac{L_2}{K_2} \quad \text{and} \quad \frac{K_1}{X_1} > \frac{K_2}{X_2}$$

Capital investment generates more employment per unit but produces less output in the production of Good 1 as compared with the production of Good 2. In this case, technique 1 which produces the labour intensive Good 1, actually requires more capital per unit of output compared to technique 2, which produces the relatively less labour-intensive Good 2. Social reallocation of scarce capital toward the labour-intensive Good 1, in this case, will come in conflict with the output objective.

Case (a) represents the classic case of 'technological dualism' in many UDCs where labour-intensive small-scale production actually requires more capital per unit of output than relatively less labour-intensive large scale production techniques. The large-scale capital intensive techniques which require less labour produce more output per unit capital due to economies of large scale production.

Case (b).

$$\frac{K_1}{X_1} < \frac{K_2}{X_2} \quad \text{and} \quad \frac{L_1}{K_1} > \frac{L_2}{K_2}$$

In this case, the labour-intensive technique 1 produces more output and also generates more employment per unit of the scarce factor capital compared with the relatively less labour intensive technique 2. From a private production point of view both techniques are efficient. Also, from a social production point of view, reallocation of scarce factors more in favour of the labour-intensive Good 1 will not conflict with the output objective. There is no conflict between output and employment objectives and maximizing employment through appropriate reallocation of capital will also maximize output.

From the analysis above, it appears that the choice of labour-output ratio as the basic investment criterion in a labour surplus underdeveloped economy may but need not conflict with the output objective. If governments in these countries can directly or indirectly control the allocation of investment, there will arise no such conflict in reallocating investment resources more in favour of labour-intensive products and away from capital-intensive products, as is exemplified by Case b.

Thus, the question of a trade-off between employment and output becomes an empirical question, the answer to which can be determined only from specific applications of this investment policy to particular labour-surplus economies.

In the present study an attempt has been made to explore the employment creating potential of the third strategy (output-mix strategy) by applying an appropriate optimization model to the economy of Bangladesh.

FOOTNOTES

Chapter 3

1. In India's First Five Year Plan document employment projections were based on a Harrod-Domar type growth model.

2. According to this view, all observed changes of technical coefficients should be regarded as dynamic transitions from one set of coefficients to another rather than as smooth substitutions along static schedules.

3. Even if technological data allow full employment of all factors, realization of that situation via the market mechanism, is still subject to an extremely restrictive condition on the demand or taste side.

CHAPTER 4

A LINEAR PROGRAMMING PLANNING MODEL

MATERIAL BALANCE CONSTRAINTS

The economy is divided into nine mutually interdependent production sectors[1]. Interdependence consists of interindustrial linkages via a sector's purchases of intermediate inputs from other sectors and via its sales of output to the other sectors. Given the sectoral division of the economy and the pattern of interconnectedness among sectors, the commodity balance constraints are specified to ensure both intersectoral and intertemporal consistency. Intersectoral consistency is ensured by requiring that the total requirement for a commodity during a period must not exceed its total availability during the same period. Intertemporal consistency, on the other hand, implies that the static demand-supply balance for each commodity within a single period must also hold during each and every period of the plan. As will become evident later, the links between two successive periods in the model are established via the expression of endogenous investment demand for capital goods in terms of increments (rather than levels) and via our assumption

of a lag of one period between investment for capacity creation and the realization of output.

Within each period, the supply of a commodity may originate either from domestic production or from foreign imports. The model introduces an explicit choice mechanism between these alternative sources on the basis of the comparative costs principle. There are six mutually exclusive sources of demand for a commodity during each period. These include inter-industry demand for output, demand for private consumption, public consumption, fixed capital formation, investment in inventories and for exports. For any particular commodity (sector) however, not all elements of demand and supply are positive. The uses of a commodity and the sources of its supply are clearly laid out in a "detached coefficients Tableau" on page 91 .

The balance between total supply and total demand for a commodity i in period t expressed in absolute levels of variables (represented by upper-case letters) may be represented by the following inequality relationship:

$$X_i(t) + M_i(t) \geq \sum_j a_{ij}X_j(t) + b_i C_T(t) + \bar{G}_i(t) + \sum_j k_{ij}I_j(t) + \hat{I}_i(t) + E_i(t) \qquad (4.1)$$

The explicit variables in our model, are however,

expressed in terms of increments to the level of each variable (over the previous period) with the notable exception of variables representing investment activities. The appropriate form of the commodity balance constraints expressed in terms of these incremental variables is derived by lagging (4.1) by one period and subtracting the latter from the former. That is,

$$\{X_i(t)-X_i(t-1)\} + \{M_i(t)-M_i(t-1)\} \geq \sum_j a_{ij}\{X_j(t) - X_j(t-1)\}$$

$$b_i\{C_T(t)-C_T(t-1)\} + \{G_i(t)-G_i(t-1)\} + \sum_j k_{ij}I_j(t) - \sum_j k_{ij}I_j(t-1)$$

$$+ \hat{I}_i(t) - \hat{I}_i(t-1) + \{E_i(t) - E_i(t-1)\} \qquad (4.2)$$

Representing the incremental variables by lower-case letters and the levels of variables by upper-case letters, the final form of the commodity balance constraints written in the standard linear programming form, with all exogenous variables on the RHS of the inequality and all endogenous variables on the left, may be represented as:

$$-x_i(t)-m_i(t) + \sum_j a_{ij}x_j(t) + b_i c_T(t) + \sum_j k_{ij}I_j(t) - \sum_j k_{ij}I_j(t-1)$$

$$+ \hat{I}_i(t) - \hat{I}_i(t-1) + e_i(t) \leq - \bar{q}_i(t) \qquad (4.3.M)$$

where, $x_i(t) = X_i(t) - X_i(t-1)$ represents the increment to gross domestic production of commodity i in period t over its level during period (t-1)

$m_i(t) = M_i(t) - M_i(t-1)$ represents the increment to the competitive import of commodity i in period t over its level in period (t-1).

$c_T(t) = C_T(t) - C_T(t-1)$ represents the increment to private consumption expenditure in period t and over its level in period (t-1).

$\bar{g}_i(t) = \bar{G}_i(t) - \bar{G}_i(t-1)$ represents the exogenous increase in government expenditure on commodity i during period t over its level in period (t-1).

$e_i(t) = E_i(t) = E_i(t-1)$ represents the increase in export of commodity i during period t over its level in the previous period.

$I_j(t)$ represents the level of gross fixed investment in sector j in period t. Gross fixed investment is comprised of the inputs of different types of capital goods combined in fixed proportions.

$\hat{I}_i(t)$ represents the level of inventory investment (addition to the stock of working capital) on commodity i during period t.

b_i represents the marginal share of consumption expenditure on commodity i per unit (Taka) increase in aggregate private consumption.

k_{ij} represents the proportion of a unit (one additional Taka's worth) of fixed investment in sector j which consists of the i^{th} type of capital good, irrespective of whether it is domestically produced or imported. Since k_{ij} is defined as a proportion of a unit of fixed investment, the sum of these proportions accounted for by all types of capital goods in the model must equal unity[2], i.e., $\sum_i k_{ij} = 1$

a_{ij} represents the incremental intermediate demand for commodity i, irrespective of whether it is domestically produced or competitively imported, per unit increase in the output of commodity j.

In the standardized form (4.3M), all variables on the LHS of the inequality with positive signs in front of their coefficients represent elements of demand (costs) while those with negative signs may be interpreted as elements of supply within a given period. The term $\sum_j a_{ij}x_j(t)$ represents incremental input demand for commodity i for interindustry uses. It is a function of the constant incremental input-output coefficients[3] and the increase in output in different sectors of the economy. The term $\sum_j k_{ij}\ I_j(t)$ represents the investment demand by different sectors for good of type i in period t. To obtain the increment, the ivnestment demand of the previous period is subtracted from the investment demand of the current period. It should be noted that these terms provide one of the links between two successive periods in the model.

PRICES AND THE ADJUSTMENT FOR THE SERVICES SECTOR BALANCE EQUATION

All the demand and supply variables, including the ones relating to foreign trade activities are expressed in terms of base year purchasers' (or market) prices of commodities. The use of market prices in interindustry models implicitly assumes that each industry

pays the domestic trade and transport costs on all its sales of output and the value of these services together form the intermediate demand for trade and transport input into that industry. In this model the inter-industry demand for services inputs is determined on the basis of fixed input-output coefficients and the levels of sectoral gross outputs.

In the case of imports, the use of domestic market prices implies that the using sectors, in addition to the c.i.f. prices (foreign exchange costs) of imports are also required to pay the government tariff and the domestic trade and transport input costs associated with moving the imported commodities from the ports of entry to their final use locations. This means that an expansion of imports from abroad would place additional demand on the output of the domestic services sector. These additional influences are taken account of by making appropriate adjustments to the commodity balance constraint for the domestic services sector. Thus, the demand-supply balance constraint for this sector is written as:

$$x_s(t)+m_s(t) \geq \sum_j a_{sj}x_j(t) + C_s(t) + \bar{g}_s(t) + \sum_j t_j m_j(t) \quad (4.4.M)$$

where the first term on the RHS represents the interindustry

input demand for the output of the services sector and the last term represents the increase in the demand for services sector output due to increases in imports from abroad. Both these terms are a consequence of using "purchasers' price" rather than "producers' price" in the model. Since one of the important elements of choice in the optimization process is between domestic production and potential (competitive) import in each trading sector, it is important to specify the cost elements of these alternative sources of supply as accurately as possible. The inclusion of the domestic services input into imports is a positive step in this direction.

PRIVATE CONSUMPTION CONSTRAINT FOR A LABOUR-SURPLUS ECONOMY

Household consumption represents by far the largest component of final demand in all developing countries. Inadequate procedures for projecting private consumption is usually a source of substantial errors in all types of planning models.

The most commonly used formula for determining sectoral consumption levels in intersectoral models is[4]

$$\frac{C_i(t)}{N(t)} = A\left|\frac{C_T(t)}{N(t)}\right|^{\varepsilon_i} \qquad (4.5)$$

where, $N(t)$ = population at time t.

$C_T(t)$ = total endogenous expenditure on consumption at time t.

$\varepsilon_i = \frac{d(C_{i/N})}{C_{i/N}} / \frac{d(C_{T/N})}{C_{T/N}}$ = Engel's elasticity for commodity i.

This equation states that sectoral consumption levels depend on expected population and total consumption, via the Engel elasticities.

In practical applications, sectoral consumption forecasts resulting from (4.5) usually do not quite add up to $C_T(t)$. To avoid this margin of error, equation 4.5 is linearized around the base year (1977) consumption pattern, which gives[5]:

$$C_i(t) = \varepsilon_i \frac{C_i(0)}{C_T(0)} C_T(t) + \frac{N(t)}{N(0)} C_i(0) (1 - \varepsilon_i) \qquad (4.6)$$

To guarantee 'adding up' the Engel elasticities are required to satisfy the condition

$$\sum_i \varepsilon_i \frac{C_i(0)}{C_T(0)} = 1$$

The sectoral structure of private consumption in our model is determined on the basis of an incremental

version of equation (4.6) derived by lagging it by one period and then subtracting the resulting equation from (4.6), which gives:

$$C_i(t) - C_i(t-1) = \varepsilon_i \frac{C_i(0)}{C_T(0)} \left| C_T(t) - C_T(t-1) \right| + \frac{N(t) - N(t-1)}{N(0)} C_i(0) \ (1 - \varepsilon_i) \qquad (4.7)$$

Letting

$$\bar{c}_i(t) = \frac{N(t) - N(t-1)}{N(0)} C_i(0) \ (1 - \varepsilon_i)$$

$$b_i = \varepsilon_i \frac{C_i(0)}{C_T(0)} = \frac{d(C_{i/N})}{d(C_{T/N})}$$

equation (3.7) is expressed in terms of our model's notation as:

$$c_i(t) = \bar{c}_i(t) + b_i c_T(t) \qquad (4.8)$$

where $\bar{c}_i(t)$ is the exogenous increase in the final demand for commodity i based upon anticipated increases in population. The marginal consumption share of commodity i for an additional unit increase in $c_T(t)$ is represented by b_i. $c_T(t)$ represents an aggregate

(incremental) endogenous consumption activity. It should be noted here that the tangential approximations (4.7) or (4.8) of equation (4.5) become less accurate, the further away an actual solution of the model gets from the initial (point of tangency) reference point. In most cases the error is insignificant (Bruno 1966).

The aggregate (incremental) consumption expenditure $c_T(t)$ is made endogenous to the "closed" input-output system in the model by tying it to the sum of wage payments out of sectoral production levels. This wage-constrained consumption specification provides a point of departure for a surplus-labor economy from the standard Keynesian consumption function[6].

The so-called closed-loop planning model makes the process of income generation endogenous by tying the factor payments to the levels of sectoral production. Income, in turn, is fed back to consumption expenditure on the assumption of fixed propensities to consume (or save) out of different forms of income, thus restricting the choice between consumption and investment.

The available input-output tables for Bangladesh do not provide any information on the actual breakdown of sectoral value added among payments to factors of production or between "wage" and "non-wage" payments.

No attempt is therefore made to restrict the choice between consumption and investment by the usual method of defining an explicit savings constraint via the assumption of fixed propensities to save (or fixed propensities to consume) out of different forms of income[7]. Instead, the same effect is achieved indirectly by imposing a wage-constrained lower bound on aggregate consumption. This is done by imposing the following constraint on consumption:

$$\bar{w}_s(t) \sum_j \ell_j x_j(t) - c_T(t) \leq \sum_i \bar{c}_i(t) \qquad (4.8M)$$

where $\bar{w}_s(t)$ = subsistence wage rate per unit of employed labour during period t.

ℓ_j = incremental labour-output ratio in sector j.

The definitions of other variables are the same as before.

Constraint (4.8M) imposes a lower bound on consumption in each period. It states that the total production for final consumption $\left[c_T(t) + \sum \bar{c}_i(t)\right]$ in any period cannot be less than the subsistence wage demand for consumer goods in that period. It is based

on the assumptions that each employed worker in the surplus-labour economy receives an institutionally fixed wage, which he spends entirely on consumption goods. If (4.8M) is strictly binding in the optimal solution of the model then total consumption will equal the subsistence wage bill in the economy, and the shadow price corresponding to this constraint will indicate the marginal cost of increasing the subsistence consumption in the economy by a Taka.

Let us now turn to one very restrictive feature of our consumption specification. The fixed pattern of sectoral consumption demand as given by the Engel's relationships does not allow price induced substitutions among different types of consumer goods. Although this assumption may not be very unrealistic for a highly aggregative model, it may sometimes contribute toward highly unstable shadow prices of commodities. For experimentation with a more flexible consumption pattern we may follow Sandee, J. (1960) and Bruno (1966) and allow sectoral consumption levels to vary between bounds constructed at some levels above and below the fixed Engel lines. For a 10% variation around the Engel line, equation (4.8.M) in the model is now replaced by the following inequality constraints:

$$C_i(t) \geq .9\bar{C}_i(t) + .9b_iC_T(t) \qquad (4.8\underline{M})$$

$$C_i(t) \leq 1.1\ \bar{C}_i(t) + 1.1b_iC_T(t) \qquad (4.8.\bar{M})$$

where the definition of all variables are the same as before. The economic implication of this alternative specification is that, within a $\pm$ 10 per cent range of variation around the Engel path, the consumption pattern automatically adjusts itself to relative factor scarcities.

GOVERNMENT CONSUMPTION:

Government expenditure in the model is assumed to consist of expenditure on defense and public administration including expenditure on Health, Education and Family Planning. "Communications" have been merged with "Government", rather than with "Transport" as is the usual practice. The rate of growth of government expenditure is assumed to be determined outside the model based on considerations of past trend. The entire increase in Government expenditure is assumed to be made on the output of the "services sector" S_1 in the model.

Thus,

$$g(t) = \gamma_g(1 + \gamma_g)^{t+1}\ \bar{G}(0)$$

and

$$g(t) = g_i(t)$$

i = services sector

where γ_g = exogenously determined rate of growth of government expenditure per period.

$\overline{G}(0)$ = base-year level of government expenditure.

$g(t)$ = increment to government expenditure in period t over the previous period.

Derivation:

Let $G(t)$ be the level of government expenditure in period t. Then,

$$G(t) = (1 + \gamma_g)^t \overline{G}(0) \text{ and } G(t-1) = (1 + \gamma_g)^{t-1} \overline{G}(0)$$

and

$$g(t) = G(t) - G(t-1) = (1 + \gamma_g)^t \overline{G}(0) - (1 + \gamma_g)^{t-1} \overline{G}(0)$$

$$= (1 + \gamma_g)^t \overline{G}(0) \left| 1 - (1 + \gamma_g)^{-1} \right|$$

$$= (1 + \gamma_g)^t \overline{G}(0) \left| \frac{1 + \gamma_g - 1}{1 + \gamma_g} \right|$$

$$= \gamma_g (1 + \gamma_g)^{t-1} \overline{G}(0)$$

CAPACITY CONSTRAINTS:

Fixed investment performs a twin role in the process of growth of an economy. It is both a source of demand for capital goods and a creator of supply capacity. Fixed investment enters the commodity supply-demand balance constraints (4.3.M)as an element of demand - as a reason for sectoral output expansion. On the other hand, it also enters what are called the "capacity constraints" as a creator of supply capacity which is a prerequisite for output expansion in any sector. The cost of investment is, of course, domestic saving which involves the sacrifice of current consumption. An upper limit on savings and hence investment is imposed, in our model, by the subsistence consumption requirement constraints(4.8.M.)

The rate of growth of the economy over the entire plan is determined by the availability of primary resources, namely, of capital (domestic saving) and foreign exchange. However, the constraints which explicitly limit the level of activity in each sector are formulated in terms of capacity available for the expansion of output. The new capacity installed during any period is given by the product of the net fixed investment in that period and the incremental output-capital ratio. For any particular sector j, the capacity constraints

in our model states that the increase in output in any period t cannot exceed the level indicated by the new capacity installed in the previous period. Thus, assuming a five-year average lag (one period in the model) between investment and realization of output, and interpolating linearly for the intervening years, the capacity constraints are represented by the following inequalities;

$$x_j(1) \leq |5/k_j|\{I_j(0) - \delta_j k_j(0)\}$$

$$x_j(2) \leq |5/k_j|\{I_j(1) - \delta_j I_j(0) - \delta_j(1 - \delta_j)\, K_j(0)\}$$

$$x_j(3) \leq |5/k_j|\{I_j(2) - \delta_j I_j(1) - \delta_j(1 - \delta_j) I_j(0) - \delta_j(1-\delta_j)^2 k_j(0)\}$$

$$x_j(4) \leq |5/k_j|\{I_j(3) - \delta_j I_j(2) - \delta_j(1-\delta_j) I_j(1) - \delta_j(1-\delta_j)^2 I_j(0)$$

$$- \delta_j(1 - \delta_j)^3 k_j(0)\} \qquad (4.9.M)$$

In general, the capacity constraint for any period T is

$$x_j(t) \leq |5/k_j|\{I_j(T-1) - \sum_{\tau=2}^{T} \delta_j(1 - \delta_j)^{\tau-2} I_j(t-\tau) - \delta_j(1-\delta_j)^{T-1} K_j(0)$$

where,

k_j is the annual incremental capital-output ratio for sector j. (Measured in terms of the value of investment per Taka's worth of increase in

output per year.)

δ_j is the rate of depreciation of capital in sector j per period.

$I_j(t)$ is Gross fixed investment in sector j during period t.

$K_j(0)$ The "initial" stock of fixed capital in sector j.

The four periods in the model are defined as

Years	Time Index (t)
1976-77	0 (Base Year)
1981-82	1
1986-87	2
1991-92	3
1996-97	4

For all periods except the first (t=1), the addition to capacity is determined endogenously by the solution to the model. However, because of our assumption of one period lag between investment for capacity creation and the realization of output, the first period capacity to increase output is exogenously given by the amount of net fixed investment undertaken during the base period (t = 0).

INVESTMENT ON CHANGES IN INVENTORIES:

In addition to investment for capacity creation, investment on changes in stocks of inventories is also required. This need arises for several reasons. First, to avoid the inconveniences (costs) arising from the natural delay in getting products transferred from producers to the users; second from the need of users to guard against any uncertainty of supply and finally because the production process is not instantaneous; that is, work in progress necessarily exists.

It is assumed that increases in inventory demand for any commodity i arises from the expansion of output of producing sectors which use commodity i as an input and from increases in the final demand for i. The producer of commodity i does not need to hold commodity i as inventory. Thus, all costs of holding stocks of inventory are changed against the using sectors, including the final demand sectors. The determination of investment on inventory of type i during any period and is given by:

$$\hat{I}_i(t) = \sum_{j \neq i} n_{ij} x_j(t) + n_i \left| C_i(t) + e_i(t) + \sum_j k_{ij} I_j(t) \right| \qquad (4.10.M)$$

where, n_{ij} = marginal working capital (inventory) requirement for commodity i per unit

increase in the output of the j^{th} sector.

n_i = marginal working capital coefficient per unit of final demand (consumption, export and investment) for commodity, i.

As in the case of fixed investment, incremental investment on inventory capital is obtained by subtracting the last period's investment in inventory capital from the present.

FOREIGN TRADE ACTIVITIES AND BALANCE OF PAYMENTS:

At the initial stage of economic development, countries tend to be much more dependent on international trade becasue of their inability to produce capital goods, chemicals and other essential commodities the production of which require non-traditional technology. Even though considerations of dynamic comparative advantage may imply the replacement of many of these imports by domestic production, this cannot be done in the short or the medium run since the cost in terms of the sacrifice of production of other essential commodities would be infinity in the economic sense. Thus, a large proportion of total imports of an underdeveloped country tends to be "non-competitive"

or complementary to domestic production. The complementarity of imports, coupled with the limited possibilities for the expansion of exports often make foreign exchange an extremely scarce asset.

One of the most critical allocation problems facing a planner, therefore, is to ensure efficiency in the allocation of foreign exchange (along with the allocation of other productive inputs) through the appropriate choice of activities in which domestic production should be expanded, usually as a substitute for imports. A second allocation problem is to ensure efficiency in the "production" of foreign exchange through the appropriate choice of activities in which exports are expanded.

The specification of the foreign trade activities in our model allow free choice between domestic production and competitive import as alternative sources of supply of a tradeable commodity. However, the model recognizes that some imports cannot be replaced even in the "medium run" because of technological reasons. Further, since in an highly aggregative model of this type sectors are defined in terms of groups of commodities and since not all cost elements can be specified, it would be unrealistic to treat all imports as "competitive" and hence potentially replaceable by domestic production.

Therefore, imports of commodities identified with sector i consists of "competitive" and "non-competitive"

components[8]. Thus:

$$m_i(t) = \bar{m}_i(t) + \bar{\bar{m}}_i(t) \qquad (4.11)$$

where, $\bar{m}_i(t)$ = incremental non-competitive imports of commodity i during period t.

$\bar{\bar{m}}_i(t)$ = incremental competitive import of commodity i in period t.

Competitive imports are purely endogenous to the model, thus the levels of these activities are allowed to be freely determined by the efficiency considerations underlying the model. Non-competitive imports, on the other hand, are tied to increments in sectoral production and to increments in the consumption of different commodities with fixed import coefficients. Thus,

$$\bar{m}_i(t) = \sum_j m_{ij} x_j(t) + m_{ic} C_i(t) \qquad (4.11.M)$$

where, m_{ij} = marginal non-competitive import of commodity i per unit increase in the output of sector j.

m_{ic} = coefficient representing the amount of import needed per unit increase in the consumption of commodity i.

The balance of payments constraint states that the incremental requirement of foreign exchange for financing "noncompetitive" and "competitive" imports during any period must not exceed the incremental availability of foreign exchange from domestic exports and from "net capital inflow" during that period. Imports and exports are evaluated in terms of their c.i.f. and f.o.b. prices. However, the overall balance of payments constraint is formulated in terms of the domestic currency so that a fixed exchange rate between domestic and foreign currencies is assumed. The algebraic formulation of this constraint is given by the following inequality:

$$\sum_i p_i^* \bar{m}_i(t) + \sum p_i^* \bar{\bar{m}}_i(t) - \sum q_i^* e_i(t) \leq \Delta\bar{F}(t) \qquad (4.12.M)$$

where, p_i^* is the c.i.f. price (foreign exchange cost) in terms of the domestic currency per unit import of commodity i.

q_i^* is the f.o.b. price (foreign exchange earnings) in terms of domestic currency per unit export of commodity i.

$\Delta\bar{F}(t)$ is the increment to "net foreign capital inflow" during period t. For simplicity $\Delta\bar{F}(t)$ is defined to include expected increases in the availability of foreign

> exchange from all possible sources exogenous to the model, including public and private foreign grants, aids, net factor income from abroad, minus the (exogenous) interest charges on past foreign borrowings.

The procedure of using the c.i.f. and f.o.b. prices of tradeables has been recommended by Diamond and Mirrlees (1971) who believe that in second best situations the balance of payments constraint in planning models should be written in terms of "world prices" rather than the tariff/subsidy ridden domestic prices, so that at least production efficiency will prevail. But a reliable data source for "world prices" is not readily available in most less developed countries. However, they may be indirectly estimated from domestic market prices by making a number of simplifying assumptions[9].

The formulation (4.12.M) for the balance of payment constraint is based on the assumption of infinite elasticity of demand for both home exports and home imports. The assumption of infinite elasticity of demand for exports violates the reality of the foreign trade market facing Bangladesh. In particular, since Bangladesh commands a relatively large share of the

world market in the export of jute, the assumption of a downward sloping demand curve for agricultural exports (exports can be expanded only at lower prices) would be more realistic. This monopolistic element in export demand could be incorporated into a "linear" programming model by a "step function" approximation of the marginal revenue curve associated with a given downward sloping demand curve for export. However, in the absence of the necessary statistical information even this method would require a number of arbitrary assumptions.

In order to take into account some of the rigidities in the export market, in a rather crude way, the exports of particular commodities may be allowed to vary only within prespecified feasible ranges, defined by an upper and a lower bound of the following type:

$$q_i^* e_i(t) \leq \bar{e}_i(t)$$

$$q_i^* e_i(t) \geq \underline{e}_i(t)$$

where $\bar{e}_i(t)$ and $\underline{e}_i(t)$ are exogenously specified upper and lower limits respectively to the increment to export of commodity i during period t.

TERMINAL CONSTRAINTS:

To ensure sufficient net investment in the terminal period, terminal capacity expansion in each sector is subjected to a lower bound. These constraints are needed to ensure a reasonable rate of growth during the post-terminal period.

The literature on intertemporal planning models does not provide any unique method of setting terminal constraints. Consequently, different authors seem to have different ways of formulating these constraints. In this model, terminal constraints are formulated on the assumption that the net fixed investment in the terminal period must be sufficient to provide for an increment in sectoral output during the post-terminal period at least as large as that during the terminal period. These are expressed as:

$$\frac{1}{k_j}\Big| I_j(4)-\delta_j I_j(3)-\delta_j(1-\delta_j)I_j(2)-\delta_j(1-\delta_j)^2 I_j(1)-\delta_j(1-\delta_j)^3 I_j(0)$$

$$-\delta_j(1-\delta_j)^4 K_j(0)\Big| \geq dx_j(4) \qquad (4.13.M)$$

T = 4 is the terminal period.

j = 1,...,6

NON-NEGATIVITY CONSTRAINTS:

The resource balance constraints which merely require that the demand for any commodity cannot exceed its supply during a period may be satisfied for many unrealistic and impossible or economically meaningless values of the variables included in those constraints. In order to define the "feasible" region for the plan further restrictions on the variables are required. Since negative values for economic variables are meaningless, feasibility requires all variables in the model be non-negative.

Many dynamic programming models provide much latitude for specialization of final demands either into consumption or into investment activity. Such specialization on consumption or investment is prevented in this model by the minimum consumption requirement constraint (4.8.M.) There is however, nothing to prevent investment in particular sectors from falling to unrealistically low levels. To prevent specialization in sectoral investment activities, we impose the following constraints:

$$I_j(t) \geq (1 - b_j)\, I_j(t-1)$$

$$0 < b < 1$$

where υ_j is exogenously given to the model on the assumption that the change in fixed investment (i.e., $I_j(t) - I_j(t-1)$) in any sector from the previous to the current period cannot be more negative than υ_j percent of the previous periods fixed investment in that sector.

THE APPLICATION OF AN "ABRIDGED" VERSION OF THE MODEL

It is often not possible to know a priori whether a multisectoral programming model has a feasible solution. The existence of such a solution is predicted upon both the quality of the theoretical construct of the model and also on the quality of the data utilized in its empirical implementation. It is therefore felt that it may be more efficient (in terms of saving on the computer cost and the overall time spent in reaching a solution) to try to implement an 'abridged' version of the 'primal' before attempting to implement the full-scale model.

Besides its usefulness as a check on primal feasibility such an exercise,it is believed might be a valuable learning experience in itself. It would allow us to study the behaviour of the model under a simplified set of conditions giving full freedom to the activities to assume any non-negative values. It is hoped that the nature of the solution to such a version of the model will shed light on the major shortcomings of the primal in ways that will help us make further improvements in the composition of the enlarged primal.

The abridged version of the model is implemented by classifying the economy into four sectors (agriculture, two manufacturing and a services sector) which are

projected over two periods. Foreign imports are allowed to compete with the outputs of the first three sectors only. The cost structure of imports includes inputs of foreign exchange and also of trade and transport input from the domestic services sector. Exports of commodities are defined as separate and independent activities.

The four sectors of this model are derived by aggregating a 47 x 47 input-output table for Bangladesh for the year 1976-77. The principal basis for aggregation has been the labour intensity of the original sectors, that is, sectors in the 47 x 47 table with similar labour-output coefficients were grouped together to define the four sectors of this model. However, in order that the inter-industrial linkages of the economy are not too seriously disturbed, farming, manufacturing and services activities were generally kept separate, so that consolidation was done mainly within each type of activity and not across activities.

The optimization behaviour in the model is assumed to be based on a policy of maximization of incremental employment (defined in man-years) over two periods.

The results of this optimization are not presented in the thesis. Also in analysing these results all details regarding the numerical values of the primal

and the dual variables are suppressed. Instead only those broad aspects of the solution are discussed that are indicative of inconsistencies and other shortcomings in the composition of the primal model.

An optimal solution to the abridged model was obtained on the first run. However, the results indicated the following peculiarities:

First, there appeared to be a problem of a commodity being both imported and exported during the same period. This feature of the solution could be justified because of the highly aggregative nature of the sectoral commodities defined in the model. However, the problem turned out to be much more serious, due to the fact that exports of some commodities during a given period were not based on domestic production of the commodities but on their prior imports. Such a process of import and re-export of commodities would be impossible to justify in a country like Bangladesh where the level of technical skill is generally very low.

The problem of the re-export was indicative of a serious structural weakness in the model. The nature of the solution seemed to suggest that the specification of imports as depending on the input of domestic trade and transport services combined with the possibility of unrestricted expansion of exports were

mainly responsible for this undesirable result.

The possibility of unrestricted expansion of exports tends to cause the shadow price of foreign exchange to be low relatively to the shadow prices of domestic resources. This tends to make imports cheaper than domestic production of commodities. On the other hand, the input of domestic services into imports implies that imports indirectly generates employment (objective function) by expanding the output of the domestic services sector. On account of the beneficial aspects of both exports and imports (in terms of their contributions to the value of the objective function) the process of importing and then re-exporting for some commodities became more 'profitable' than the process of producing and exporting those products.

Given the linear structure of the model, cheaper imports are expanded and are re-exported until further expansion is prevented by some resource limitation. Trade and transports services being an input into competitive imports, such imports are brought to a stop only when the services sector output reached its capacity limitation. This gave a high shadow price to domestic services.

Like all linear models, the solution to the abridged version of the model displayed tendencies toward complete specialization in production and foreign trade activities. There also seemed to be some degree of temporal specialization in the sense that the model tended to rely more on competitive imports during the first period while during the second period domestic production seemed to predominate.

Finally, it was observed that the optimal structure of production during the first period was such that the available sector capacities in this period (supplied by 'initial' sectoral investments) were not fully utilized. This implied an inconsistency in based period investments and the planned production in the first period. However, the endogenously determined sectoral capacities during the second period were all fully utilized.

FOOTNOTES

Chapter 4

1. The details of the basis for sector classification is explained in Appendix A.

2. If the flows of capital goods are measured in physical terms then there is no reason why the columns of matrix (k_{ij}) should sum to unity. Aggregation problems however, almost always rule out such specification. If, on the other hand, the matrix (k_{ij}) is interpreted as referring only to nationally produced or competitively imported goods, then the columns of the matrix (k_{ij}) may not sum to unity even in value terms because of dependence of the country on non-competitive imports.

3. We need not assume strict proportionality between imports and output in a sector. Since the variables of the model are expressed in terms of increments, the linear non-homogenous input-output relation of the type $X_{ij} = \overline{X}_{ij} + a_{ij}X_j$ is perfectly consistent with our model. ($\overline{X}_{ij}$ is some constant.)

4. To mention just a few, this formula is used by Bruno (1966); Taylor (1975), Bergendroff, Blitzer and Kim (1973) and L.E. Westphal (1971).

5. The linearization is achieved by using Taylor series expansion.

6. A wage constrained consumption specification was originally suggested by Little and Mirrlees (1969). A similar constraint was also employed by Louis Lefeber (1968).

7. Regarding the need for introducing an explicit saving constraint in planning models there seems to be some differences of opinion among planners and model builders. There seems to be two basic approaches to the treatment savings in planning models. The first of these is based on the belief that:

   "any development scheme that is physically, technically, and organizationally feasible and that makes sense on the foreign exchange side, need encounter no insurmountable domestic financing difficulties." J.P. Lewis, 1962 "Quiet Crisis in India."

Footnotes (Chapter 4.)

This approach suggests that domestic savings do not impose a binding constraint on economic growth. Planning models of the so-called "open-loop" type which embody this approach carrying out the optimization process subject to the primary resource of foreign exchange only leaving the determination of domestic savings (in terms of shadow prices) to the optimization process itself (usually by the interaction of consumption maximization and the investment demand specification in the model.

On the other hand, planning models of the so called "closed-loop" variety, exogenously restrict the choice between consumption and investment by explicit upper bound constraints on domestic saving based on fixed marginal propensity (or propensities) to save (or consume) out of total income (or different forms of income). Such explicit saving constraints are based on the belief that institutional, political and economic courses tend to impose a definite upper limit to the feasible rate of savings in underdeveloped countries (A.K. Sen, 1961).

8. If the sectors of the model could be defined in terms of distinct homogeneous commodities (meaning complete disaggregation) it would be unnecessary to divide imports into a sector as composed of a competitive and a non-competitive part. In that situation, imports into a sector could be treated as either entirely competitive or entirely noncompetitive.

9. Assuming that tariffs and subsidies are the only commercial instruments used by the government, the domestic market price of an importable commodity i will in competitive equilibrium, equal the world price of commodity i (small country assumption) plus the government's tariff on commodity i plus the internal services input cost charged against the import of commodity i. Thus:

$$p_i = p_i^* + t_i + t_{ji}$$

where, p_i is the domestic market price of commodity i.

p_i^* is the "foreign price" of commodity i.

t_i is the 'average'tariff per unit import of commodity.

t_{ij} is the domestic trade and transport import coefficient per unit import of commodity i.

Footnotes (Chapter 4)

Now, by convention if we set all base year domestic market prices equal to unity, then the c.i.f. price of commodity i may be calculated from the following relation:

$$p_i^* = 1 - t_i = t_{ji}$$

The f.o.b. prices of exportables may be calculated by a similar reasoning.

CHAPTER FIVE

INTRODUCTION:

The results of the optimization exercise of the previous chapter with the so called "abridged" version of the model revealed some of the obvious shortcomings of its structural composition. The "enlarged" programming model of this chapter carries over the basic structure from the model of the previous chapter but introduces a few modifications in order to achieve a more realistic set of outcomes. In this and the following chapter (chapter six) of the thesis we study the "enlarged" allocation model in both its primal and dual forms.

A preliminary optimization exercise under the "most liberal" specification of the enlarged primal is performed in order to examine how the model uses the freedom it has been given. Its main purpose is to contribute to our understanding of the working of the primal optimization processes. The "quantity solution" of this exercise shows the sectors of the economy in which the model indicates that the economy's scarce resources should be allocated. It also indicates the resources or sectors which form bottlenecks for the economy when expansion of employment is the primary social target.

Each shadow price of the "dual solution", on the other hand, gives a quantitative measure of the relative seriousness of each bottleneck resource. For reasons explained later we have termed the results of this exercise as the "Naive Solution". The presentation and the analysis of the results of the "Naive Solution" forms the subject matter of this chapter.

The contents of this chapter are organized under four sections. In section two the 'enlarged' programming model is presented in a compact matrix form, followed by a brief discussion focusing on the elements that are new to the enlarged model. Section three is devoted to analysing the properties of the 'dual' to the employment maximization problem. In section four, the assumptions which characterize the primal model in its "most liberal specification" are spelt out. In this section we also present the results of the "Naive Solution" and provide an interpretation of the same in the light of the scarcity price of the dual solution.

SECTION II: REFORMULATION OF THE PRIMAL MODEL

Essentially, the enlarged programming model of this chapter is derived from the model of the previous chapter by further disaggregating the economy into nine sectors and by extending the planning horizon to four periods. The nine sectors for this model are derived by consolidating the 1976/77 input-output table (47 x 47) on Bangladesh. For details of the aggregation procedure see Appendix A.

The model of this chapter, in the spirit of its smaller counterpart of the previous chapter, seeks a set of production and trade variables which maximize the use of surplus labour services over a finite period and at the same time satisfy

1. Limitations on overall demand in each sector during each period.
2. Limitations on the structure of final demand and on the minimum level of the increment to aggregate consumption each period.
3. Limitations introduced by the need to hold inventories of inputs of various commodities by the "using" sectors.

4. Limitations imposed by non-competitive imports of intermediate and capital goods.
5. Limitations on the incremental availability of foreign exchange during each period.
6. Limitations imposed by the structure of production and finally
7. Limitations imposed by the need to provide for economic growth during the post-terminal period.

A matrix representation of these sets of restrictions on the primal, with an explicit count on the number of constraints arising from each type of restriction is presented below.

A variable with the distinguishing mark (') is a row vector, other variables that are dated represent column vectors, and an upper-case letter with no time dimension represents a matrix, unless an alternative meaning is explicitly mentioned. The appropriate dimensions of these vectors and matrices are presented at the end of the model. Table (5.1) on page No. 91 shows in "detached coefficients" form.

The notations used in the previous chapter are preserved here. The only new variables introduced into the enlarged model are variables NTM(t), which represent

"net competitive import" of commodity, during period t. All the symbols carry the same meaning as in the previous chapter with the only exception of the variables, $I_j(t)$ which previously represented sectoral physical investments now represent sectoral investments measured in terms of capacity output.

The competitive import and the export of the "Products" of each internationally trading sector were treated as separate and independent activities in the model of the previous chapter. Aggregation over commodities (sectors) gave rise to the possibility that a sector may both import and export its output. In the model of this chapter, the "competitive import" and the "export" activities for each traded "commodity" are combined into a single "net competitive import" (NTM) activity. This is done in order to avoid the problem of import and re-export (of a commodity) which arose under the old specification.

We may now formally present the "enlarged" allocation model in its most general form. It involves the maximization of the function Z, where

$$Z = \frac{1}{(1+\gamma)^t} \left[\ell' \, x(t) \right]$$

subject to the following restrictions:

Commodity Balances

$$-[I-A]\ x(t) + B[I(t) - I(t-1)] + [\hat{I}(t) - \hat{I}(t-1)] + bc_T(t)$$

$$+\ h'\ NCM(t) + d'\ NTM(t) - NTM(t) \leq -\bar{g}(t)$$

$t = 1,2,3,4$ No. of Constraints = 4 x 9 = 36

Minimum Consumption Constraints

$$\ell'\ W\ x(t) - c_T(t) \leq 0$$

$t = 1,2,3,4$ No. of Constraints = 4 x 1 = 4

Inventory Investment Constraints

$$N \cdot x(t) - \hat{I}(t) \leq 0$$

$t = 1,2,3,4$ No. of Constraints = 4 x 7 = 28

Non-Competitive Import Constraints

$$M\ x(t) + m_c c_T(t) - NCM(t) \leq 0$$

$t = 1,2,3,4$ No. of Constraints = 4 x 8 = 32

Balance of Payments Constraints

$$p_1^{*'}\ NCM(t) + p_2^{*'}\ NTM(t) \leq F(t)$$

$t = 1,2,3,4,$ No. of Constraints = 4 x 1 = 4

Capacity Constraints

$$x(1) \leq I(0) - \delta_1' K(0)$$

$$x(2) \leq I(1) \leq -\delta_1' I(0) - \delta_2' K(0)$$

$$x(3) \leq I(2) + \delta_1' I(1) \leq -\delta_2' I(0) - \delta_3' K(0)$$

$$x(4) \leq I(3) + \delta_1' I(2) + \delta_2' I(1) \leq -\delta_3' I(0) - \delta_4' K(0)$$

No. of Constraints = 4 x 9 = 36

Terminal Constraints

$$-I(t) + I(t-1) \leq 0$$

where, t = 4

Dimensions of the various matrices are as follows:

$A = |a_{ij}|$ = (9 x 9) matrix of incremental input-output coefficients

$B = |k_{ij}|$ = (9 x 9) matrix of marginal capital-output coefficients

$W = |W_j|$ = (9 x 9) diagonal matrix of sectoral wage rates

$M = |m_{ij}|$ = (8 x 9) matrix of non-competitive import coefficients.

$N = |n_{ij}|$ - (7 x 9) matrix of incremental working capital coefficients.

D_1, D_2 = 9x9 Diagonal matrices whose elements represent the sectoral rates of depreciation of capacity per period, for the first and the second periods, respectively.

Vectors:

b = (9 x 1) Column vector of marginal consumption proportions.

d' = (1 x 9) Row vector of trade margins (Sector 8), associated with net Competitive imports.

h' = (1 x 9) Row vector of trade and transport margins (Sector 8) associated with Non-Competitive imports.

ℓ' = (1 x 9) Row vector of sectoral Labour-Output ratios.

$P_1^{*'}$ = (1 x 8) Row vector of foreign exchange cost (cif) coefficients associated with Non-Competitive imports.

$P_2^{*'}$ = (1 x 6) Row vector of foreign exchange cost/revenue coefficients associated with net competitive imports.

δ_i' (for i = 1,2,3,4) represents (1 x 9) row vector of rates of capacity depreciation, measured in terms of percentage loss of sectoral output per period.

Endogenous Variables

$x(t)$ - (9 x 1) Column Vector of Sectoral gross outputs

$I(t)$ - (9 x 1) Column Vector of sectoral fixed investment by destination, measured in terms of incremental capacity outputs.

$\hat{I}(t)$- (9 x 1) Column Vector of inventory investment on different types of commodity inputs.

$NCM(t)$ - (8 x 1) Column vector of non-competitive imports of various commodities.

$NTM(t)$ - (6 x 1) Column vector of net competitive import/export of various traded commodities

$c_T(t)$ is a scaler representing the increment to aggregate consumption during any given period.

Exogenous Variables

$\bar{g}(t)$ = Scaler representing incremental govt. consumption during period t. Government Consumption consists of incremental expenditure on health, education and defence and

comes out of the services sector S_2 (or Sector 9).

$\bar{F}(t)$ = Scaler representing incremental availability of foreign exchange from all exogenous sources.

$K(0)$ = (9 x 1) column vector of the stocks of total available capacity in different sectors at the start of the plan.

$I(0)$ = (9 x 1) column vector of new capacities created in the various sectors during the base period ($t = 0$)

The meanings and the derivations of the above sets of primal constraints have been explained in detail in chapter four. However, some clarifying comments regarding the new capacity variables $I(t)$ and the foreign trade variables $NTM(t)$ are in order here.

The variables $I(t)$ make provision for the expansion of the capacity levels of each sector (industry) to meet the requirements of future final demands. B is a matrix of incremental capital coefficients in which the j^{th} comumn represents the inputs from each capital goods industry needed to build an additional unit of fixed capacity for the j^{th} sector.

TABLE (5.1)

THE LP TABLEAU FOR THE FIRST PERIOD SHOWING ITS LINKAGES WITH THE SECOND PERIOD

VARIABLES		x(1) 9	$C_T(1)$ 1	I(1) 9	$\hat{I}(1)$ 9	NCM(1) 9	NTM(1) 6	x(2) 9	$C_T(2)$ 1	I(2) 9	$\hat{I}(2)$ 9	NCM(2) 9	NTM(2) 6		Exogenous Right Hand Side
CONSTRAINTS															
Commodity Balances	9	-(I-A)	$\mathfrak{b}$	B	I		-I							$\leq$	$BI(0)+I\hat{I}(0)-G(1)$
Consumption	1	$\ell'W$	-1											$\leq$	0
Working Capital	7	N			-I									$\leq$	0
Non-Comp. Imports	8	M	m_c			-I								$\leq$	0
Foreign Exchange	1					$p_1^{*'}$	$p_2^{*'}$							$\leq$	F(1)
Capacity	9	I												$\leq$	$I(0)-D_1K(0)$
Commodity Balances	9			-B	-I			-(I-A)	$\mathfrak{b}$	B	I		-I	$\leq$	-G(2)
Consumption	1							$\ell'W$	-1					$\leq$	0
Working Capital	7							N			-I			$\leq$	0
Non-Comp. Imports	8							M	m_c			-I		$\leq$	0
Foreign Exchange	1											$p_1^{*'}$	$p_2^{*'}$	$\leq$	F(2)
Capacity	9			-I				I						$\leq$	$-D_1I(0) - D_2K(0)$
Maximize ΔL	=	ℓ'						ℓ'							

Let

$$I'(t) = |I_1(t),\ I_2(t) \ \ldots\ I_9(t)| \quad = \text{the}$$

nonnegative capacity expansion vector, where $I_i(t)$ is the additional capacity for industry i in period t. Then the i^{th} row of the product $B\,(t)$, that is, $b_{i1}I_1(t) + b_{i2}I_2(t) + \ldots + b_{i9}I_9(t)$ represents the amount of the i^{th} (capital good) sector's production that is used to build additional fixed capacity in time period t for all the industries in the economy. Since the model is expressed in terms of increments, the current period's incremental demand for the i^{th} type of capital good over its demand in the previous period is obtained by subtracting the previous period's demand BI(t - 1) from the current demand BI(t). It may be noted that for t = 1, the terms BI(0) (demand for capital goods for capacity formation is the base period) are exogenously given to the model. For $t \geq 2$, these become endogenous to the model and are determined along with other decision variables by the optimization process.

The elements of the vector NTM represent net competitive import of specific products. The i^{th} net competitive import $NTM_i(t)$ represents the difference between the incremental competitive import and the increment export of the i^{th} "commodity" during period t. These variables are not required to be nonnegative. Their signs are left unrestricted by introducing negative

lower bounds $[NTM(t) \geq -\bar{K}]$ on them. It may be expected that those sectors which have a comparative advantage in domestic production will be net exporters with the sign of the corresponding NTM variable negative, while trading sectors whose products are costly to produce domestically will be net importers and the signs of their NTM variables will be positive in the optimal solution.

SECTION III. AN ECONOMIC INTERPRETATION OF THE DUAL TO THE EMPLOYMENT MAXIMIZING PROBLEM

The dual variables (shadow prices) in a programming model play a similar allocative role as actual prices in a competitive market economy. The selection procedure in the simplex algorithm ensures efficiency in the allocation of resources by economizing on inputs which are very scarce and therefore expensive (high shadow price) while using as much as possible of the inputs which are cheap (Low shadow prices). Production of commodities with high shadow value are given priority over those with low values. Because of this important function which they perform, the shadow prices which emerge from the primal optimization should themselves make proper economic sense. Failure on this account would cast serious doubt on the credibility of the results of the primal system, at least as far as its allocative or comparative advantage aspects are concerned.

An examination of the dual price system is also necessitated by the fact that these prices can be used to check the logic of optimization underlying the primal system. Critical assumptions regarding economic behaviour may be implied by the primal optimization process.

These may not be evident from a large primal with numerous constraints. Yet an inspection of the dual may clearly bring these to the surface. In this sense an explicit analysis of the dual may be considered a prerequisite for the full understanding of the working of the primal model, and for a full assessment of its weaknesses and shortcomings.

UNITS OF MEASUREMENT OF SHADOW PRICES

If measurement units are applied consistently throughout the primal model, then the unique structural relationship between the primal and the dual ensures that the dual will also be free from units problem. Ideally choice of units in defining variables (and parameters) should be made on efficiency or theoretical considerations. In actual model implementation, however, such choices are often constrained by the nature of the available data. When units are chosen on the basis of data availability, it is important to ensure that they are mutually consistent and make sense along each row in the primal. The following relations show how units chosen for the primal uniquely determine the unit of measurement of the dual variables in this model.

The primal problem is to maximize

$$\sum_{j=1}^{n} \left(\frac{\text{man years per year}}{\text{Takas of output j per year}}\right) \left(\frac{\text{Million Takas of output j}}{\text{period}}\right)$$

$$= \frac{\text{Million Man Years}}{\text{Period}}$$

Subject to

$$\sum_{i=1}^{m} \left(\frac{\text{input i}}{\text{output j}}\right) \left(\frac{\text{Million Takas of output j}}{\text{period}}\right) \leq \frac{\text{Million Takas of input}}{\text{period}}$$

for all i

and, $$\left(\frac{\text{Million Takas of output j}}{\text{period}}\right) \geq 0 \quad \text{for all j}$$

and the dual is to minimize

$$\sum_{i=1}^{m} \left(\frac{\text{Million Takas of input i}}{\text{period}}\right) P_i = (?)$$

Subject to

$$\sum_{i=1}^{m} \left(\frac{\text{input i}}{\text{output j}}\right) P_i \geq \left(\frac{\text{man years per year}}{\text{Takas of output j per year}}\right)$$

for all j

$$P_i \geq 0, \quad \text{for all i}$$

We see that the dual constraints will be consistent only when the shadow price P_i, on the i^{th} primal resource, has the following unit.

$$P_i = \frac{\text{man years}}{\text{Takas of resource } i} = \text{for all } i$$

Therefore, the shadow price on each type of resource in this model, must be interpreted as being measured in units of labour services. Labour is the 'numeraire'. All value expressions in the cost-benefit evaluations of activities will also be expressed in terms of labour units.

With employment as the primal maximand it is not surprising that the resource prices should be measured in labour units. In fact, this follows from the linear programming definition of shadow prices. The shadow price of a scarce resource,in this model, represents the increase (decrease) in the optimized (discounted) value of the expansion in employment over the plan which results from the "availability" of one additional (one less) unit of the resource (commodity and factor) in question. In order to explain what this means let us assume for a moment that the optimal solution has been reached with activities $(A_1,\ldots,A_k)$ in the optimal basis and the optimal scales of these activities are $(x_1^*,\ldots,x_k^*)$. Now, let us increase the "availability" of resource i by a unit by increasing the exogenous RHS of the i^{th} resource constraint by one unit. If this extra unit of resource i feeds through the system without

changing the activities in the optimal basis, then the levels of these activities must adjust such that these adjustments in the aggregate consume just one more unit of resource i and nothing more and nothing less of any other resource in the system. Suppose these changes in the levels of the optimal basic variables are given by $(\Delta x_1^*,\ldots,\Delta x_k^*)$. Some of these changes may be negative, some zero, but at least one must be positive. The resulting increase in the value of the objective function (OF) will be given by $\Delta(OF^*) = \sum \ell_i \Delta x_i^*$, and this change will measure the shadow price of the resource i whose quantity was raised by a unit. In this sense, the shadow price of a resource measures the implicit value of a unit of that resource to the model in terms of the maximand. We shall see in a moment that this interpretation of a resource price will be very helpful in the explanation of some of the dual constraints in the model.

The dual problem may now be given the following meaning. It is to find a set of shadow prices (in labour units) for the scarce resources of the economy such that the (incremental) value (cost) of the resources at these prices is minimized over the plan, subject to the condition that no price can be negative, and that each activity at best operates at zero profit with respect to these prices. Any activity which incurs a loss at these prices will not be used.

DUAL VARIABLES

The following symbols are used to designate the shadow prices of the dual solution:

$P_i(t)$ = shadow price of commodity i during period t.

$P_c(t)$ = shadow price of consumption during period t.

$P_{mi}(t)$ = shadow price of non-competitive import of commodity i during period t.

$P_{n_i}(t)$ = shadow price of inventory demand for good i during period t.

$P_{vj}(t)$ = shadow rental of the capacity constraint in sector j during period t.

$P_F(t)$ = shadow price of foreign exchange during period t.

$P_i^{UB}(t)$ = the opportunity cost associated with the upper bound on the exports of commodity i during period t.

P_{Tj} = shadow price of the terminal constraint on sector j.

$P_{kj}(t)$ = shadow price of capacity constraint on sector j during period t.

The constraints of the dual fall into five groups, each associated with a particular type of activity in the primal:

1. Those associated with the domestic production activities. These may best be interpreted as equating the "marginal cost" and the "marginal benefit" of operating each sector's production activity at the unit level. In terms of the earlier notation on resource prices, the dual to the j^{th} sector's production activity for period t may be written as

$$- P_j(t) + \left[\sum_{i=1}^{9} a_{ij} P_i(t) + (\ell_j W_j) P_c(t) + \sum_{i=1}^{7} n_{ij} P_{ni}(t) + \sum_{i=1}^{8} m_{ij} P_{mi}(t) + P_{Kj}(t) \right] \geq \ell_j$$

$$j = 1,2,\ldots,9$$
$$t = 1,2,3,4 \qquad \text{(D.1)}$$

When this sector actually produces the above constraint must hold as a strict equality, allowing us to write it as

$$\left[\sum_{i=1}^{9} a_{ij} P_i(t) + (\ell_j W_j) P_c(t) + \sum_{i=1} n_{ij} P_{ni}(t) + \sum_{i=1} m_{ij} P_{mi}(t) + P_{Kj}(t) \right] = \ell_j + P_j(t) \qquad \text{(D.2)}$$

The expression on the left represents the unit domestic cost of production for commodity j (or activity j)

where each element of cost is evaluated at the shadow price of the respective input. The RHS represents the sum of "direct" and "indirect" benefits associated with the production of a unit of commodity j. Domestic production of a unit of commodity j directly contributes ℓ_j to the value of the objective function by operating the j^{th} production activity at unit level. On the other hand, the "availability" of the additional unit of commodity j which this (production) entails indirectly contributes P_j to the objective function through the readjustment of the levels of the "basic" activities, as explained earlier.

If allocative efficiency is defined purely in terms of output then the condition (D.2) implies too much production (marginal cost > price) is realized because employment is chosen as the objective. This, in turn, suggests that GNP (in terms of shadow prices) could be increased if maximization of employment is not an objective.

However, some sacrifice of output may be justified for additional employment in situations of large scale unemployment and underemployment. The "direct" contributions ℓ_j^s which represent the employment coefficients associated with the various production activities could also be viewed as the "weights" the society puts on production

in different sectors of the economy. Such weights could be justified not only because widespread unemployment may be looked upon as a "social bad" but also because in many less developed countries production as a means of employment expansion and the consequential wage payment, may be the least costly if not, the only feasible mechanism for attacking abject poverty among the least fortunate groups in society*. (See F. Stewart and P. Streeten (1971) A.K. Sen. (1975).

In models which maximize consumption, gross output is not given any "direct" social value because such models assume that only "final" goods matter. However, if expansion of employment becomes an overriding social objective then gross output will not only have an indirect value (its shadow price) but also a direct value to the society. When this happens, the cost of the resources embodied in a product may exceed its shadow price by the amount of its direct contribution to the social objective.

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* The view that espouses growth first distribution later presupposes an efficient fiscal system. Taxation combined with unemployment relief, free social services and other forms of assistance to the unemployed could be used as an engine of redistribution. In the absence of an efficient fiscal system or any other systemmatic channel of redistribution job creation may be the only way by which income can be redistributed to those who would otherwise remain unemployed.

2. The constraint associated with the aggregate consumption activity represents the second type of dual constraint in this model. Aggregate consumption is treated as a "composite" basket and is represented by a single primal activity in each period. The individual elements of this basket are the products of the various sectors. Each product included in aggregate consumption may have two components, a domestically produced component and a (non-competitive) imported component. So long as even one domestic sector produces, the aggregate consumption activity will be in the optimal basis. This activity must, therefore, just break even. Thus:

$$P_c(t) = \sum_{i=1}^{9} b_i P_i(t) + \sum_{i=1} m_{ic} P_{mi}(t) \qquad (D.3)$$

$$t = 1,2,3,4$$

where b_i and m_{ic} are the "marginal shares" of the domestically produced and noncompetitively imported components of commodity i in a unit of aggregate consumption such that $\sum_i b_i + \sum_i m_{ic} = 1$. The sum of the product of these shares with the shadow prices of

the respective commodities gives the "shadow cost" of a unit of consumption in this model. Equation (D.3) therefore, equates the shadow price of a unit of consumption with the "shadow cost" of a unit, of the same.

3. Relations for the interdependence of efficiency prices over different time periods may be obtained by considering the dual restrictions associated with the capacity building activities in the model. For instance, when a positive amount of fixed capacity is built in sector j in period $t(I_j(t) > 0)$, then the following dual relation must hold exactly.

$$k_{6j}P_6(t-1) + k_{7j}P_7(t-1) - k_{6j}P_6(t) - k_{7j}P_7(t) -$$

$$- P_{kj}(t) + \sum_{\tau=t+1}^{T} \delta_j(1-\delta_j)^{\tau-3} \; P_{kj}(\tau) = 0 \qquad \text{(D.4)}$$

Sectors 6 and 7 are the two capital goods producing sectors in the model

where $t = 2,3,\ldots T$

$j = 1,2,\ldots 9$

Collecting the like terms and solving for $P_{kj}(t)$ the above equation can be rewritten in the following way:

$$P_{kj}(t) = \{k_{6j}\left[P_6(t-1)-P_6(t)\right]+k_{7j}\left[P_7(t-1)-P_7(t)\right]\} +$$

$$+ \sum_{\tau=t+1}^{T} \delta_j(1-\delta_j)^{\tau-3}P_{kj}(\tau) \qquad \text{(D.5)}$$

$$t = 2,3,\ldots T$$

The interpretation of this equation becomes easier if we remind ourselves that a unit of new capacity built in the $(t-1)^{th}$ period actually becomes available for output expansion in the t^{th} period when it starts to depreciate and continues to do so up to the terminal period T. There are, therefore, two separate elements of cost associated with capacity expansion, namely, cost of fixed capital and the cost of depreciation of capacity (measured in terms of percentage loss of output of respective sectors).

Now, let us take a closer look at equation (D.5). k_{6j} and k_{7j} represent the amounts of machinery capital (Sector 6) and construction capital (Sector 7), respectively, needed to build a unit of fixed capacity in sector j, while P_{6j} and P_{7j} represent the shadow prices of these two types of capital goods. Thus, the expression in the second set of brackets on the RHS of (D.5) may be interpreted as the incremental fixed capital cost of a unit of new capacity in sector j. It (capital cost) is measured by the "weighted" sum of the changes in the prices of capital goods between the current and the following periods, the weights being the physical quantities of the different types of capital goods required per unit capacity. The price change terms in (D.5) occur because

the demand for capital goods, like all other variables in this model, is expressed as an increment of current demand over the level of demand in the previous period. If last period's new capacity is just maintained in this period, then there will be no new demand for capital goods in the current period. It is as if building a unit of new capacity in this period reduces the need for new capacity by one unit in the next period.

The last term on the RHS of (D.5) represents the accumulated increment to the cost of capacity depreciation per unit of new capacity built in the j^{th} sector during the period.

These two elements summed together give the "marginal" cost of adding a unit of fixed capacity in sector j during period t. The marginal benefit from the same unit of capacity is measured by its shadow price $P_{kj}(t)$ on the LHS of equation (D.5). It is now clear that equation (D.5) merely states the generalized "complementary slackness" condition (every activity in the optimal basis must just cost out) on the capacity building activities in this model.

It is interesting to note that for any given value of t, the price change terms $[P_6(t-1) - P_6(t)]$ and $[P_7(t-1) - P_7(t)]$ are the same for all sectors in the

system. This means that if the variation in the rate of depreciation across sectors is not very large, then the variation in capacity shadow prices among sectors within the same period will mainly reflect the differences in sectoral capital-intensities, where the j^{th} sector's capital intersity is given by $k_j = k_{6j} + k_{7j}$. The higher the capital intensity for a sector, the higher will be the shadow price on its capacity constraint and hence larger will be the contribution to the value of the objective function from a unit relaxation of this restraint. In this special sense the shadow price on a sector's capacity constraint may be taken as an indicator of the sector's "own" rate of return on fixed investment.

4. The dual constraint to an activity producing inventory demand states that if the inventory demand for commodity i during period t actually exceeds its level during period (t-1) then the imputed value of commodity i in its use as working capital during period t, $P_{ni}(t)$, will equal the excess of commodity's shadow price during period (t-1) over its shadow price during period t.

$$P_{ni}(t) = P_i(t-1) - P_i(t) \qquad (D.6)$$

$$i = 1,2,\ldots,7$$

$$t = 2,3,4$$

This may be given a similar interpretation as the dual constraints on the capacity variables in the model. We may treat the maintaining of a level of inventory investment on some commodity i, as a process of transferring it from one period to the next. If last period's investment is just maintained in this period there will be no new demand for commodities in the current period on this (inventory) account. It is as if a unit of inventory investment made in this period leads to a unit reduction in the need for inventory accumulation in the next period. Because of this, the "net shadow cost" of operating the i^{th} inventory activity at unit level in period t is given by the difference in the shadow price of commodity i during period t and its price during period (t-1).

5. The non-competitive import activities produce complementary imports of intermediate and capital goods for the domestic production activities. For any positive increment in employment, these primal variables will be in the optimal basis. Thus, the dual constraints associated with this set of primal activities will hold as strict equalities.

$$t_{8i}P_8(t) + p_i^* \quad P_F(t) = P_{mi}(t) \qquad \text{(D.7)}$$

$$i = 1,2,\ldots,6,\ 8 \text{ and } 9$$

$$t = 1,2,3,4$$

Equation (D.7) states that for a positive increment in the noncompetitive import of commodity i, its shadow price P_{mi} during any period will be determined by its marginal import cost during the same period.

6. The final set of constraints on the price system of the "dual" are associated with the "net competitive import" activities in the "primal" model. The tying together of competitive import and export activities into a single "net competitive import" activity compels us to treat exports as symmetrically opposite to competitive imports, that is, a commodity will be exported when its "net competitive import" activity is operated in the reverse (negative) direction.

When commodity i is an importable, its unit shadow cost of import (consisting of the sum of the value of the inputs of foreign exchange and the value of the domestic trade and transport margins into its import) may either exceed or equal the domestic shadow value $P_i(t)$ of a unit of commodity i. Thus, the dual constraint for an importable i will read as follows

$$p_i^* P_F(t) + t_{si} P_s(t) \geq P_i(t) \qquad (D.8)$$

Commodity i will be optimally imported if the two sides

of (D.8) are exactly equal. If, however, import cost of commodity i is strictly greater than its shadow value to the domestic economy then the efficiency requirement of the optimization system will force the corresponding (net) competitive import activity to operate at zero level or possibly at a negative level, in which case, commodity i will actually be exported rather than imported.

If commodity i is an exportable then the "net domestic cost" of supplying a unit of i for export must be at least as great as the "net domestic benefit" from the export of a unit of commodity i. Thus,

$$\left[p_i^* P_F(t) + t_{si} P_s(t) - P_i^{UB}(t)\right] \leq P_i(t) \qquad (D'.8)$$

Since the actual export of commodity i necessitates a positive domestic production of the commodity (this follows from the material balance constraint for commodity i), it follows from the "complementary slackness" condition (D.2) (see page 100) that the shadow price $P_i(t)$ of the commodity i will exactly equal its 'net domestic cost' of production (Gross domestic cost minus 'direct' benefit). Thus the shadow price $P_i(t)$ (RHS of D'.8) measures the net domestic cost of supplying a unit of commodity i for exports.

The "net domestic benefit" from the export of commodity i (LHS of D'.8) consists of the sum of the value of the foreign exchange earned from its export and the value of the trade and transport margins "released" by its export minus the opportunity cost $P_i^{UB}(t)$ associated with the sector specific upper limit on the export of commodity i. $P_i^{UB}(t)$ will be positive only if the export of commodity i hits its predetermined upper limit, and will then measure the "opportunity cost" which is incurred due to this restriction on the further expansion of export of i. $P_i^{UB}(t)$ being a measure of cost is subtracted from the benefits derived from the export of i to derive its "net domestic benefit".

It is difficult to rationalize the "release" of trade and transport margins from the expansion of export. This term appears in (D'.8) because of combiniing competitive import and the export of a commodity into a single net competitive import activity. Clearly, the existence of this term in (D'.8) overstates the actual benefits derived from exports. For this reason, the trade and transport margins are dropped from the basic solutions of the model. (These margins may be introduced later and their significance studied in terms of sensitivity analysis.)

CRITERIA FOR RESOURCE ALLOCATION

There are two independent constraints on the shadow price of each internationally traded commodity, one imposed by its domestic cost of production (D.2) and the other by the cost of importing it from abroad (D.8). For the j^{th} importable these constraints are

$$\left[\sum_{i=1}^{9} a_{ij}P_i(t)+\ell_j(w_jP_c-1)+\sum n_{ij}P_{n_i}(t)+\sum_{i=1} m_{ij}P_{ij}(t)+P_{kj}(t)\right] > P_j(t)$$

'Net' resource cost of domestic production of commodity j — Shadow Price of Commodity j

and

$$p_j^* \cdot P_F(t) \geq P_j(t)$$

Foreign exchange cost of importing commodity j — Shadow price of commodity j

At least one of these relations must hold as a strict equality during any period since otherwise both domestic production and imports will be zero. This cannot be. From the nature of the inequalities it is clear that the lower of the two costs will determine the shadow price of a traded commodity. If the import cost for commodity j is lower (than its cost of production)

then the shadow price $P_j(t)$ of commodity j will be determined by its cost of import and the commodity will be optimally imported rather than produced domestically. This implies that the shadow price of foreign exchange $P_F(t)$, during any period, will be determined by the ratio of the "shadow price" and the "world price" of each optimally imported commodity.

If, for a traded commodity, the net production cost is lower than its import cost, such a commodity will be optimally produced and possibly exported. For those commodities which are optimally exported, the dual constraints (D.2) and (D.8) will both hold as strict equalities. This means that the shadow price of an exported commodity will simultaneously equal its net domestic production cost and the net benefit from its export.

SECTION FOUR

A NAIVE SOLUTION

As mentioned in the introduction to this chapter, a preliminary optimization exercise consisting of the "most liberal" specification of the primal was carried out to examine how the model exploits the freedom it is given. Within the limitations of its basic structure, a maximum number of degrees of freedom to increase the value of the objective function are created by adopting the following set of assumptions regarding the composition of the primal model.

1) All exogenous restrictions on the incremental levels of all variables are eliminated. In particular, no direct upper or lower bounds are imposed on the scale of operation of any of the decision variables in the model. We saw before (see Section 2 of this chapter) that economic considerations require the net competitive import (NTM) variables to be unrestricted in sign. The twin conditions that both the signs and the numerical values of these variables be allowed to be determined endogenously, uninhibited by any prior restrictions, are met simultaneously by setting the lower bounds on these variables at minus infinity, that is: $NTM_i(t) \geq -\infty$ for $i = 1,2,\ldots,6$ and $t = 1,2,3,4$. Of course, in reality these variables will never assume values of minus infinity

since the commodity balance constraints themselves impose a finite lower bound on potential net export of each product. Also, the scarcity of foreign exchange will prevent any of these variables to assume a value of plus infinity.

2) Scope for increasing the value of objective function was also created by expressing the entire set of primal restrictions as weak inequalities of the type ($\leq$) with the general meaning that the incremental demand for a resource must not exceed its incremental supply during any period. This allows the model to "overproduce", and "underutilize capacity" and/or to "overimport" some commodities, if it is optimal to do so.

3) Further opportunities are created by setting the incremental availability of foreign exchange from all exogenous sources, including aid, grants and private remittances, at an outside limit of 2500 million takas (or 160 million U.S. dollars) during each period. When compared to the past trend in the growth of aid, this does not seem to be an over ambitious target. However, in later exercises (Chapter 6) the effect of unanticipated decreases in the availability of foreign exchange is studied.

4) To avoid the "export bias" which the introduction of "trade margins" (into imports) tend to produce (See section 3), these margins are ignored in this preliminary exercise.

5) Finally, additional scope for enhancing the value of the objective function is also created by maximizing incremental employment over the plan in the undiscounted form; that is, the same weight is given to future employment as to present employment. This assumption is relaxed later and the results are discussed in Chapter 6 of this thesis.

The set of assumptions described above, characterize the model in its "most liberal" specification. The solution to the model under this set of assumptions will be referred to as the "Naive" solution.

The rest of this section describes the results of the "Naive" solution to the model and points out the aspects of the solution which are important for sectoral investment planning from the vantage point of a central planner, when employment creation is considered to be the primary target. With linear production and import cost functions one source of supply for each traded commodity will be cheaper than the other at all

levels of supply. This, along with the asssumptions of the "most liberal specification" (no bounds) will tend to produce tendencies toward complete specialization in the internationally trading sectors of the model.

The specialization tendency is the reflection of the economy's comparative advantage. With employment as the maximand, the directions of the economy's comparative advantage during any period may be made the basis for defining sectoral priority for incremental employment generation. Therefore, a sector which produces and exports its product in the optimal solution is to be treated as a priority sector for future employment decisions. A sector thàt produces and also imports some of its products from competing sources should be treated as a priority sector in comparison with a purely importing sector.

The specification of sectoral priorities based on the specialization tendencies of the solution must be qualified in the following ways:

1. For most sectors of the economy, some non-competitive import is specified in the model. If it is profitable to expand production in some sector and if noncompetitive import of that type of product is somewhere specified, then there will be two sources of supply despite zero competing import of that product.

A sector that expands (and probably exports) even though some of its product is noncompetitively imported is to be treated as a priority sector.

2. Comparative advantage and hence sectoral priority may change over time in the model because of dynamic changes in relative prices of inputs. Thus, it is conceivable that a sector which is a purely "importing sector in the earlier periods may emerge as a priority sector in later periods. Of course, the converse of this is equally likely.

Finally, in interpreting the results it should be remembered that all current variables in this model measure increments of values over the previous period. Thus, if the production variable in a sector has a value zero in the optimal solution while the net competitive import variable for that product has a positive value, this must not be interpreted to mean that the domestic industry in question should be entirely shut down and all its demand met from foreign imports. It merely means that this particular sector is not a priority sector in the sense that investment in this sector should not be expanded over previous levels for future expansion of employment.

The results of the "Naive" solution are presented on Tables (5.T.1) and (5.T.2). Table (5.T.1) presents the optimal structure of domestic production and the associated structure of foreign trade activities for each of the four periods in the model. The shadow price system corresponding to various sets of primal constraints are presented in Table (5.T.2). These prices form an integral part of the cost-benefit comparisons on the basis of which all optimal decisions on the quantity variables are made (see section 3 of this chapter).

Table (5.T.1) is divided into three blocks. Down any column in the top rectangle are recorded the optimal values of a sector's gross output for different periods, followed by net competitive import (positive numbers) or export (negative numbers) of its product over the same periods, in the second block, and finally the values in the third block are the optimal complementary import of this sector's product from the first to the terminal period. A symbol underneath each value of output indicates whether the output in question has reached its upper bound (UB), lower bound (LB) or whether it is within bounds (B). Under the assumptions of the "Naive" Solution, only the first period outputs are constrained

from above by the fixed capacities created in the base period (t = 0). (Since period one's capacity "constraints" are defined as "bounds", no shadow prices corresponding to capacity constraints during this period exist (see Table (5.T.2))). Sectoral outputs in all other periods are constrained to be in the range zero (LB) and infinity (UB). The "opportunity cost" incurred when a sectors' production activity hits upper or lower limit is indicated by the (decimal) number beneath the bounds symbol. The opportunity costs for all trading activities are zero since these variables are always within bounds ($-\infty$ to $+\infty$). The first six sectors in table (5.T.1) , namely the two agricultural sectors (A_1 and A_2) and the four manufacturing sectors (M_1, M_2, M_3, and M_4) are open to competition from imports of similar products from abroad. These will be referred to as the "international" sectors. The last three activities in Table (5.T.1) namely, the activities producing construction capital (C), and the two types of domestic services (S_1 and S_2) will be referred to as the "National" sectors. Imports are not allowed to compete with these activities, although domestic production of the outputs of some of these activities may depend on noncompetitive imports from abroad.

In the decision regarding the optimal choices among the international sectors during period one (t = 1),

it is interesting to note that none of the four manufacturing activities are operated at positive level while the outputs of the two farm activities which have lower labour intensities than manufacturing sector M_3 are pushed to their "initial" capacity limits. The comparative advantage and the consequent specialization in farm products, the relative disadvantage in manufactured products and their import can be explained by a cost-benefit analysis of the activities which produce these products.

For an activity to be chosen in the optimal basis it must break even, that is, its total contribution (direct plus indirect) to the objective function must equal the cost of the resources which the activity uses up.

On the benefit side, the indirect benefits indicated by the shadow prices are higher for the farm activities than for the non-farm activities (see Table 5.T.2). The farm products derive their higher shadow prices from their higher potential export (foreign exchange) values. There are two reasons for this. First, their value added coefficients are much larger than the corresponding coefficients for the manufacturing activities. This means that per unit of gross output,

the farm activities produce larger quantities of export (final output) than the activities producing manufactured products. Second, the unit foreign exchange coefficients (world prices) are higher for agricultural than for other traded commodities. This is due to higher degrees of tariff protection of industrial activities in the past. Higher "world prices" of farm products make them potential candidates for exports while the lower "world prices" of manufactured products encourage competitive import of these products.

An inspection of the domestic cost structures of the farm and manufactured activities show that the latter activities rely more heavily on costly (high shadow prices) complementary imports. Also, with the exception of sector M_4 (capital goods) rest of the manufacturing activities depend significantly for intermediate pruchases on the farm products the shadow prices of which, as we have just seen, are high. Thus, the manufacturing activities are costlier to operate than the farm activities.

Therefore, from both benefit and cost consideration the farm activities are more likely to break even than the manufactured products. In fact, it can be shwon from the dual constraints that evaluated at the shadow prices, the 'net domestic cost' of production for each of the industrial activities is

strictly greater than the (foreign exchange) cost of importing their products from abroad. A net saving of foreign exchange and other scarce inputs is realized by importing these commodities rather than producing them domestically.

To finance the required imports of manufactured products the model is forced to produce at least one of the remaining internationally traded commodities (namely, the two farm products A_1 and A_2) domestically and export it. For this it first chooses the non-food agricultural product (Jute) - which is the "most attractive" export commodity during this period. Its highest shadow price in this period (.001279) is a reflection of this sector's foreign exchange earning capacity. The model fully exploits the higher foreign exchange earning capacity per unit output of this sector by pushing production in this sector to its "initial" capacity limit. The 'opportunity cost' associated with this sector's upper bound (UB) is also higher than that associated any other sector's upper bound. This means that more can be gained (in terms of increasing the value of the objective function) by relaxing the production limit on activity A_2 than by relaxing the upper limit on any other production activity.

The upper bound limits the production expansion of sector A_2^*. The effect of this loss of production possibilities on the expansion of net exports of sector A_2 is unfavourable. That is, sector A_2 increases its exports less than it would in the absence of the production bound. In order to compensate for the loss of foreign exchange earnings another international sector - the "food" agricultural sector (A_1) which is the next best source of supply of foreign exchange - is forced to produce domestically and export its product during this period. The foreign exchange requirements of period one are fully satisfied by expanding the output (and export) of this sector. However, if, even after this, more foreign exchange were needed, the optimizing system would then substitute domestic production for imports in the "third best" sector for export expansion and so on. Since the need for additional foreign exchange is met by forcing successively less attractive (more costly) domestic sectors into production, this process implies an increasing marginal cost on foreign exchange during the first period in the model.

* In fact, it is conceivable that if the production bound was set at a sufficiently low level, it might even be necessary to increase imports of product A_2 rather than its exports during period one.

Turning to the choice of activities among the non-trading or "National" sectors (C_1, S_1 and S_2) we find that these activities are forced into the 'optimal basis' because of the absence of any alternative source of supply of the commodities which these activities produce. They remain in the optimal solution during all four periods. However, the "initial" capacities available to these sectors are only partially utilized, although beyond the first period all available capacities are fully utilized.

It is puzzling that although construction capital (sector C) has the highest shadow price (.001466) during period one, the available capacity in this sector given by the "initial" fixed investment during period $t = 0$ is only partially utilized in this period. An explanation of this depends only partly on the low demand for construction capital implied by the optimal pattern of production during period one and partly on the pattern of allocation in the second period.

Capital goods provide the primary link between successive periods. These goods are used in fixed proportions in the production of "fixed capacity" in different sectors. Because of the assumption of one period lag, how much new capacity is added in a particular sector during any period depends on the decision to

expand output of that sector in the following period. Decisions to expand sectoral outputs in the following periods depend on the scarcity prices of that period. This means that the demand for capital goods during any period depends not only on the contemporaneous shadow prices but also on the prices of the following period. The underutilization of the available capacity in the construction goods sector (C) during period one despite its high scarcity price during the same period can now be explained as a case of low demand for this type of capital implied by the scarcity prices (and the pattern of allocation) of the second period. In particular, the complete specialization in the production of non-food crops (sector A_2) and the dramatic drop in 'food' production (Sector A_1) during the second period, is a definite cause for low demand for construction capital in period one.

In general, all shadow prices decline from the first to the second period (See Table (5.T.2)). However, there is little change in the ratio of pairs of shadow prices, so that the pattern of comparative advantage for the economy do not undergo much change from the first to the second period. Like the first period, all manufactured goods are still imported rather than produced. However, in the absence of any upper limits on sectoral outputs beyond period one, all imports of

this period are financed through complete specialization in the production and export of the "most attractive" or the cheapest source of foreign exchange which still happens to be the non-food agricultural sector A_2.

The possibility of earning all foreign exchange requirements of period two through the expansion of output and export of a single commodity implies that unlike period one (during which the model incurs increasing marginal cost for foreign exchange) the marginal cost of foreign exchange remains constant in this period. However, the resultant expansion in the output and the export of this commodity (A_2) is unrealistically large (see table (5.T.1)). This causes the marginal productivity of foreign exchange to decline in this period, which in turn, is responsible for the drop in the shadow price of foreign exchange both in comparison to its own price during period one and also in relation to other resource prices in period two. Since all commodity prices are directly or indirectly tied to shadow prices of foreign exchange (through the dual constraints associated with the net competitive import/export activities) there occurs a general deflation in all shadow prices during period two.

There is no change in the pattern of comparative advantage between period 2 and period 3.

The same activities appear in the optimal basis during both periods. The situation changes somewhat in the terminal period (t = 4). Now two of the "international" sectors namely, the non-food agricultural sector A_2 and the labour intensive manufacturing sector M_3, produce domestically and export their products. The emergence of Sector M_3 as a net exporter during period 4 from being a net importer in the earlier periods suggests that the scarcity values of resources have changed in a way such that the domestic production cost of sector M_3 has declined relative to the cost of importing its product from abroad. It also implies that in terms of the direct and indirect contribution to the value of the objective function, Sector M_3's relative ranking among the international sectors must have improved over time. (See Table 5.T.3)).

TABLE (5.T.1)

THE DISTRIBUTION OF PRODUCTION AND FOREIGN TRADE VARIABLES IN THE "NAIVE SOLUTION" AND THEIR OPPORTUNITY COSTS

Period	A_1	A_2	M_1	M_2	M_3	M_4	C	S_1	S_2
T = 1	49.388 (UB) .000244	25999 (UB) .000278	zero (LB) .000343	zero (LB) .000621	zero (LB) .000258	zero (LB) .000374	4767 (B) zero	10556 (B) zero	27929 (B) zero
T = 2	zero (LB) .000019	151194 (B) zero	zero (LB) .000211	zero (LB) .000499	zero (LB) .000264	zero (LB) .000424	11012 (B) zero	28282 (B) zero	50062 (B) zero
T = 3	zero (LB) .000011	164304 (B) zero	zero (LB) .000154	zero (LB) .000147	zero (LB) .000121	zero (LB) .000229	15308 (B) zero	30948 (B) zero	57130 (B) zero
T = 4	zero (LB) .000005	155760 (B) zero	zero (LB) .000105	zero (LB) .000052	55488 (B) zero	zero (LB) .000067	4383 (B) zero	37184 (B) zero	68698 (B) zero

Net Competitive Imports (+) Exports (-)	NTM_1	NTM_2	NTM_3	NTM_4	NTM_5	NTM_6
T = 1	-10198	-14574	10203	4401	10866	1299
T = 2	72213	-130287	18341	9195	22552	13841
T = 3	82385	-147487	20349	10200	24634	16447
T = 4	97038	-134249	29514	12871	-21545	9132

Non-Competitive Imports	NCM_1	NCM_2	NCM_3	NCM_4	NCM_5	NCM_6	NCM_8	NCM_9
T = 1	792	291	966	70	23	1468	127	49
T = 2	253	1575	1721	142	47	2592	339	89
T = 3	281	1713	1876	158	52	2878	371	101
T = 4	739	1639	1860	183	9233	4541	446	122

TABLE (5.T.2)

SHADOW PRICES OF RESOURCES IN THE NAIVE SOLUTION

Commodity Balance Constraints	A_1	A_2	M_1	M_2	M_3	M_4	C	S_1	S_2
T = 1	.001266	.001279	.001253	.000816	.001196	.000974	.001466	.000839	.000929
T = 2	.000694	.000702	.000687	.000448	.000656	.000534	.000884	.001033	.000745
T = 3	.000309	.000312	.000306	.000199	.000292	.000238	.000419	.000569	.000358
T = 4	.000036	.000037	.000036	.000024	.000034	.000028	.000023	.000272	.000096
Capacity Constraints									
T = 1	---	---	---	---	---	---	---	---	---
T = 2	.000092	.000051	.000229	.000068	.000037	.000103	.000039	.000537	.000198
T = 3	.000063	.000035	.000155	.000047	.000025	.000069	.000024	.000378	.000148
T = 4	.000048	.000026	.000116	.000036	.000019	.000051	.000016	.000292	.000123
Inventory Investment Constraints									
T = 1	.000571	.000577	.000566	.000369	.00054	.000439	.000582		
T = 2	.000386	.000390	.000382	.000249	.000364	.000297	.000465		
T = 3	.000272	.000275	.000269	.000176	.000257	.000209	.000397		
T = 4	.000036	.000037	.000036	.000025	.000035	.000027	---		
Non-Competitive Import Constraints									
T = 1	.001266	.001279	.001253	.000816	.001196	.000974		.001207	.001207
T = 2	.000694	.000702	.000687	.000448	.000656	.000534		.000663	.000663
T = 3	.000309	.000312	.000306	.000199	.000292	.000238		.000295	.000295
T = 4	.000036	.000037	.000036	.000024	.000034	.000028		.000035	.000035

TERMINAL CONSTRAINTS

	T = 1	T = 2	T = 3	T = 4			
Sector 1				.000004			
Sector 2				.000002			
Sector 3				.000011			
Sector 4				.000003			
Sector 5				.000002			
Sector 6				.000005			
Sector 7				.000002			
Sector 8				.000022			
Sector 9				.000007			
Aggregate Consumption Constraint	.001137	.000705	.000325	.000061			
Foreign Exchange Constraint	.001361	.000746	.000332	.000039			

TABLE NO. (5.T.3)

RANKS OF SECTORS BASED ON THEIR TOTAL CONTRIBUTIONS TO THE OBJECTIVE FUNCTION IN DIFFERENT PERIODS

Sector Name	Total Benefit Per Unit activity by sector	T = 1	Rank of Sector	T = 2	Rank of Sector	T = 3	Rank of Sector	T = 4	Rank of Sector
A_1	$\ell_1 + P_1$	.001352	2	.000766	5	.000381	5	.000108	4
A_2	$\ell_2 + P_2$	.001352	2	.000775	4	.000385	4	.00011	3
M_1	$\ell_3 + P_3$	.00127	4	.000704	7	.000323	7	.000053	9
M_2	$\ell_4 + P_4$	.000833	9	.000493	9	.000244	9	.000069	8
M_3	$\ell_5 + P_5$	.00126	5	.00073	6	.000366	6	.000108	4
M_4	$\ell_6 + P_6$	.001021	6	.000581	8	.000285	8	.000075	7
C	$\ell_7 + P_7$	.001528	1	.000946	2	.000481	2	.000085	6
S_1	$\ell_8 + P_8$	.000908	8	.001102	1	.000638	1	.000341	1
S_2	$\ell_9 + P_9$	.--1006	7	.000822	3	.000435	3	.000173	2

CHAPTER SIX

POLICY EXPERIMENTS

INTRODUCTION

We have seen in the previous chapter (Chapter 5) that the essential "linearity" of the model and the "liberal assumptions" underlying the "Naive Solution" together produce strong tendencies toward specialization along lines of the economy's comparative advantage as implied by the structure of the primal. The resultant numerical values of variables in the "optimal" solution are unrealistic and therefore cannot be realized in practice.

In order to ensure that the optimal values of variables remain within a more or less realistic set of possible outcomes, some of the freedom given to the model under the "Naive Solution" must be reduced. In the context of this model, there are two economically meaningful ways of doing this. The first is to restrict the supply side of the model by imposing upper bounds on the sectoral production variables. Second is to constrain the demand side through the imposition of realistic upper limits on the "net exports" of individual products.

Some of the important consequences of the introduction of production bounds have already been analysed in the context of the "Naive" model, which is characterized by "initial" investments that constrain from above the scales of sectoral outputs in the first

period. (See Chapter 5 pages 120-123) Besides, it seems that in the context of the economy of Bangladesh there exists some structural and institutional reasons which lend strong support to the restriction of exports of individual products from the country (see Section II of this chapter, pages 135-136) For these reasons, we have chosen to restrict the freedom of the model through the imposition of upper bounds on "net exports". The solution to this export-restricted version of the model is made the basis for comparison of the results of all policy experiments that are conducted in this chapter. This solution will be referred to as the "Basic Solution" in the future.

There are four objectives of the exercises performed in this chapter. In order to realize these objectives, a series of optimizations have been conducted in each case and the results are analysed and reported below in a systematic sequence.

Section II of this chapter contains the results of the first set of experiments. These are conducted to explore the consequences of the introduction of upper bounds on net sectoral exports. The results of these experiments are analysed in relation with the results of the "Naive" model which allowed unconstrained expansion of the export of individual products.

The results of the second set of experiments

are analysed in the Section III. These are designed to explore the sensitivity of the optimal allocation strategies to the choice of the long-term development goal and to alternative forms of specification of the development goal. The two alternative development goals considered are employment maximization and consumption maximization. The alternative forms of specification of the objectives considered are "incremental" and "cumulative" forms and "discounted" and "undiscounted" forms.

The third set of experiments examine the sensitivity of the results to moderate changes in some constraints and are the subject of study in Section IV of this chapter. It examines the production and distributional consequences of alternative assumptions regarding the relative wage rates between the agricultural and the non-agricultural sectors; the sensitivity of the results to the availability of foreign exchange from exogenous sources and to moderate variations in the sectoral pattern of tariff rates.

The final set of optimizations are used to derive the trade-off relationships between employment and consumption under alternative sets of assumptions regarding the form of the two development goals. The nature of these trade-offs are graphed and analysed in the final section of the chapter.

It is important to bear in mind that in this process of experimentation with the model, our aim is to look for effects which are relatively insensitive to the changes introduced. Aspects of the solution which display such relative stability may be treated as characteristics of the overall structure of the economy as they are independent of particular assumptions regarding either the objective function or the constraints. The greater the degree of stability of the results to exogenous changes in either the objective or the constraints the higher is the degree of confidence that may be placed on the policy implications derived from the model. If, on the other hand, the development programs are found to be quite sensitive to variations in goal and in constraints then this may be taken as an indication that more careful scrutiny of goals and constraints is required before making any policy recommendations based on the model.

A BASIC SOLUTION - CONSEQUENCES OF DEMAND RESTRICTIONS

This section analyses the consequences of the introduction into the model of upper bounds on "net competitive exports" of the products of the international sectors. The bounds are implemented by imposing negative lower bounds on "net competitive imports" of the type

$$NTM_i(t) \geq - NTM_i(t) \quad \text{for} \quad i = 1, 2, \ldots, 6 \quad \text{and} \quad t = 1, 2, 3, 4$$

Export bounds naturally fit into the overall design of our model which is meant to assess the employment creating potential of the "Sectoral output-mix Strategy" that emphasizes labour intensive sectors. With no direct substitution possibilities in production and with rigid Engels' relations linking private consumption to sectoral outputs (implying no scope for price induced substitution possibilities in consumption) the model has to rely largely upon changes in "net exports" and "net imports" to accommodate the new supply structure resulting from this investment strategy. But, as foreign exchange is assumed to be a primary limiting factor to long-run economic growth, bounds on export of specific products are needed to ensure some degree of realism both in the structure of foreign trade and

in the overall capacity of the economy to earn foreign exchange and grow.

The limitations on the expansion of the export of specific products can also be justified in terms of at least two other considerations.

The first is that the assumption of constant returns to scale implied by linear sectoral technologies is inappropriate in the agricultural sectors due to the presence of land as a fixed factor of production. Since the fixity of land is not introduced as an explicit constraint in the model, decreasing returns to scale in agriculture may be crudely simulated by imposing direct or indirect upper bounds on farm outputs. The introduction of export bounds on farm products imposes such indirect limits on farm production.

Another justification for upper bounds on exports is that increased jute supply by Bangladesh may depress its world market price implying that export earnings may actually be limited.

In the light of these considerations limits on exports of individual commodities are introduced. However, the capacity of the economy to export individual products is allowed to grow overtime. The assumed growth rates of the export of individual products are such that the rate of growth of overall export during any period does not exceed 40% or 8% per year . The

resultant upper limits on the exports from each sector over different periods is shown in Table 1 on page 205

Before analysing the solution resulting from the imposition of simultaneous upper bounds on net exports of all the international sectors (Basic Solution), we first isolate the impact of an upper bound on the exports (during different periods) of a single sector. To make sure that these upper bounds will be optimally active, the sector that is chosen is the one that was found to be the most attractive (least costly) exporting sector under the naive solution (i.e., the solution with no such export bound). Recall that this sector was the Non-Food Agricultural Sector A_2.

Algebraically, the newly added constraints take the following simple form: $NTM_{A_2}(t) \geq -\overline{NTM}_{A_2}(t)$ for t = 1, 2, 3 and 4. This apparently increases the total number of constraints in the model by four. However, since period one's upper bound on the export of sector A_2 makes this sector's production bound in the same period (imposed by the new capacity installed in "base" period) non-binding, there is a net increase in the number of restrictions by only three. Consequently, the number of basic variables in the optimal solution also increases by three.

Given domestic demand, the upper bound on net export imposes an implicit (upper) limit to the output

of sector A_2. When this limit is reached, the model selects another international sector for domestic production and for additional foreign exchange revenue. The sector that is chosen during any period depends on the sector's "opportunity cost of production" under the Naive Solution (i.e., in the absence of export bounds) during the same period. Obviously, the model chooses the sector with the lowest opportunity cost, that is, the sector which requires the least sacrifice of the value of the objective function. Thus, sector A_1 (Food-Agriculture) which under the Naive Solution is a net importer but has the lowest opportunity cost during each of the last three periods (T = 2, 3, 4) emerges as a producing sector and a net exporter of its product in the solution under upper bounds on the exports of the most attractive sector A_2. The same logic seems to apply when export bounds are extended to the top two most attractive international sectors (i.e., sectors A_2 and A_1) under the Naive Solution. Now, the model first expands production in Sectors A_2 and A_1 until the upper limits on exports from these sectors are reached during each period. Beyond this the model has to rely on the relatively more costly manufacturing sectors for additional foreign exchange revenue. Again, the choice of sectors during any period is based on that period's opportunity cost of production of the remaining interna-

tional Sectors (i.e., excluding Sectors A_2 and A_1) under the Naive Solution.

It may be concluded, therefore, that extension of upper bounds on net exports from the most attractive international sector to successively less attractive sectors increases the marginal cost of foreign exchange by preventing complete specialization in the cheaper sources of foreign exchange. Since the model must rely for export expansion on successively higher-cost-sectors, the marginal productivity of foreign exchange declines with each extension of export bounds to an additional sector.

The decline in the marginal productivity of foreign exchange is indicated by the fact that the shadow price of foreign exchange for any given period declines in successive experiments in the process of extending the upper bounds to exports of additional products (or sectors). Since the shadow prices of the internationally traded commodities bear a direct and fixed relationship with the shadow price of foreign exchange, these prices also decline in successive experiments. The shadow prices of the products of the 'national' sectors (services and the construction sectors) also register a similar decline as their intermediate input deliveries from the international sectors become cheaper. Therefore, the

introduction of upper bounds on exports by adversely affecting the productivity of foreign exchange leads to a general deflation of all shadow prices in the system.

SECTION III.A

COMPARISON OF THE RESULTS OF "INCREMENTAL" EMPLOYMENT AND CONSUMPTION MAXIMIZATIONS

In this section simultaneous upper bounds are imposed on "net exports" of the products of all the international sectors. The model in this form is used to study the sensitivity of the optimal allocation strategy to the choice of the development goal between employment maximization and consumption maximization.

The numerical values of the "quantity solutions" corresponding to the two optimizations are presented in Tables (6.T.1), (6.T.2), (6.T.3) and (6.T.4). Their "price solutions" are compared on Table (6.T.5). The results are organized in a manner that allows for easy visual comparisons.

An inspection of the sectoral and temporal distribution of production and trade variables as presented in Table (6.T.1) shows that no significant qualitative changes in the optimal structures of production and foreign trade take place following a change in the development goal of the society. The optimal distribution of production and hence the allocation of resources are remarkably similar under both goals. The few structural changes that do occur seem to be confined to

the manufacturing sectors of the economy. The agricultural and the services activities which weigh heavily in their contributions to incremental employment and output over the plan remain in the optimal basis during all periods under both development goals.

Both these strategies of development rely heavily on farm production and on the labour intensive manufacturing output (M_3) for foreign exchange revenue. Exports in these sectors (A_1, A_2, and M_3) are pushed to their prespecified upper limits during each and every period. The relatively higher shadow prices associated with their sector-specific export limits indicate that further expansion of exports will have the greatest payoff in the two agricultural sectors. The shadow prices corresponding to the sectoral export bounds establish export priorities for the economy. (These prices are shown underneath the values of export variables which hit their upper limits in Table (6.T.1)).

The economy enjoys a comparative advantage in the production and the export of the products of manufacturing Sector M_1 during the first two periods under both development strategies. This advantage is lost in later periods and significant amounts of the products are imported under both strategies. However, under consumption maximization domestic demand for M_1 during the last two periods is met partly from both

sources of supply, while under employment maximization domestic demand in the final period (T = 4) is entirely met from imports.

Sector M_1 is relatively foreign exchange intensive and it is also the least labour intensive sector in the economy. The dynamic loss of comparative advantage in this sector occurs because of our assumption of sector-specific export growth rates. These growth rates allow more liberal export of the products of the relatively cheaper sectors (namely, exports of products A_1, A_2 and M_3) in the later periods than in the earlier periods. This in turn, makes it possible for the economy's foreign exchange requirements during the later periods to be entirely met from the export of the relatively cheaper domestic products, namely the exports of the two farm products and the labour-intensive manufactured product M_3.

There is some evidence that the optimal development strategy under employment maximization tends to be more foreign trade oriented than the consumption maximization strategy. Both the volumes of exports and competitive imports are about a percentage point higher under the employment maximization strategy. (See Table (6.T.4)). Larger volume of export is the result of larger net output (see Table (6.T.2)). By contrast, the consumption maximization development strategy is implemented by a modest import replacing industrialization

program. The consumption maximization program is forced to rely on competitive import substitution because of the higher complementary import intensity of production under this strategy. (Thus, despite its lower net output, non-competitive import is higher under consumption than under E-maximization.) The key sectors in which such import-replacing domestic expansion takes place include the manufacturing sector M_1 and the domestic machinery capital goods sector M_4.

All in all, it may be concluded that the optimal pattern of resource allocation implied by the structure of this model is not very sensitive to the choice of the development goal between employment maximization and consumption maximization. No significant structural changes occur with a change in the development goal, so that differences in the numerical values of employment and consumption that are observed under the two optimizations are mainly due to quantitative changes in the optimal scales of operation of the endogenous variables in the model. Whatever qualitative and quantitative changes do occur seem to come about toward the later periods in the model, due probably to the fact that time is not discounted in this particular specification of the long-term development goals.

An alternative interpretation would be that in the earlier periods the economy is moving toward an efficient allocation, but that once that is achieved the development patterns associated with the two goals begin to diverge. This is suggested by the exact correspondence of the two solutions in period 1 and could be tested by running the model for more periods. (See concluding chapter on future extensions, page 210.)

Some insights into the causes for the relative insensitivity of the results to a change in the development goal can be obtained from a close examination of the form in which the employment and the consumption goals are specified. The particular algebraic form of these goals are as follows:

$$\Delta E = \sum_{t=1}^{4} \Delta L(t) = \sum_{t=1}^{4} \sum_{j=1}^{9} \ell_j x_j(t) \qquad (5.1)$$

and

$$\Delta C_T = \sum_{t=1}^{4} c(t) \geq \sum_{t=1}^{4} \sum_{j=1}^{9} b_j x_j(t) \qquad (5.2)$$

There are two noteworthy features of this particular representation of the objective functions.

First, the sectoral output variables x(t) represent increments to current period's output levels over the previous period's output levels. These increments are interpreted in the model as being realized

in the final year of each period. (For example,

$$x_j^{1982}(t) = X_j^{1982}(t) - X_j^{1977}(t-1), \quad \text{for} \quad t = 1, 2, 3, 4$$

and $j = 1, 2, 3, \ldots, 9$) The indices representing employment (ΔE) and consumption (ΔC_T) being directly dependent on output therefore measure the sum of each period's increment to the respective objective over the previous period.

Second, in the above specification of the goals, time is not discounted. Thus, a given increase in employment is assumed to be equally valuable regardless of the period in which the increase actually takes place. The same is also true of the consumption objective.

With employment as the social target variable, there is no "direct" benefit associated with a consumption activity. There is only an "indirect" benefit to employment to the tune of the shadow price of consumption which is equal to the accounting value of the resources released for alternative uses from the reduction of consumption by a unit. There is thus a tendency to push consumption down toward zero. However, the model provides for a structural lower bound on consumption of each period equal to the value of the wage income of the period. Therefore, under employment maximization, consumption during each period exactly

equals the period's wage bill and total consumption over the plan equals the total wage bill, i.e.,

$$\Delta C_T = \sum_{t=1}^{4} C(t) = \sum_{t=1}^{4} \sum_{j=1}^{9} b_j \, x_j^*(t) \qquad (5.3)$$

On the other hand, consumption under consumption maximization is a "profitable" activity because now there is a "direct" benefit associated with it. The optimization system may now generate consumption during any period in excess of the period's wage bill and therefore the aggregate consumption over the plan may equal or exceed the aggregate wage bill. But the essential point to note is that the presence of a structural lower bound on each period's consumption eliminates the possibility of very large differences in aggregate consumption under the two social objectives being considered here.

The relative insensitivity of the volume of employment creation to the variation in the objective function is a direct consequence of the particular form of representation of the social objectives as given by equations (5.1) and (5.2). Under this particular representation of the objectives the weight which a sector receives under employment maximization is positively correlated with the weight which it receives under consumption maximization. This is because sectors with high labour-output coefficients (employment weight) also tend to have high unit wage cost (consumption weight)

and sectors with low labour coefficients tend to have low unit wage cost. Although this positive association between the two sets of weights is somewhat broken by our assumption of differential wage rates for the agricultural, the manufacturing and the services sectors, the assumed wage differentials are not large enough to make any dramatic difference to the optimal choice of activities under the two objectives. Whatever scope this leaves for qualitative differences in the choice of activities under the two goals is further mitigated by the existence of upper bounds on the net exports of specific products which effectively prevent specialization in production under both objectives and therefore reduce the possibility of large differences in employment creation in the two situations.

A few brief comments regarding the nature of the price solutions corresponding to the two objectives are in order. These prices are compared in Table (6.T.5).

Even a cursory look at this table makes it immediately apparent that the shadow prices of commodities and factors are vastly differently under the two objectives. This result in itself is not significant to the extent that differences in the two sets of prices are the result of differences in the units in which the two objectives are measured. Employment in this study is measured in man-years while consumption is expressed

in constant base Takas. The units of the former represent much smaller numerical values as compared with the units of the latter. However, since the optimal basis for the two objectives are different (see Table 6.T.1) suggests that each constraint plays a somewhat different role - that is, the differences in the two price solutions are not solely a matter of counting units. This can be seen by looking at ratios of corresponding shadow prices, which are not the same, either across periods for the same constraint or across constraints for the same period.

The absolute values of shadow prices decline from one period to the next under both objectives. This is because under our assumption of a maximum of eight percent compound growth in exports, the absolute availability of foreign exchange increases from one period to the next which causes the shadow price of foreign exchange to fall over time. Since all other shadow prices in the model are directly or indirectly tied to the price of foreign exchange, the decline in its price from one period to the next causes all prices to fall in successive periods (see dual equations D.7 and D.8)

It may be noted here that the implicit domestic savings constraint underlying the structure of the primal poses as the most severe bottleneck to the overall growth of the economy under both the consumption and the employment

maximization development strategies. The shadow price of the implicit saving constraint is several times higher than the shadow price of foreign exchange under both development programs*. (See Table 6.T.5.) This result has an interesting policy implication. It implies that if a politically feasible policy instrument could be found that would release the domestic savings constraint then the country could grow and at the same time minimize its dependence on "foreign aid". This in turn has strong implications for the future wage policies in the country. (See Section IV of this chapter.)

One puzzle is why the 4th period shadow prices under employment maximization fall so dramatically as compared to consumption maximization.

We have seen earlier (see pages 144-5) that the differences in the efficient allocations under the two goals become more pronounced over time. Thus, the faster rate of fall of the terminal period's shadow prices under employment maximization may be indicative of this policy's lower dependence on foreign exchange than the alternative policy that maximizes consumption.

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* For an explicit derivation of the domestic savings constraint and its shadow price see Appendix B.

SECTION III.B

CUMULATIVE FORM OF THE DEVELOPMENT GOALS

The "incremental" form of specification of the development goals of the previous section was analogous to a change in the value of a function while the "cumulative" form of specification of the goals is analogous to an integral of a function. In the incremental form, aggregation over time involves taking into account only a period's increment to the respective goals (over the level achieved in the previous period) while in the cumulative form one is essentially looking at the "total" increment to the respective goal from t = 1 to the final period. For instance, in the case of the employment objective, the t^{th} period's "increment" to employment in the i^{th} sector is given by $\ell_i x_i(t)$ whereas as the "cumulative" increase in employment in the same sector up to period t is the amount

$$\ell_i\left[x_i(t) + x_i(t-1) + \ldots + x_i(2) + x_i(1)\right]$$

Thus, for t = 1, 2, 3, 4 and i = 1, 2, 3,...,8,9 the overall cumulative increase in employment during the plan is given by ΔE, where

$$\Delta E = \Big[\ell_1 x_1(1) + \ell_1\{x_1(2) + x_1(1)\} + \ell_1\{X_1(3) + x_1(2) + x_1(1)\} + \ell_1\{x_1(4) + x_1(3) + x_1(2)$$

$$+ x_1(1)\}\Big] + \Big[\ell_2 x_2(1) + \ell_2\{x_2(x_2) + x_2(1)\}$$

$$+ \ell_2\{x_2(3) + n_2(2) + x_2(1)\} + \ell_2\{x_2(4)$$

$$+ x_2(3) + x_2(2) + x_2(1)\}+\Big]+\ell_3\{\ldots\} + \ldots$$

$$\ldots+ \ell_9\{x_9(4) + x_9(3) + x_9(2) + x_9(1)\}\Big]$$

Collecting the like terms, this equation may be written in the following alternative form:

$$\Delta E = \Big[4\ell_1 x_1(1) + 4\ell_2 x_2(1) + \ldots + 4\ell_9 x_9(1)\Big]$$

$$+ \Big[3\ell_1 x_1(2) + 3\ell_2 x_2(2) + \ldots + 3\ _9 x_9(2)\Big]$$

$$+ \Big[\ldots\Big] + \Big[\ell_1 x_1 + \ell_2 x_2 + \ldots + \ell_9 x_9\Big] \qquad (5.4)$$

By the same logic, the overall increase in consumption during the plan (ΔC^*) will be exactly estimated by the equation:

$$\Delta C^* = 4C(1) + 3C(2) + 2C(3) + C(4) \qquad (5.5)$$

It is interesting to note that the form of the social objectives as represented by equations (5.4) and (5.5) dictate uniformly declining weights to be associated with more and more distant future[6]. However,

it must be emphasized that these weights do not arise from discounting of time, rather they are the result of the particular assumption regarding the definition of the two social goals. (The effect of the introduction of explicit discounting of the future has the same effect as specifying the objectives in the cumulative form.)

The results of "cumulative employment" and "cumulative consumption" maximizations are compared on Tables (6.T.6), (6.T.7) and (6.T.8).

The results in (6.T.6) show that the choice of the development goal between "cumulative employment" and "cumulative consumption" is not a very significant choice, since the patterns of resource allocation implied by these goals are not very different. Since we had found a similar insensitivity of the results to the choice of the goal when the goals were specified in the incremental form, it may be concluded that the choice of the development goal, irrespective of their form makes no significant difference to the optimal structure of production and allocation of scarce resources. The reasons for this strong result were explained before (see pages 145-7).

The only notable difference in the structure of production occurs in the construction sector (C) output. The cumulative E-maximization program relies

more heavily on the output of the construction sector than the C-maximization program. This is because E-maximization, in general, puts more emphasis on the relatively more labour intensive sectors (namely the two services sectors S_1 and S_2 and the labour intensive manufacturing Sector M_3) and production in all these sectors depend intensively on the output of the construction sector. Thus, under cumulative E-maximization positive increments to construction output are produced during all periods except the first, the first period's requirement being entirely met from the "initial" supply of construction output. In contrast, under cumulative C-maximization production in construction sector shows a flip-flop tendency, with positive increments being produced during the even numbered periods (i.e., $t = 2$ and 4) only.

SECTION III.C

SENSITIVITY OF THE RESULTS TO A CHANGE IN THE FORM OF THE DEVELOPMENT GOAL

The study of the changes in the structure of production following a change in the "form" of the development goal entails a comparison of the results of employment and consumption maximization presented in Table (6.T.1) (the incremental form) with their respective counterpart solutions in Table 6.T.6)(the cumulative form).

There occurs a significant shift in the time profile of production and hence in the allocation of resources, away from the later periods, as the specification of the development goal is changed from the "incremental form" to the "cumulative form". Although time is not discounted explicitly either in the "incremental" or in the "cumulative" form of the objective functions, production in later periods is made less desirable in the case of the latter form of specification due to an implicit or effective discounting of time caused by the fact that the "cumulative" value of an objective during any given period is derived by piling up the increments (to the goal) of all the previous periods.

The "effective discounting of time" under the

cumulative form of the goals makes production in earlier periods more desirable relative to production in later periods. This is clearly reflected in the time-profile of the commodity shadow prices under the two forms of the goals. (See Tables 6.T.5 and 6.T.8)

Commodity shadow prices under the cumulative form (of the goals) are uniformly higher in the first period than the corresponding prices under the incremental form. However, the prices under cumulative form decline at a more rapid rate over time so that in the final period their numerical values become smaller than the corresponding commodity prices under the incremental form of the goals.

It is interesting to note that the increased desirability of production in earlier periods under the cumulative form (of the goals) is actually implemented more through the reduction in production in later periods than through an increase in production in the earlier periods. In fact, net output in terms of value added instead of increasing in the first period registers a marginal decline as the specification of the development goal is changed from the "incremental" to the "cumulative" form. This decline which occurs both for the employment and the consumption objectives may be attributed to the upward rigidity of first period outputs due

both to "initial" (t = 0) capacity limitations and also to the relatively more stringents export limits on this period's outputs. The employment maximization production structure is relatively insensitive to the change in the form of the goal. The production of textile manufactures (M_2) shows a flip-flop tendency under the incremental form. Effective discounting of time under the cumulative form gives more uniformity to the distribution of textile output overtime with positive amounts being produced in each of the first three periods. Part of period one's requirement for machinery capitals (M_4) is met from domestic production under the incremental form while under the cumulative form all of domestic demand for such capital is met from competitive imports from abroad.

The consumption maximization development program is significantly more sensitive to a change in the form of the goal than the employment maximization program. This is evident both from the larger number of structural changes and also from the larger percentage changes in the net outputs of different periods that occur under the consumption objective following a change in the form of the goal. Net output in terms of value added increases during the second and the third period while output in the final period declines as a result of effective discounting of time under the cumulative form of the goal.

Because the increase in net output in the

earlier periods is more than offset by the fall in net output in the terminal period, the overall rate of growth of the economy declines both under the employment and the consumption objectives following a change from the "incremental" to the "cumulative" form of these goals. The drop in the rate of growth of the economy is much larger in the case of the consumption objective relative to the drop in the case of the employment objective. The larger drop in the growth of the economy under the consumption objective is mainly due to a heavy fall in production in the terminal period. This point comes through clearly when we note that the drop in value added in the final period (T = 4) under the employment objective is only 1.5%, while the corresponding drop in the case of the consumption objective is over 30%. (See Tables (6.T.2 and (6.T.7)). The greatest decline occurs in the production of industrial output (70%), both because fewer of these activities are operated in the optimal basis and also because of significant decline in the optimal scales of these activities in this period. In terms of the drop in output, the manufacturing output is followed by the output of farm products (28.4%) and then the services' output (22%).

The dual solutions to the employment maximization problem show that although the shadow prices of resources change following a change in the form of this goal, the relative ranking of these prices remain stable. This is consistent with the relative insensitivity of the results of the corresponding primal solutions to the same change in the form of the objective. In general, under both forms of employment maximization, foreign exchange, non-competitive imports and domestic manufactured commodities pose as the main bottlenecks to the growth of the economy.

In contrast, a change in the form of the consumption objective sets off changes not only in the absolute values of all resource prices but it also alters the relative ranking of some of these prices. In general, however, for $^{t} = 1$, the ratio of the shadow price of a resource under the "cumulative" form to its shadow price under the "incremental" form is larger for the consumption objective than for the employment objective. This indicates the larger potential profitability of expanding production in the first period compared to production in later periods under cumulative consumption maximization than under cumulative employment maximization. But since sectoral output in this period (t = 1) is constrained from above both by the "initial" capacity limitations and also by upper

bounds on exports, the optimization system is forced to postpone production to later periods at the cost of the growth of the economy. The sacrifice of the growth of output is greater in the case of the cumulative consumption objective than in the case of the cumulative employment objective because of the lower profitability of expanding production in the terminal period compared to production in earlier periods under the former objective than under the latter.

PRODUCTION AND DISTRIBUTIONAL CONSEQUENCES OF DOMESTIC WAGE POLICIES

Two types of distortions pervade all labour surplus economics. The first of these relate to the domestic factor markets in these economies and are analysed in the literature on Dual economy development (e.g., Dixit (1968), Stern (1972)). The concept of Dual economy explicitly recognizes that labour market distortions which are reflected in high open and disguised unemployment and wide wage differentials between the agricultural and the non-agricultural sectors of these economies, are more pervasive and fundamental than any other type of distortions.

The second type of distortions is assumed to arise from the protectionist trade policies pursued by the governments of these countries. These impinge upon the foreign exchange and domestic capital constraints of these economies and are analysed in the context of the savings and foreign exchange gap models (e.g., Chenery and Strout (1966), McKinnon (1964)).

The policy experiments conducted in this section focus on these two structural features of the Bangladesh economy. The first set of experiments studies the production and distributional consequences of domestic wage policies aimed at eliminating the existing wage differentials by raising agricultural wages up to the

levels of the non-agricultural wages. This set of experiments also includes an attempt to test the power of domestic real wage policies to reduce the dependence of the economy on "foreign aid" without affecting the country's per-capita consumption. The second set of experiments studies the sensitivity of the results of the "Basic solution" to variations in the existing structure of government tariffs.

SENSITIVITY TO VARIATIONS IN AGRICULTURAL WAGES

Simulations are run for five, ten, fifteen, twenty and twenty-five percent increases in agricultural wages over their values in the basic solution. A twenty-five percent increase in agricultural wages reduces the assumed wage differential between the agricultural and the manufacturing sectors to zero. The production and distributional* consequences of these increases in agricultural wages are briefly analysed against the backdrop of the results of the "Basic solution". Important aspects of the results of these simulations are presented in Tables (6.T.9), (6.T.10), (6.T.11), and (6.T.12).

* Distributional consequences of policy changes are analysed up to the point that such changes affect the distribution of output and employment between different sectors of the economy.

Table (6.T.9) compares the values of the macro-variables of employment (objective), output and consumption for different rates of increases in agricultural wages with the values of the same variables in the "Basic Solution". It shows that a five percent increase in farm wages which causes agricultural output in terms of value added to drop by 1.1 percent (see Table 6.T.10) actually causes the economy's output to decline by 3.4 percent, consumption by 1.7 percent and employment by 3.7 percent relative to the values of these variables in the basic solution. A 20 percent increase in farm wages causes the values of the same macro variables to decline by 13.8 percent, 9.0 percent and 16.3 percent respectively.

These results underscore the importance of the growth of the agricultural sectors for the growth of the rest of the economy. An increase in agricultural wages adversely affects the growth of the economy directly by raising the domestic cost of production of farm products and indirectly by raising the domestic cost of production of agro-based manufacturing industries relative to the cost of importing those products. It is interesting to note that although the absolute values of contribution to employment and output of all sectors decline as labour costs in the agricultural sectors rise (see Tables 6.T.10 and 6.T.11), the relative shares of agriculture

in both of these macro-variables steadily increase and the relative shares of the consolidated industrial sector decline. This suggests that at least at this stage of development, low agricultural wages help to promote industrialization. This in turn implies a conflict between the "basic needs" approach* to development and the industrialization approach.

Within agriculture the employment and the output shares of non-food sector (A_2) declines somewhat but this sector's relative contraction is more than offset by the increase in the relative shares of the food-agricultural Sector (A_1). Among the manufacturing sectors the greatest contraction takes place in textile manufacturing (M_2) and in the miscellaneous labour intensive manufacturing (M_3) both of which rely heavily

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* The "basic needs" strategy to development aims at securing the provision of at least the minimum means of livelihood for everyone, through redistribution and growth. Essentially, the basic needs approach shifts attention from output maximization to poverty minimization. Therefore, the critical question is to what extent a trade-off between these objectives is required. Critics of the basic-needs approach have argued that by emphasizing consumption oriented activities, this approach implies a reduction in the rate of growth. On the other hand, proponents of this approach point to the human capital aspects of basic needs, which could be instrumental in increasing labour productivity and growth in output.

on the agricultural sectors for intermediate inputs. The textile manufacturing (M_2) and the capital goods manufacturing (M_4) sectors which partially met the domestic demand for their products from domestic production in the basic solution, rely entirely on foreign imports as labour costs in the agricultural sectors rise by 15 percent or more. Finally, the relative contributions of the services sectors which are almost entirely independent of farm inputs increase as labour costs in agirculture rise.

SENSITIVITY OF THE RESULTS TO UNIFORM RATES OF INCREASES IN ALL WAGES:

A uniform rate of increase in all sectoral wages makes domestic production relatively costlier than foreign imports. Production in the 'international' sectors become less attractive as compared to the competitive import of their products. Outputs of the "national" sectors are also adversely affected because of the higher wage costs. But since domestic production is the only source of supply for the outputs of the national sectors, these commodities become relatively

more scarce than the products of the international sectors. This is reflected in the greater percentage increase in the shadow prices of non-tradeables compared with the increase in the scarcity prices of tradeable commodities.

Although higher domestic wages make competitive imports relatively more attractive, aggregate import of the economy declines. This is because at higher wages the economy grows more slowly and this results in lower demand for imports. On the other hand, since domestic production less domestic demand imposes an effective ceiling on the export of a commodity, higher wages also result in lower exports through the reduction of the production possibilities of the economy. (For some commodities this limit becomes effective before the "direct" limits on their exports are reached.)

Simulations with five, ten, fifteen, twenty and twenty-five percent uniform increase in all wages have been performed. The sensitivity of the value of the objective function (incremental-employment) to these changes in domestic wages are reported in Table (6.T.13). A twenty-five percent increase in all wages is infeasible*.

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* A linear programming problem is infeasible if there does not exist any solution vector satisfying the constraints of the system.

The "Basic Solution" results are highly sensitive to variations in domestic wages. For a 5% uniform increase in all wages, the value of the objective function (incremental employment) decreases by more than 8% and for a 25% increase in all wages employment decreases by more than 34% over the plan period. The ratio of the percentage change in employment to a percentage change in domestic wages remains stable around the value 1.7 over the entire range of wage changes considered here. Since the drop in employment at higher wages is the result of slower growth of the economy and not of direct factor substitution, the value 1.7 should not be interpreted in the usual textbook sense of price elasticity of demand for labour.

Since the model assumes all wages to be consumed, higher wages might be expected to lead to higher consumption. But consumption actually drops because of the slower growth of the economy at higher wages. This result suggests that although in a short-run partial equilibrium context higher wages might imply higher consumption, a wage-based expansion in consumption cannot be sustained in the long-run when the macro feedback effects are taken into account. In fact, the results suggest that a higher wage policy will significantly

reduce the potential long-run expansion in consumption (See Table 6.T.13). However, the opportunity cost of consumption does not show any systematic movement in response to higher wages, although in most cases higher wages leads to higher opportunity cost of consumption (See Table 6.T.14). The shadow price of foreign exchange also shows a similar instability.

Commodity shadow prices generally rise to indicate the higher opportunity costs of domestic production at higher domestic wages. However, the shadow prices of the imported commodities tend to fluctuate in both directions.

The results of the "basic solution" have shown that the implicit savings constraint underlying the structure of the primal poses a bottleneck to the growth of the economy. However, among all the constraints that are explicitly introduced in the model, foreign exchange has the highest shadow price during each period. This means that among all the explicit constraints, the relaxation of the foreign exchange constraint will add more to the development objective than any other constraint. Despite its high productivity on paper, the economy's dependence on "aid" has grown overtime without really bringing any relief to the poverty-stricken lives of the people. Consequently, excessive reliance on "aid" is neither popular nor a desirable strategy of development.

The high degree of sensitivity of the macro-variables to variations in sectoral real wage rates suggests that the domestic real wage policy can be a powerful instrument in reducing the dependence of the economy on "foreign aid" without hurting the country's per-capita consumption and per-capita income. The previous results have indicated that the rate of absorption of the unemployed and therefore the pace of development of the economy can be accelerated by cutting domestic real wages without requiring a concommitant increase in "foreign aid". This means that foreign aid sufficient to achieve a given level of per-capita domestic consumption (or income) would be positively correlated to real wages. Therefore, if the country can muster the political will to absorb its unemployed by cutting the levels of existing real wages it can then proceed along the path of economic development without excessive reliance on "foreign aid". Cutting real wages may not be politically feasible in a situation where their levels are already at or near subsistence. However, the implications of the above analysis for the future rate of growth of real wages in the (Labour-surplus) country is clear.

In the Basic Solution, the expected increase in the availability of "foreign aid" was set at the

outside limit of 2500 million takas per period (that is, about 150 million U.S. dollars at the current official exchange rate, every five years). To assess the quantitative effectiveness of domestic wage policies in reducing the dependence on "foreign aid", a five percent across the board wage cut is implemented with simultaneous reductions in the exogenous availability of "foreign aid" from its level in the "Basic Solution". Expected availability of "aid" is reduced in iterative steps (10%, 20%, 30%, and so on) and an optimization exercise is performed at each step, until the value of the expansion in consumption over the plan approximately coincides with its value in the "Basic Solution". This does not happen before the expected increase in the availability of "foreign aid" is reduced from 2500 million Takas per period (its value in the Basic Solution) to 1650 million Takas per period, a reduction of more than 34% per period.

The highlights of the results of this final iteration are presented along with the results of the "Basic Solution" in Table (6.T.15). A comparison of these two sets of results reveals the kinds of accommodation in the structures of production and foreign trade that would be made necessary if a policy of foreign aid reductions were to be implemented through cuts in domestic wages.

Before discussing these changes in the structures of production and trade it is important to note the effects of the policy on the other macro-variables. A 5 percent across the board wage cut along with a 34 percent foreign aid reduction maintains the expansion in consumption at the value achieved in the Basic Solution. It, at the same time, increases the net output (value added) by 4 percent (from 520921 million takas to 542924 million takas) and employment by 4.8 percent (from 52.26 million man years to 54.89 million man years) over the values of these variables in the basic solution (see Table 6.T.15). These numbers suggest that further reductions in foreign aid could be realized if the level of employment achieved in the Basic Solution, rather than consumption, was to be held constant.

Real wage cuts help reduce dependence on foreign aid primarily by releasing the implicit savings constraint on investment and thus allowing the economy to grow faster. Since all wages are assumed to be consumed, a reduction in unit labour costs of a sector (through a cut in the sector's wage rate) leads to an equal increase in the sector's contribution to domestic savings per unit of its output. Thus, in effect wage cuts lead to the replacement of foreign funds by domestic capital.

In the basic solution, the ratio of the shadow price of domestic savings to the shadow price of foreign exchange is over eleven during each period (see Table 6.T. 5). This implies that domestic saving is a much more serious constraint on the growth of the economy than foreign exchange. Thus, a given percentage increase in domestic savings through domestic wage cuts may be expected to lead to a greater percentage decrease in foreign aid without necessarily worsening the consumption and employment levels achieved under the basic solution.

The results presented in Table (6.T.16) seem to bear out these expectations. Thus, a 5% across the board wage cut which expands domestic fixed investment by 20.9 percent (from 30826 million takas in basic solution to 37286 million takas after the change in policy) actually leads a reduction in foreign funds by 34 percent and yet maintains the level of consumption achieved in the basic solution.

Besides releasing the domestic savings constraint on investment, there is a second and a more indirect mechanism through which cuts in domestic wages enhances the rate of expansion of the economy. This is by lowering the absolute costs of all domestic production and the relative costs of production of domestic

goods which compete with foreign imports. The change in the cost structure encourages import-replacing domestic expansion in some of the international sectors of the economy. As a result, competitive imports decline marginally and non-competitive imports which are complementary with domestic production rise by 9.6 percent over their values in the basic solution. Domestic expansion enhances export of domestic products by 13.9 percent over the level achieved in the basic solution. Thus, the reduction in foreign funds is almost entirely replaced by the additional foreign exchange revenue earned through the expansion of exports of domestic products.

TABLE (6.T.1)

INCREMENTAL PRODUCTION AND TRADE VARIABLES PER PERIOD BY SECTOR - BASIC SOLUTION (IN MILLION TAKAS)

Activities	Max. Employment				Consumption Max.			
	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4
Domestic Production								
A_1	49388 (.00008)	55532	58680	62948	49388 (.6639)	55525	58555	67853
A_2	18677	24688	27271	45846	18677	24698	27202	35743
M_1	20145	23239	19028	-- (.000058)	20145	23235	19371	7537
M_2	-- (.000009)	5150	-- (.000058)	11736	-- (0.0974)	5188	-- (0.3022)	-- (0.1739)
M_3	18173	22358	25951	27732	18173	22348	25790	27915
M_4	5279	-- (.000034)	-- (.000087)	-- (.000029)	5279	-- (0.2834)	-- (0.3591)	-- (0.3039)
C	-- (.00025)	5658	10346	3189	-- (1.9648)	5624	9978	3258
S_1	15486	17799	18640	23876	15486	17803	18583	21902
S_2	29278	36049	40741	49585	29278	36049	40630	50634
Net Imports (+) & Net Exports (-)								
A_1	-2000* (.00061)	-3000* (.00048)	-4000* (.00022)	-5000* (.00008)	-2000* (4.638)	-3000* (3.701)	-4000* (1.481)	-5000* (1.445)
A_2	-5500* (.00071)	-8036* (.00050)	-11804* (.00023)	-17500* (.00009)	-5500* (5.456)	-8036* (3.838)	-11804* (1.589)	-17500* (1.533)
M_1	-2000* (.00022)	-3000* (.00021)	1402	17982	-2000* (1.570)	-3000* (1.585)	1043*	12314
M_2	5334	2375	6035	-981	5334	2348*	6012	7730
M_3	-3000* (.00017)	-4000* (.00017)	-6000* (.00024)	-8000* (.00006)	-3000* (1.318)	-4000* (1.368)	-6000* (0.428)	-8000* (0.441)
M_4	419	8075	8455	5517	419	8096	8908	5332

TABLE (6.T.2)

SECTORAL INCREMENTS TO VALUE ADDED OVER THE PREVIOUS PERIOD - BASIC SOLUTION
(IN MILLION TAKAS)

	Employment Maximization				Consumption Maximization			
Sectors	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4
A_1	37939	42659	45078	48356	37939	42656	44982	52125
A_2	13930	18415	20342	34197	13930	18422	20290	26661
M_1	6288	7255	5940	--	6288	7253	6047	2353
M_2	--	1227	--	2796	--	1236	--	--
M_3	5682	6991	8115	8672	5682	6988	8065	8729
M_4	2311	--	--	--	2311	--	--	--
C	--	2477	4530	1396	--	2465	4369	1427
S_1	13192	15163	15879	20339	13192	15167	15831	18659
S_2	24782	30513	34485	41972	24782	30513	34392	42859
Total Incremental Value Added	104124	124700	134369	157728	104124	124698	133976	152813
Incremental Private Consumption	80897	98874	107330	127621	80897	98868	106888	133858
Incremental Employment (Mill. Man-Years)	10.17767	12.43653	13.52426	16.12272	10.17767	12.43583	13.46885	15.30055

SECTORAL INVESTMENT MEASURED IN CAPACITY TERMS - BASIC SOLUTION
(million takas)

	Employment Maximization				Consumption Maximization			
	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4
A_1	92008	103483	116553	116553	92001	103357	121441	121441
A_2	43888	53174	73290	73290	43898	53106	63178	63178
M_1	34129	33172	16807	16807	34124	33514	24391	24391
M_2	15541	11111	22848	22848	15578	11117	11117	11117
M_3	36525	43248	48662	48662	36515	43086	48821	48821
M_4	6016	5112	5853	5853	6016	5111	5853	5853
C	25121	31223	26651	26651	25086	30846	26620	26620
S_1	32904	36236	44082	44082	32907	36180	42101	42101
S_2	50563	58860	71779	71779	50563	58750	72817	72817
	PHYSICAL INVESTMENT BY SECTOR							
A_1	14068	15823	17822	17822	14068	15804	18569	18569
A_2	3702	4485	6182	6182	3702	4480	5329	5329
M_1	13746	13361	6769	6769	13746	13499	9824	9824
M_2	1774	1268	2607	2607	1774	1269	1269	1269
M_3	2263	2680	3015	3015	2263	2670	3025	3025
M_4	1017	864	989	989	1017	864	989	989
C	1647	2047	1747	1747	1647	2022	1795	1745
S_1	28558	31450	38259	38259	28558	31402	36541	36541
S_2	15293	17803	21711	21711	15293	17770	22024	22024

TABLE (6.T.4)

MACRO-ECONOMIC ACCOUNTS - INCREMENTS OVER THE PREVIOUS PERIOD - BASIC SOLUTION (Million Takas)

	Employment Maximization					Consumption Maximization				
	Period 1	Period 2	Period 3	Period 4	Total	Period 1	Period 2	Period 3	Period 4	Total
Consumption	89500	109627	120771	144422	464320	89500	109621	120329	150659	470109
(i) Private	80897	98874	107330	127621	414722	80897	98868	106888	133858	420511
(ii) Public	8603	10753	13441	16801	49598	8603	10753	13441	16801	49598
Investment	23029	18673	20819	10581	73102	23027	18595	21076	8906	71604
(i) Fixed	13753	7753	9320	--	30826	13753	7712	9593	--	31058
(ii) Working	9276	10920	11499	10581	42276	9274	10883	11483	8906	40546
Exports	11508	16619	19928	28720	76775	11508	16619	19928	28132	76187
Imports										
(i) Competitive	3500	7208	10967	20494	42169	3500	7026	10947	19797	41270
(ii) Complementary	10508	11911	11461	10726	44606	10508	12093	11481	10835	44917
Net Capital Inflow	-2500	-2500	-2500	-2500	-10000	-2500	-2500	-2500	-2500	-10000
Employment (million man-years)	10.1776	12.4365	13.5243	16.1227	52.26	10.1776	12.4358	13.4688	15.3005	51.38

TABLE (6.T.5)

PRICE SOLUTIONS UNCER "INCREMENTAL" FORM OF DEVELOPMENT GOALS

Constraints								
Constraints	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4
Commodity Balances								
A_1	.000407	.000205	.000125	.000008	3.30554	1.64220	1.04745	0.66994
A_2	.000318	.000194	.000127	.00000	2.57183	1.56138	0.97423	0.60400
M_1	.000786	.000470	.000352	.000085	6.29335	3.70419	2.51101	2.09328
M_2	.000656	.000443	.000229	.000055	5.12265	3.44571	1.63578	1.36366
M_3	.000790	.000477	.000312	.000026	6.18527	3.67876	1.96759	1.55622
M_4	.000783	.000529	.000274	.000066	6.11468	4.11299	1.95256	1.62774
C	.000306	.000406	.000270	.000010	3.23034	3.23034	1.55081	1.38556
S_1	.000298	.000308	.000280	.000198	2.37168	2.42060	2.41563	1.78887
S_2	.000307	.000182	.000133	.000033	2.44473	1.42609	1.09181	0.73108
Capacity								
A_1		.000034	.000038	.000041		0.26695	0.34127	0.27343
A_2		.000019	.000021	.000023		0.14708	0.18823	0.15081
M_1		.000102	.000105	.000110		0.80062	0.92021	0.74152
M_2		.000025	.000028	.000031		0.19388	0.25241	0.20387
M_3		.000014	.000015	.000017		0.10692	0.13746	0.11101
M_4		.000043	.000045	.000046		0.33922	0.39274	0.30691
C		.000024	.000021	.000018		0.18898	0.17110	0.12625
S_1		.000157	.000199	.000236		1.23328	1.85863	1.50491
S_2		.000019	.000053	.000082		0.15229	0.56851	0.47956
Non-Comp. Imports								
A_1	.001018	.000688	.000355	.000086	7.94367	5.34324	2.53660	2.11461
A_2	.001028	.000695	.000359	.000087	8.02733	5.39952	2.56332	2.13688
M_1	.001007	.000681	.000352	.000085	7.86352	5.28933	2.51101	2.09328
M_2	.000656	.000443	.000229	.000055	5.12265	3.44571	1.63578	1.36366
M_3	.000961	.000649	.000336	.000081	7.50346	5.04714	2.39603	1.99743
M_4	.000783	.000529	.000274	.000066	6.11468	4.11299	1.95256	1.62773
S_1	.000971	.000656	.000339	.000082	7.57811	5.09735	2.41987	2.01730
S_2	.000971	.000656	.000339	.000082	7.57811	5.09735	2.41987	2.01730
Consumption	.000467	.000274	.000185	.000034	2.73182	1.15583	0.38639	0.00000
Foreign Exchange (P_F^*)	.001094	.000739	.000382	.000092	8.53775	5.74284	2.72631	2.27276
Domestic Saving (P_S^*)	.01255	.00848	.00487	.00113	98.08	65.20	33.97	27.17
P_S^*/P_F^*	11.5	11.5	12.7	12.3	11.4	11.3	12.4	11.9

TABLE (6.T.6)

"QUANTITY SOLUTIONS" UNDER "CUMULATIVE" SPECIFICATION OF THE DEVELOPMENT GOALS

Activities	Max Employment				Max Consumption			
	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4
Domestic Production								
A_1	49388	56939	57040	58389	49388	57105	56028	45357
A_2	20144	24619	30980	46198	20144	24375	28241	28569
M_1	20014	23983	10168	--	20014	24089	9725	--
M_2	3882	5085	11022	--	3882	1480	---	--
M_3	18070	23131	25249	25714	18070	23380	23690	8657
M_4	--	--	--	--	--	--	---	--
C	--	6411	6949	2971	--	7238	---	2557
S_1	15273	18042	20287	21586	15273	17958	20038	15431
S_2	29299	36595	42020	46260	29298	36602	46303	40203
Non-Comp. Imports								At Market Prices
A_1	1508	1795	1429	1165	1508	1802	1544	826
A_2	365	459	729	508	365	426	334	322
M_1	2946	3515	2206	1340	2946	3525	2250	971
M_2	284	368	700	104	284	319	117	83
M_3	3011	3853	4207	4285	3011	3895	3955	1459
M_4	3480	4239	3756	3872	3480	4216	3402	1952
S_1	183	216	243	259	183	215	240	185
S_2	52	65	74	82	52	65	82	71
Total Gross Investment	82986	89219	92963	93963	82986	89296	82142	82142
Net Imports (+) and Net Exports (-)								
A_1	-2000 (0.001235)	-3000 (0.000748)	-4000 (0.000347)	-5000 (0.000069)	-2000 (10.1615)	-3000 (6.2075)	-4000 (2.7448)	-5000 (0.7226)
A_2	-5500 (0.001788)	-8036 (0.000796)	-11804 (0.000369)	-175000 (0.000079)	-5500 (14.4988)	-8036 (6.6059)	-11804 (2.9237)	-17500 (0.8124)
M_1	-2000 (0.000542)	-3000 (0.000075)	8471	15854	-2000 (4.2356)	-3000 (0.7422)	9278	10746
M_2	2573	2296	-1724	5919	2573	2948	7107	5082
M_3	-3000 (0.000441)	-4000 (0.000294)	-6000 (0.000146)	-8000 (0.000053)	-3000 (3.7607)	-4000 (2.5895)	-6000 (1.0173)	3427
M_4	3471	7697	6543	4881	3471	7188	-435	3797

SECTORAL INCREMENTS TO VALUE ADDED UNDER CUMULATIVE FORM OF SPECIFICATION OF THE OBJECTIVES
(Million Takas)

Sectors	Employment Maximization				Consumption Maximization			
	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4
A_1	37939	43741	43818	44854	37939	43868	49954	34843
A_2	15025	18363	23108	34459	15025	18181	21065	21309
M_1	6248	7487	3174	---	6248	7520	3036	---
M_2	925	1211	2625	---	925	353	---	---
M_3	5651	7233	7895	8041	5651	7311	7408	2707
M_4	---	---	---	---	---	---	---	---
C	---	2807	3043	1301	---	3169	---	1119
S_1	13011	15370	17283	18389	13011	15299	17071	13146
S_2	24800	30976	35568	39157	24800	30982	39193	34432
Total Incremental Value Added	103599	127188	136514	146201	103599	126683	137727	107556
Increments to Private Consumption	80847	101042	111129	115835	80847	101182	130781	93256
Increments to Employment (Million man-years)	10.18832	12.704	13.9716	14.7149	10.18832	12.6014	13.6099	10.3102

TABLE (6.T.8)

"PRICE SOLUTIONS" UNDER "CUMULATIVE" SPECIFICATION OF GOALS

Commodity Balances	Employment Maximization Period 1	Period 2	Period 3	Period 4	Consumption Maximization Period 1	Period 2	Period 3	Period 4
A_1	.001228	.000272	.000094	.000009	10.2633	2.6554	1.3682	0.7978
A_2	.000702	.000234	.000078	.00000	6.1411	2.3505	1.2327	0.7241
M_1	.001897	.000952	.000437	.000078	15.9832	8.03;3	4.0716	1.5051
M_2	.001589	.000658	.000285	.000051	13.1714	5.715	2.6524	0.9805
M_3	.001886	.000671	.000271	.000021	15.5322	5.7823	2.8677	1.4362
M_4	.001897	.000785	.000340	.000061	15.7222	6.8223	3.1661	1.1704
C	.000588	.000588	.000228	.000008	5.1701	5.1701	1.7027	1.2400
S_1	.000643	.000652	.000395	.000201	5.4971	5.5964	3.9172	2.2898
S_2	.000636	.000165	.000115	.000021	5.4544	1.6833	1.5071	0.7772
Capacity Constraints								
A_1		.000117	.000069	.000045		0.9452	0.6061	0.3926
A_2		.000064	.000038	.000025		0.5207	0.3343	0.2165
M_1		.000365	.000187	.000125		2.9488	1.6071	1.1116
M_2		.000086	.000052	.000034		0.6938	0.4493	0.2923
M_3		.000047	.000028	.000018		0.3838	0.2442	0.1598
M_4		.000146	.000079	.000051		1.1829	0.6883	0.4509
C		.000081	.000034	.000022		0.6548	0.2892	0.2012
S_1		.000522	.000380	.000242		4.2405	3.3721	2.0567
S_2		.000047	.000118	.000072		0.3931	1.0909	0.5532
Non-Comp Imports								
A_1	.002464	.001020	.000442	.000079	20.4249	8.8629	4.1131	1.5205
A_2	.002490	.001031	.000447	.000080	20.6400	8.9563	4.1564	1.5365
M_1	.002439	.001009	.000437	.000078	20.2188	8.3375	4.0716	1.5051
M_2	.001589	.000658	.000285	.000051	13.1714	5.754	2.6524	0.9805
M_3	.002327	.000964	.000417	.000075	19.2930	8.3718	3.8851	1.4362
M_4	.001897	.000785	.000340	.000061	15.7221	6.8223	3.1661	1.1704
S_1	.002351	.000973	.000422	.000075	19.4899	8.4551	3.9238	1.4505
S_2	.002351	.000973	.000422	.000075	19.4949	8.4551	3.9238	1.4505
Consumption	.001196	.000392	.000174	.000031	6.0258	0.5759	0.0000	0.0000
Foreign Exchange	.002648	.001096	.000475	.000085	21.9524	9.5258	4.4207	1.6342

TABLE (6.T.9)

SENSITIVITY OF SOME MACRO-VARIABLES WITH RESPECT TO INCREASES IN AGRICULTURAL WAGES

	Basic Solution	5%	10%	15%	20%	25%
Value of the Objective (million man-years)	52.261173	50.290954	48.367544	46.199724	43.750833	41.172057
Value of consumption (million takas)	414722	407592	400363	390370	377515	362852
Expansion in value added	520921	503291	485437	468517	449099	----

TABLE (6.T.10)

VALUES AND PERCENTAGE DISTRIBUTION OF VALUE ADDED BY SECTOR AND ITS SENSITIVITY TO AGRICULTURAL WAGES

Sector	Basic Solution	Increase in Agricultural Wages 5%	10%	15%	20%
A_1	174032 (.334)	170541 (.338)	167042 (.344)	163563 (.349)	158083 (.352)
2^A2	86884 (.166)	83377 (.166)	78416 (.162)	73845 (.157)	71552 (.159)
M_1	19483 (.037)	18478 (.037)	17502 (.036)	18263 (.039)	17841 (.0397)
M_2	4023 (.008)	2012 (.004)	412 (.0008)	31 (.00006)	-- (.0000)
M_3	29460 (.057)	28558 (.057)	27827 (.057)	24249 (.052)	19953 (.044)
M_4	2311 (.004)	1100 (.002)	23 (.00005)	-- (.0000)	-- (.0000)
C	8403 (.016)	7349 (.015)	6773 (.014)	6222 (.013)	6996 (.011)
S_1	64573 (.124)	62006 (.123)	59418 (.122)	56710 (.121)	54019 (.120)
S_2	131752 (.253)	129870 (.258)	128024 (.264)	125634 (.268)	122655 (.273)
TOTAL	520921 (1.00)	503291 (1.00)	485437 (1.00)	468517 (1.00)	449099 (1.00)

NOTE: The figures in the parentheses are fractions of the column total.

TABLE (6.T.11)

DISTRIBUTION OF INCREMENTAL EMPLOYMENT BY SECTOR FOR ALTERNATIVE RATES OF INCREASE IN AGRICULTURAL WAGES

Sector	Basic Solution	5%	10%	15%	20%
A_1	16 31	15.98	15.66	15.33	14.82
A_2	8.50	8.16	7.67	7.23	7.00
M_1	1.06	1.01	0.95	0.99	0.97
M_2	0.76	0.38	0.08	0.006	0.00
M_3	6.97	6.76	6.58	5.74	4.72
M_4	0.26	0.12	0.003	0.00	0.00
C	1.19	1.04	0.96	0.88	0.71
S_1	5.23	5.02	4.81	4.59	4.38
S_2	11.98	11.81	11.65	11.43	11.16
TOTAL	52.26	50.28	48.363	46.196	43.76

TABLE (6.T.12)

INCREMENTAL SHARE OF EMPLOYMENT BY SECTOR FOR DIFFERENT RATES OF INCREASE IN AGRICULTURAL WAGES

Sector	Basic Solution	5%	10%	15%	20%
A_1	.312	.318	.324	.332	.339
A_2	.163	.162	.159	.156	.1599
M_1	.020	.020	.019	.021	.022
M_2	.015	.008	.002	.0001	--
M_3	.133	.134	.136	.124	.108
M_4	.005	.002	.00006	--	--
C	.023	.021	.019	.019	.016
S_1	.100	.099	.099	.099	.100
S_2	.229	.235	.241	.247	.255
TOTAL	1.00	1.00	1.00	1.00	1.00

TABLE (6.T.13)

SENSITIVITY OF EMPLOYMENT, OUTPUT AND CONSUMPTION TO UNIFORM RATES OF INCREASES IN REAL WAGES AND SOME RELEVANT ELASTICITIES

	Rate of Increase in Real Wages					
	Basic Solution	5%	10%	15%	20%	25%
Employment (million man-years)	52.261	48.003	43.289	38.626	34.203	Infeasible
% decline in Employment / % Increase in Wages		1.6	1.7	1.7	1.7	---
Output (value - added)	520921	481625	445209	405095	365447	Infeasible
% decrease in Employment / % decrease in output		1.08	1.17	1.17	1.14	---
Private Consumption	414722	399062	375141	348049	319924	Infeasible
% decrease in Consumption / % Increase in Wages		0.76	0.95	1.07	1.15	---

TABLE (6.T.14)

SENSITIVITY OF THE SHADOW PRICES OF FOREIGN EXCHANGE AND CONSUMPTION TO UNIFORM RATES OF INCREASES IN REAL WAGES

		Basic Solution	Rate of Increase in Real Wages 5%	10%	15%	20%	25%
			Shadow Price of Foreign Exchange				
Shadow price of Foreign Exchange	T = 1	.001094	.0010195	.0010396	.0013603	.0010796	
	T = 2	.000739	.0007262	.0006236	.0008055	.0008706	Infeasible
	T = 3	.000382	.0003864	.0003438	.0003979	.0004020	
	T = 4	.000092	.0000703	.0002346	.0000841	.0002518	
			Shadow Price of Consumption				
Shadow Price of Consumption	T = 1	.000467	.0005373	.0005321	.0006595	.0005341	
	T = 2	.000274	.0002696	.0003201	.0003984	.0004240	
	T = 3	.000185	.0001921	.0001951	.0001967	.0002106	Infeasible
	T = 4	.000034	.0000314	.0001291	.0000653	.0001913	

TABLE (6.1.15)

PRODUCTION AND FOREIGN TRADE STRUCTURES UNDER THE "BASIC SOLUTION" AND UNDER A SIMULTANEOUS REDUCTION IN DOMESTIC WAGES BY 5% AND FOREIGN AID BY 34%

Domestic Production	BASIC SOLUTION				Simulation Results with 5% wage-cut and 34% reduction in "Foreign aid"			
Activities	Period 1	Period 2	Period 3	Period 4	Period 1	Period 2	Period 3	Period 4
A_1	49388	55532	58680	62948	49388	53197	59825	66344
A_2	18677	24688	27271	45846	19456	25463	27291	52810
M_1	20145	23239	19028	--	20643	22686	24075	--
M_2	--	5150	--	11736	1902	9121	--	23294
M_3	18173	22358	25951	27732	18728	22170	27146	29531
M_4	5279	--	--	--	8709	--	---	--
C	--	5658	10346	3189	--	6216	12926	3351
S_1	15486	17799	18640	23876	16409	18006	18811	26892
S_2	29278	36049	40741	49585	29297	35074	40252	51943
Net Imports (+) Net Exports (-)								
A_1	-2000	-3000	-4000	-5000	-2000	-3000	-4000	-5000
A_2	-5500	-8036	-11804	-17500	-5500	-8036	-11804	-17500
M_1	-2000	-3000	1402	17982	-2000	-3000	-2121	19672
M_2	5334	2375	6035	-981	3999	-849	5753	-8726
M_3	-3000	-4000	-6000	-8000	-3000	-4000	-6000	-8000
M_4	419	8075	8455	5517	-1000	9366	10522	6142

TABLE (6.T.16)

THE EFFECTIVENESS OF DOMESTIC WAGE POLICIES IN REDUCING DEPENDENCE ON FOREIGN AID WITHOUT ALTERING PER-CAPITA CONSUMPTION

Total Increment to	Basic Solution	Simulation with 5% Wage Cost and 34% reduction in "Foreign Aid"
Private Consumption	414722	414722
Value Added	520921	542942
Employment	52.26118	54.89589
Fixed Investment	30826	37286
Non-Competitive Imports (c.i.f.)	53280	58431
Competitive Imports (c.i.f.)	55594	55454
Exports (f.o.b.)	83821	95536

TABLE (6.T.17)

Distribution of Incremental Employment and Labour Earnings

Under the Cumulative Specification of Development Goals

Sectors	EMPLOYMENT (MILLION MAN-YEARS)		LABOUR EARNINGS (MILLION TAKAS)	
	Employment Maximization	Consumption Maximization	Employment Maximization	Consumption Maximization
A	24.86 (.482)	22.36 (.486)	186510 (.456)	167731 (.461)
M	9.65 (.187)	7.22 (.157)	85866 (.210)	64412 (.177)
S	17.06 (.331)	16.47 (.357)	136474 (.334)	131804 (.362)
Column Total	51.57	46.06	408850	363947
Cumulative Total	121.53	114.07	964607	981756

(Figures in the parentheses are fractions of the column total.)

TRADE-OFF BETWEEN EMPLOYMENT AND CONSUMPTION

This section is devoted to the analysis of the nature of the trade-off relationships that can be generated between employment and consumption under alternative assumptions regarding the "form" of these two long-term social goals. The principal "forms" of specification considered include the "incremental" form as represented by the set of equations (5.1) and (5.2) and the "cumulative" form represented by the equation set (5.4) and (5.5). The time-discounted versions of each of these forms have also been briefly considered.

The technique employed for generating the trade-off path is the same in each case. For any particular form of specification of the objectives, it takes the solution for the employment objective and the solution for the corresponding consumption objective to define two extreme points in the employment-consumption space. The intermediate points are then defined by repeated employment maximization solutions that are derived by raising the level of consumption, in successive steps, from the level achieved under the "initial" employment maximization solution toward the level attained under the consumption maximization solution. To implement

this process a new constraint which imposes a lower bound on overall consumption is added to the model, that is:

$$C(1) + C(2) + C(3) + C(4) \geq \overline{K}$$

The intermediate points on the employment-consumption trade-off locus correspond to repeated employment maximization solutions which are the result of variation of $\overline{K}$ in the range $C^* \leq \overline{K} \leq C^{**}$, where C^* and C^{**} represent the consumption levels achieved under the "initial" employment and consumption maximization solutions respectively.

TRADE-OFF LOCUS BETWEEN "INCREMENTAL EMPLOYMENT" AND "INCREMENTAL CONSUMPTION"

Graph No. 1 depicts the opportunity cost locus between consumption and employment when these goals are specified in the incremental form. The extreme points on this graph correspond to the "initial" employment maximization solution E^* (52.261173 million man years, 414722 million takas) and the consumption maximization solution C^* (51.382421 million man years, 420512 million takas). The origin 0 (51.382421 million man years, 414722 million takas) on the graph refers to the level

of employment achieved under the consumption maximization solution and the level of consumption achieved under the "initial" employment maximization solution respectively. The numerical proximity of the points E and C is indicative of the relative insensivity of the optimal development program to the choice of the development goal for the incremental form of specification of the goals. The "gain" in employment that would be realized by changing the economy's long-term development goal from "incremental" consumption maximization to "incremental" employment maximization is only 1.4% over the level achieved under the incremental consumption maximization. Similarly, the "gain" in consumption which would be achieved in moving from the incremental employment to the incremental consumption objective is only 1.7%.

The conflict between consumption and employment implied by the negative slope of the opportunity cost locus occurs because of differences in the factor intensities and the productivity of the technolgies in the different sectors of the economy. For instance, starting at the consumption maximization solution C^*, the society can trade-off consumption for additional employment along the opportunity cost locus, by altering the sectoral allocation such that the "average" labour intensity of overall production increases (i.e., average capital intensity decreases). Since, in general, the relatively more labour intensive sectors are also less

productive, such reallocation of resources results in higher aggregate employment at the cost of lower aggregate output and hence, lower consumption. Also, since the relatively more labour intensive sectors pay relatively lower wages (see Section III, page 147-8) the economy's "average" wage rate and therefore, the average consumption per worker, fall as one moves from the consumption toward the employment maximization solution.

In reality, substitution between consumption and employment will call for two types of accommodations in the structure of production. The first and the less costly type of accommodation is adjustment in the scales of optimal activities while the other more costly type of accommodation involves switches between sectoral technologies. These two types of adjustments have different implications for the opportunity cost locus.

For example, starting at E^*, the terms at which employment can be traded-off for additional consumption remain constant so long as the required increases in consumption can be realized through appropriate substitutions in the scales of activities in the optimal basis corresponding to the solution at E^*. This is possible up to point N. For further increases in consumption beyond point N, the rate at which employment has to be sacrificed increases resulting in a kink at N on the trade-off locus. This is because optimal increases

in consumption beyond N necessitates changes not only in the scales of activities but also in the optimal activities themselves. The nature of the structural change is such that a relatively less labour intensive activity (sector of production) is introduced into the optimal basis to the exclusion of a relatively more labour intensive activity. Such an exchange of activities causes employment to fall at a faster rate than the rate at which employment would have fallen if the required increase in consumption could be realized by merely adjusting the scale of activities in the optimal basis . Therefore, the kinks on the trade-off locus are the result of changes in the structure of production which are made necessary by the successive increases in consumption requirements as we move up from point E^* toward point C^*. The kinks, in turn, give the trade-off path a convex shape implying that in order to achieve more of one objective the sacrifice of the other objective must be made at an increasing rate at the margin.

TRADE-OFF LOCUS BETWEEN "CUMULATIVE" EMPLOYMENT AND "CUMULATIVE CONSUMPTION

Graph No.2 depicts the nature of the trade-off relationship between the "cumulative employment" and "cumulative consumption" objectives. The residual

employment generation under the "cumulative" consumption maximization strategy is 116.45818 million man years over the plan. The residual consumption under the cumulative employment maximization objective is 964607 million takas. These two magnitudes define the origin 0 for graph No.2 .

The maximum achievable employment under the "cumulative" employment maximization strategy is 121.529197 million man years, while the maximum achievable consumption under cumulative consumption maximization strategy is worth 981757 million takas. This means that the actual magnitudes involved in the trade-off are 5.07101 million man years of employment (i.e., about 4.5% of the amount of employment achieved under the cumulative consumption objective) for 17150 million takas worth of consumption (about 1.8% of the amount of consumption achieved under the cumulative employment objective) over the plan.

Therefore, on the average, for every 3382 takas' worth of sacrifice of consumption (measured in shadow prices), at the margin, an additional one man-year of employment can be created. However, the rate of trade-off between the two goals does not remain uniform over the entire range. Thus, starting at the cumulative consumption maximization solution at C*, for every additional man-year of employment, the required rate of

sacrifice of consumption remains constant at Taka 1392 up to the point M^*. Between point M^* and point N^* the required rate of sacrifice rises to taka 2329 and beyond point N^* the rate is 25,249 takas.

In concluding this section it may be noted that except for units, the nature of the trade-off is not much different in the incremental and the cumulative specifications. This apparent robust association between development programs and different specifications of goals is probably to be expected because the specifications actually considered are all essentially "linear" and therefore not dissimilar enough to cause any dramatic differences in the structure of the solution to the linear program.

DISTRIBUTIONAL EFFECTS OF EMPLOYMENT VERSUS CONSUMPTION MAXIMIZATION

Given the trade-off that exists between consumption and employment, it is not readily apparent that either employment maximization or consumption maximization is the preferred objective function if both consumption and employment are accepted as valuable in themselves. Some additional criterion must be introduced to provide a basis for choosing one of the two objective functions. One possible criterion could be a measure of income distribution, with the rule that anything that makes income less inequitably distributed is better than an objective function which results in a more inequitable distribution of income.

The solution to the model described in this work can be used to compute the structure of employment and the structure of labour earnings during each period. Aggregating these over time and after further consolidating the economy, the resulting information can be arranged to define the distribution of labour earnings across the agricultural, the manufacturing and the services occupations in terms of Lorenz curves.

Graph No. 3 compares the sectoral distribution of (incremental) labour earnings at the end of the plan

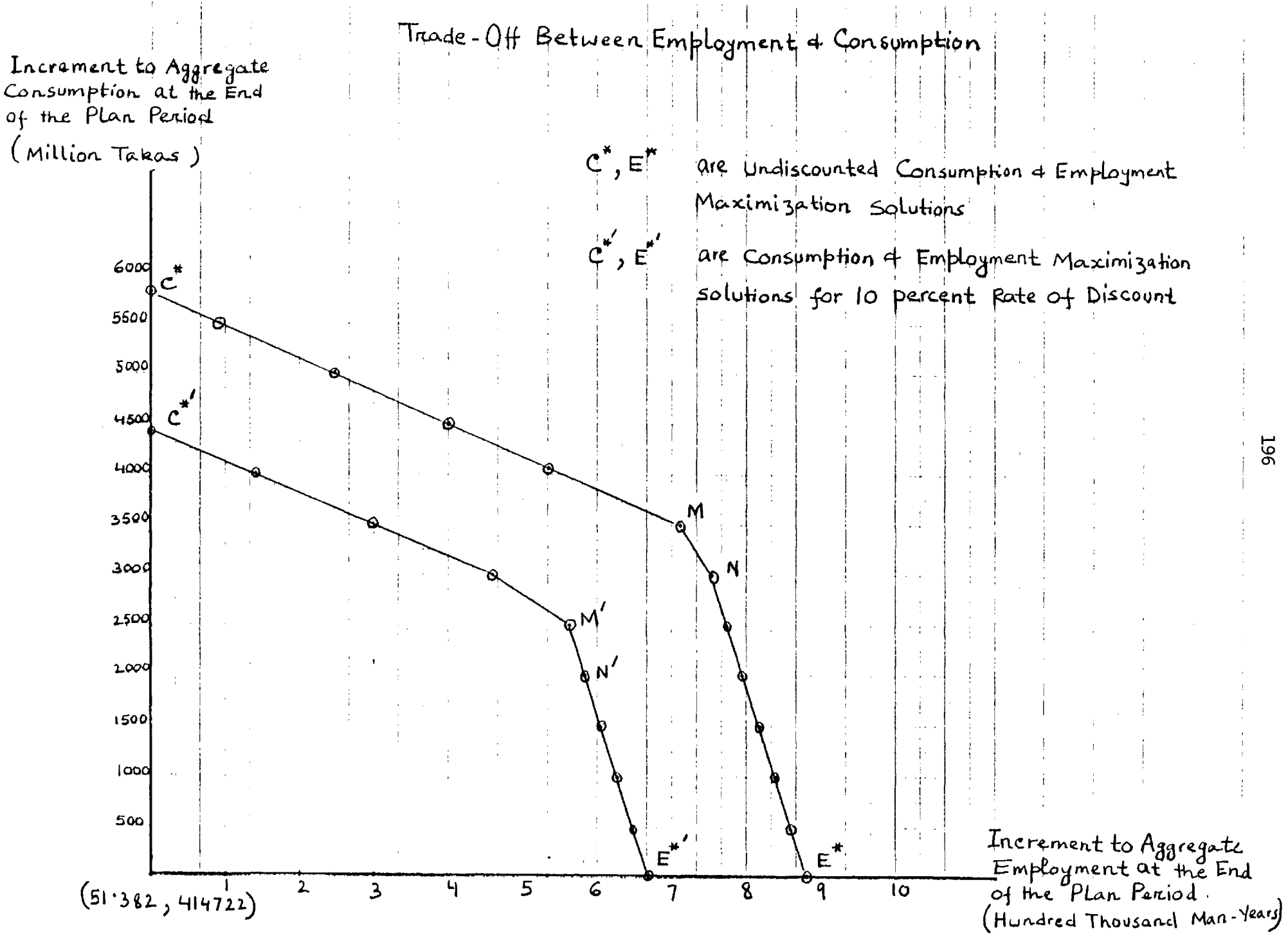
horizon (1976-1996) under the employment and the consumption maximization development objectives. It shows that the Lorenz Curve associated with the employment objective lies entirely "inside" that associated with the consumption objective, so that by the definition of the Lorenz Curve, the former represents an unequivocally superior income distribution in relation to the latter. Starting with the distribution under the consumption objective, it would be possible to pass to the distribution under the employment objective by a series of income transfers from the high wage (richer) sectors to the low wage (poorer) sectors of the economy. In this sense, the pattern of distribution associated with the employment objective represents a lower degree of inequality.

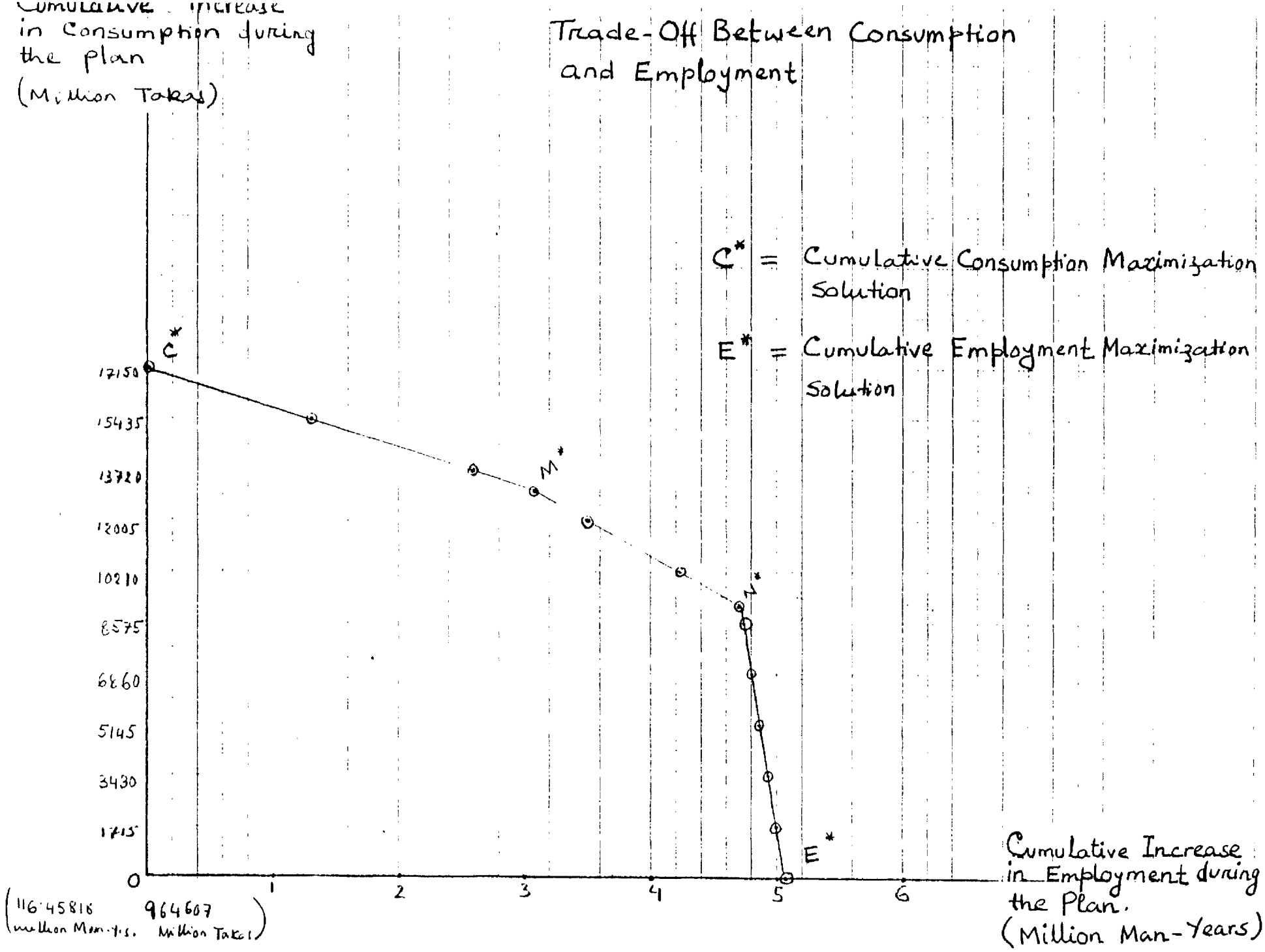
The explanation is clear. The switch in the development objective from consumption to employment releases the pressure on the use of the economy's scarce resources by allowing the structure of production to move closer in the directions of the economy's comparative advantage. This allows the economy to grow at a faster overall rate under the employment objective for the same availabilities of scarce resources. This faster growth rate of the economy and also the changes in the composition of output towards relatively labour

intensive activities both within and outside of agriculture are responsible for a more rapid absorption of unemployment under the employment objective vis-a-vis the consumption objective. For the same labour supply growth rates, the unemployment rate is reduced from the assumed "initial" level of 30 per cent to a level of 18 per cent under the employment objective and to a level of 21 per cent under the consumption objective. (See Figure 3.)

It is interesting to note that (see Table 6.T.17) employment maximization strategy is actually associated with a higher proportion of total employment being engaged in the high wage manufacturing sectors. This is equivalent to an increase in ratio of the skilled to unskilled labour in the composition of employment and it has the effect of increasing the degree of inequality among employed workers. This result is a reflection of the peculiar structural characteristics of the Bangladesh economy. It essentially points to the fact that the interindustrial linkages in Bangladesh require the growth of farm output as a necessary prerequisite to the expansion of the labour-intensive, agro-based manufacturing industries. (See pages 163-4 for further elaboration on this point.)

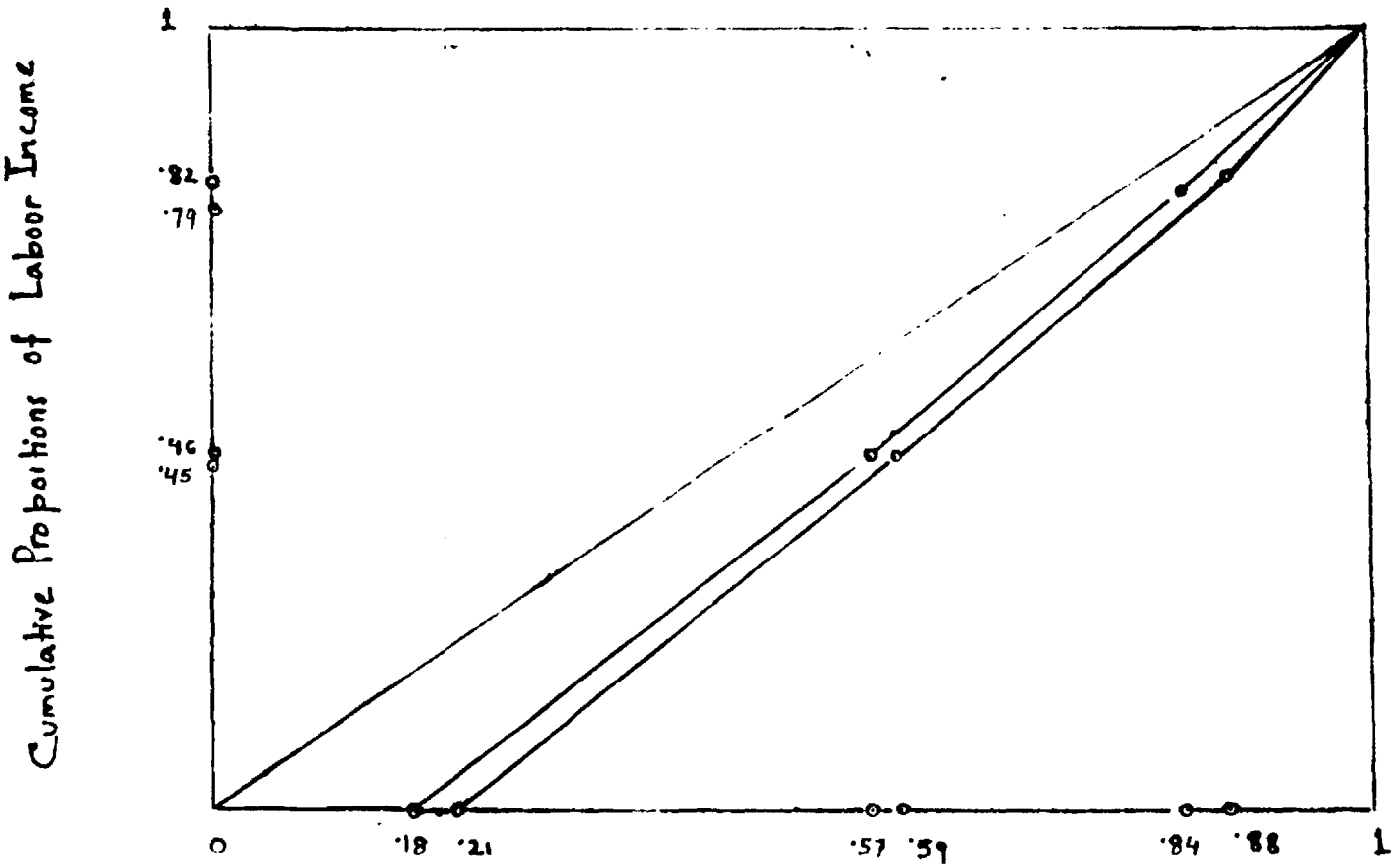
The net effect of the faster growth of output (employment) and of the changes in the composition of output (employment) associated with the move from the consumption to the employment objective is greater equality in the distribution of income. The basic message is that in a labour surplus economy with rigid sectoral wage structure, faster growth is equalizing. Faster growth which reduces the unskilled labour pool will have a net equalizing effect because the positive effect of faster elimination of unemployment will overwhelm the possible negative effect arising from changes in the composition of employment.


Trade-Off Between Employment & Consumption
Increment to Aggregate Consumption at the End of the Plan Period (Million Takas)
C*, E* are Undiscounted Consumption & Employment Maximization Solutions
C*', E*' are Consumption & Employment Maximization solutions for 10 percent Rate of Discount
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
C*
C*'
M
N
M'
N'
E*'
E*
1
2
3
4
5
6
7
8
9
10
(51·382, 414722)
Increment to Aggregate Employment at the End of the Plan Period. (Hundred Thousand Man-Years)


Cumulative Increase in Consumption during the plan (Million Takas)
Trade-Off Between Consumption and Employment
C* = Cumulative Consumption Maximization Solution
E* = Cumulative Employment Maximization Solution
C*
M*
M*
E*
17150
15435
13720
12005
10290
8575
6860
5145
3430
1715
0
1
2
3
4
5
6
(116·45816 million Man-Yrs. 964607 Million Takas)
Cumulative Increase in Employment during the Plan. (Million Man-Years)

— Lorenz Curve Under the Employment Objective

— Lorenz Curve Under The Consumption Objective



CHAPTER 7

CONCLUSION

INTRODUCTION:

The primary objective of this thesis has been the application of a multisectoral planning model to the study of the employment creating potential of an economy based upon given sectoral technologies and existing composition of demand. This chapter offers a brief summary of the results that have emerged from the study and their policy implications. The major qualifications of the results along with some possible future extensions to the model are discussed toward the end of the chapter.

MAIN CONCLUSIONS AND THEIR POLICY IMPLICATIONS:

The primary conclusion which emerges from this study is that within the framework of the existing demand and technological structures of the economy and the assumed future availabilities of complementary inputs, the "maximum" feasible increase in employment that can be generated over the period 1977-1997, will not result in full employment of labour by the end of this period. The results of the basic solutions to the

model show that even if the government were assumed to pursue an employment-maximizing investment policy the resultant expansion in employment would only absorb about 90 percent of the exogenous increase in labour supply which would take place during the plan period. This suggests that over the next two decades the size of the "initial" (labour) surplus is likely to grow rather than fall.

Although the results of the computations based on the model are subject to the limitations imposed by the nature of the model itself and also by the nature of the data employed, the large gap between labour supply and labour requirement underscores the fact that in planning for full employment sole reliance must not be placed on employment creation. Rather, some resources must be diverted to control the growth of population. Direct and compulsory measures must be taken to this end and the effects of these measures should be studied endogenously within the framework of the cost-benefit analysis of the model. Reduction of the supply of labour force seems to be the only logical long-run solution to the problem of unemployment and underemployment in Bangladesh.

While population control is the necessary long-run solution, the implications of the employment maximization goal for resource allocation in the short and the medium run is also clear. The results of the study show that if employment is considered to be the primary development goal then investment has to be diverted from industry to agriculture in the short and the medium run. This is the major conclusion which follows from the results of the 'naive' model.

It may be recalled that the underlying assumptions of the "naive" model produce strong tendencies toward specialization along lines of the economy's comparative advantage. The principle of comparative advantage can be made the basis for defining sectoral priority for employment expansion in the future. The results indicate that at the present stage of development Bangladesh should specialize in the production and the export of agricultural commodities while the manufactured commodities in which it has a comparative cost disadvantage should be imported, at least during the earlier periods in the model.

The fact that the manufacturing sector M_3 emerges from being a net importer during the earlier periods to being a net exporter of its products during the final period in the model seems to suggest that

industrialization as a policy for labour absorption can be justified only as a long-run objective. It suggests that the primary resource constraints (domestic savings and foreign exchange) which are responsible for the relative cost disadvantage of the manufacturing activities must be first relaxed through the growth and development of the agricultural sectors before the initial spurt of industrialization can take place. In this sense, development of the agricultural sectors in Bangladesh may be considered as a 'prerequisite' to industrialization.

Next to agriculture, the greatest employment potential exists in trade, transport, administration, health, education and other services activities. These activities are in general labour intensive and are treated as non-tradeables. They produce substantial amounts of output in the optimal solutions both under the employment and the consumption objectives. Therefore, in planning for fuller employment the tertiary activities should be treated as a priority sector for investment.

From the point of view of employment expansion, manufacturing is not a priority sector, at least in the short and possibly in the medium run. Within this sector, efficient, labour intensive small scale industries should be given priority over large scale capital

intensive industries. Such a shift is likely to reduce labour productivity and the growth of national income. But a choice seems unavoidable.

One of the principal conclusions which emerges from the sensitivity analysis conducted in the study is that the labour market distortions which are reflected in wide wage differentials between the agricultural and the non-agricultural sectors and in high open and disguised unemployment are more pervasive and fundamental than any other type of domestic distortions, e.g., those emanating from government's protectionist trade policies.

Policy experiments which aim at eliminating the wage differentials between the agricultural and the industrial sectors show that for any given increase in farm wages, the economy's aggregate output and employment fall by a much larger percentage than the percentage decline in agriculture's own contribution to these macro variables. This result underscores the importance of the growth of the agricultural sector for the growth of the rest of the economy.

An increase in agricultural wages adversely affects the growth of the economy directly by raising the domestic costs of production of farm products and indirectly by raising the cost of production of agro-based manufactured commodities relative to the costs of importing

these products. It is interesting to note that although the absolute values of the contribution to employment and output of all sectors decline as labour costs in the agricultural sectors rise, the relative shares of agriculture in both of these macro-variables steadily increase and the relative shares of the consolidated industrial sector decline. This seems to suggest that at least at the present stage of development, low agricultural wages help promote industrialization. This, in turn, implies a conflict between the 'basic needs' approach to development and the 'industrialization approach'.

Another conclusion which emerges from the study is that irrespective of whether consumption or employment is the social maximand, the domestic real wage policies are potentially a powerful instrument for reducing the economy's dependence on 'foreign aid' without adversely affecting the overall growth of the economy.

The results of wage policy simulations indicate that a five percent across the board wage cut can sustain as much as a thirty-four percent reduction in 'foreign aid' during each period without hurting the economy's per capita consumption or per capita income. An even greater percentage reduction in foreign capital could

be realized for the same wage cut if the level of employment achieved in the 'basic solution' rather than consumption was to be held constant. This suggests that an employment creating investment strategy would be less dependent on 'foreign aid' than an allocation policy which is geared to the expansion of consumption.

Since the effects of wage policies are transmitted mainly through the savings constraint while the effects of foreign capital are transmitted through the foreign exchange constraint, the high degree of effectiveness of wage cuts in replacing 'foreign aid' implies that the marginal productivity of domestic savings (in terms of its contribution to the objective function) must be significantly greater than the marginal productivity of foreign exchange. This in turn implies that at the present stage of development, savings is a more severe bottleneck to the growth of the economy than foreign exchange.

Therefore, if the country can muster the political will to absorb its unemployed by cutting the levels of existing real wages it can then proceed along the path of economic development without excessive reliance on 'foreign aid'. Cutting real wages may not be politically feasible in a situation where their levels are already at or near subsistence. However,

the implications of this result for the future rate of growth of real wages in the (labour-surplus) country is clear.

Finally, our results show that higher standards of living and fuller employment of labour are at present conflicting social goals, although the degree of the conflict is not very serious. Under a consumption maximizing development strategy, the 'derived demand' for labour is determined residually. On the other hand, an employment maximizing growth strategy requires the structure of production to adjust as if the government were implementing a policy to induce producers to use larger amounts of labour, at their fixed sectoral productivity rates. This will occur if low productivity sectors expand production while competitive imports are allowed to replace domestic production in high productivity sectors. Thus, the additional employment under the employment objective can be realized only at the cost of inefficient allocation of resources (efficiency being defined purely in terms of final output). The "average" per worker consumption in the economy will decline from its level under consumption maximization, both because of the loss of production possibilities and also because lower productivity sectors pay lower wages.

Finally, the optimal development programs are not found to be very sensitive to the choice of the development goal or to the forms of specification of these goals.

The study in this thesis has been conducted more for illustrative and learning purposes than for actual policy-making in Bangladesh. The results discussed above can be expected to hold only under the special circumstances assumed in the study and should be so interpreted. Thus, it is necessary to state the qualifications to the study arising from the assumptions underlying the structure of the model and others arising from the limitations of the data employed.

One source of qualification of the results arises from the assumption of complete linearity of the model. This assumption is unlikely to apply equally throughout the economy. Linearity of sectoral technologies assumes away possibilities of any direct factor substitution in the production of individual commodities. Possibility of such substitution is, however, an empirical question. To the extent that a commodity in reality may be produced by more than one technique and the possibility that each of the techniques may allow for direct substitution between factors of

production, the results of employment projection in our model may have to be modified. However, if the relative factor prices may be expected to remain stable around their base year values then the assumption of linear technologies would be harmless.

The assumption that production coefficients do not change over time rules out changes in factor productivities through technical progress.

The problem of variable coefficients can be addressed within the existing framework by means of 'periodic' revision of the empirical input-output table. Two such tables relating to two different periods could be used to extrapolate future trends. Such extrapolation however, has serious limitations. Probably a better strategy is to make several projections (based upon available information) and record the sensitivity of the results to changes in the coefficients. If the resultant effects are small then the problem can be ignored, otherwise the results of the sensitivity analysis of the projected changes in the technological coefficients should be carefully recorded and analysed.

On the demand side, the assumption of fixed Engel's elasticities linking aggregate consumption to the consumption of individual commodities rules out possible changes in the (sectoral) composition of

consumption through the differential in price and income elasticities of demand for these comoodities. This is a serious limitation but in view of the overwhelming importance of the supply side of the economy (because of its reaching upper limits of production set by resource constraints) it has become a common practice to assume such consumption functions in planning models. However, some arbitrary range of variation for the marginal consumption shares for individual commodities could be defined in a way that satisfies the 'adding up' property and the effects of introducing this change could be studied within the existing framework of this study.

Finally, the shadow prices obtained from the optimal solution to the model are not operationally relevant for more than one reason.

First, these prices apply to highly aggregated commodity bundles. Second, the upper bounds on 'net exports' which were introduced to achieve a more plausible set of primal solutions may not be the correct specification for obtaining reliable estimates for optimal prices. Thirdly, the objective function may be misspecified or may not accurately reflect the motivating factors behind the behaviour of various economic agents. Finally, since the model is defined in terms of increments, any deviation

of the projected relative marginal availabilities of factor endowments from their average values is likely to affect the relative shadow prices of these resources.

THE SCOPE FOR FUTURE RESEARCH:

A significant part of the effort in this thesis has been directed to testing how robust are the associations between allocation policies and development goals. Experiments with alternative forms of employment and consumption goals have shown this association to be fairly strong. However, it would be presumptuous to believe that this answer is definitive, since under alternative circumstances not considered in this thesis the results may be different. It would be interesting to simulate the effects of introducing some of these changes into the model and see how the results differ from those obtained in this thesis. This is a prospective area for future extentions of the study.

First the results of optimization based on a multisectoral model are affected by the particular aggregation scheme used in implementing the model. A highly aggregative model like ours is likely to make the employment effects and the sectoral distribution effects

of alternative strategies less pronounced. It is also likely to make the employment projections less accurate. The model can be easily extended in the direction of accommodating more commodities and also more techniques of production for each commodity. However, such an extension has to await the availability of reliable information on the separate cost structures of existing alternative techniques (such as the large-scale, small scale and the cottage industry techniques for manufactured commodities; the modern seed-fertilizer technology and the traditional technology for agricultural commodities) for the production of individual commodities. Disaggregations along these lines will widen the differences in the relative factor intensities among the production activities. This in turn, is likely to cause the differences between the optimal development programs under alternative goals be more pronounced.

One puzzle in the study has been the fact that the pattern of resource allocation under the employment and the consumption objectives are identical during the first period while differences between the solutions appear only during the later periods in the model. One interpretation offered in the thesis is that in the earlier periods the economy is moving toward an

efficient allocation but that once that is achieved the development patterns associated with the two goals begin to diverge. This could be tested by running the model for more periods in some future extension of this work.

APPENDIX A

The 9 sectors of this model are derived by aggregating a 47 x 47 input-output table for Bangladesh for the year 1976-77. The primary basis for aggregation has been the labour intensity of the original sectors, that is, sectors in the 47 x 47 table with similar labour-output ratios were grouped together to form the sectors of our model. In general, however, the agricultural, the manufacturing and the services activities are kept separate in order that the inter-industrial structure of the economy is not disturbed too much. The relationship between an aggregate sector of this model with the sectors on the 47 x 47 table is shown below:

Our classification (9 sectors)	Planning Commission's Classification (47 sectors)
1. Food Agricultural Sector A_1	1. Rice
	2. Wheat
	6. Other Crops
2. Non-Food Agricultural Sector A_2	3. Jute
	4. Cotton
	5. Tea
3. Manufacturing Sector M_1	10. Sugar
	11. Edible oil
	13. Tobacco products

	19. Paper and Paper products
	21. Fertilizer
	24. Cement
	37. Petroleum products
	38. Electricity
	39. Gas
4. Manufacturing Sector M_2	15. Cotton Yarn
	16. Cloth: mill made
	17. Cloth: handloom
	18. Jute Textiles
5. Manufacturing Sector M_3	12. Salt
	14. Other food
	20. Leather
	22. Pharmaceuticals
	23. Other chemicals
	29. Wood
	30. Miscellaneous industries
6. Manufacturing Sector M_4	25. Steel/basic metals
	26. Metal products
	27. Machinery
	28. Transport equipment
7. Construction Sector C	31. Urban housebuilding
	32. Rural Housebuilding
	33. Construction of non-residential buildings

35. Transport construction (roads, bridges, etc.)
36. Other construction

8. Services
   Sector S_1
40. Transport service
41. Trade service
42. Housing service

9. Service
   Sector S_2
43. Health
44. Education
45. Government service
46. Banking service
47. Other service

APPENDIX B

Implicit in the structure of the primal model, there is a savings constraint on investment of each period. This constraint may be derived explicitly by adding together the commodity balance rows, the consumption row, non-competitive import rows and the foreign exchange row of a given period. Adding the above mentioned constraints and collecting the like terms give:

$$\sum_j (-1 + \sum_i a_{ij} + \sum_i m_{ij})\, x_j(t) + \{(\sum_i c_i + \sum_i m_{ic})C_T(t)$$

$$-C_T(t) + \sum_j \bar{w}_s\, \ell_j x_j(t)\} + \{\sum k_j I_j(t) - \sum k_j I_j(t-1)\}$$

$$+ \{I(t) - I(t-1)\} - \{\sum_i t_i(NCM_i(t) + NTM_i(t))\} \leq \Delta F(t) - \Delta G(t)$$

Note that:

a. $\sum (-1 + \sum_i a_{ij} + \sum_i m_{ij}) x_j(t) = \Delta V(t)$ = Incremental value added in period t.

b. $\sum_i c_i + \sum_i m_{ic} = 1$ Since marginal consumption shares add up to one.

c. $\sum_j k_j I_j(t) - \sum k_j I_j(t-1) = I(t) - I(t-1)$

= incremental fixed investment in period t.

(measured in terms of capacity output.)

d. $I(t) - I(t-1)$ = Incremental investment in working capital in period t.

e. $\sum t_i\{(NCM_i(t) - NTM_i(t)\} = \Delta T(t)$ = Incremental tariff revenue in period t.

Introducing these definitions and cancelling like terms, the above inequality can be written as follows:

$$\{-\Delta V(t) + \sum \bar{w}_s \ell_j x_j(t)\} + \{I(t) - I(t-1)\}$$

$$+ \{I(t) - I(t-1)\} - \Delta T(t) \leq \Delta F(t) - \Delta G(t)$$

Noting further that the first term on the LHS represents incremental domestic savings, the above inequality may be written in the following way:

$$\{I(t) - I(t-1)\} + \{I(t) - I(t-1)\} + \Delta G(g)$$

$$\leq \Delta S(t) + \Delta T(t) + \Delta F(t)$$

Thus, the implicit savings constraint underlying the structure of our model implies that the sum of the incremental fixed investment, incremental

inventory investment, and incremental government consumption during any period must not exceed the sum of the incremental private domestic savings, incremental 'net' foreign capital inflow and incremental government tariff revenue of the same period.

The implicit saving constraint will be optimally active provided all of the primal constraints from which it is derived are strictly binding in the optimal solution. When this happens, the shadow price of domestic savings can be determined by summing the shadow prices of the primal constraints from which the savings constraint is derived.

STATISTICAL APPENDIX

TABLE NO. 1

INCREMENTAL EXPORT LIMIT BY SECTOR (In million takas)

	T = 1	T = 2	T = 3	T = 4	Base Year Export	Assumed Annual Rate of Growth
A_1	821.5	1205.3	1770.5	2600.6	349.8	.08
A_2	5463.8	8036.3	11804.7	17521.2	2330.4	.08
M_1	628.5	923.9	1357.7	1995.5	268.2	.08
M_2	4545.5	6085.7	8142.1	10893.7	2692.3	.06
M_3	2375.5	3489.4	5126.2	7529.8	1012.8	.08
M_4	67.2	110.1	183.3	926.3	22.3	.10
Sum of the upper limits to the export of individual products	13902	19851	28384	40834	6674 x 5 = 33370	.08
Maximum increment to each period's exports	13000	17999	25995	35000		

TABLE NO. 2

INPUT-OUTPUT COEFFICIENTS MATRIX (YEAR 1976-77)

	1 Food Agriculture (A_1)	2 Non-Food Agriculture (A_2)	3 K-Intensive Manufactures (M_1)	4 Textiles Manufactures (M_2)	5 L-Intensive Manufactures (M_3)	6 Investment Goods Manf. (M_4)	7 Construction (C)	8 Trade & Commerce (S_1)	9 Other Services (S_2)
	.028544	.054601	.212611	.000000	.031857	.000000	.000000	.000000	.002584
	.079849	.026459	.03687	.231807	.095121	.000000	.055057	.009911	.011676
	.021411	.007819	.129833	.038004	.072287	.021119	.073469	.069850	.009581
	.001338	.004366	.007216	.158746	.010564	.000125	.000000	.006598	.006092
	.003445	.014933	.034668	.072633	.085321	.053405	.201082	.008910	.024317
	.006613	.008874	.015225	.035834	.022598	.114166	.228859	.013262	.010118
	.011111	.000175	.011879	.000000	.000000	.000000	.002560	.005451	.060299
	.062626	.133638	.149019	.103714	.106469	.147082	.000737	.012984	.011688
	.001688	.003232	.003817	.032497	.022937	.017025	.000335	.030121	.017189
Value Added =	.768200	.745907	.312178	.238200	.312704	.413828	.437901	.851922	.846456

TABLE NO. 3

INCREMENTAL WORKING CAPITAL-OUTPUT MATRIX AGGREGATED FROM MCEWAN'S 1964-65 TABLE (35 x 35)

	A_1	A_2	M_1	M_2	M_3	M_4	C	S_1	S_2
A_1	.04782	.00000	.07151	.00021	.06087	.00191	.05981	.00045	.00013
A_2	.00520	.05502	.00000	.09035	.00000	.00000	.01500	.00000	.00000
M_1	.00038	.00047	.01613	.01250	.07261	.03025	.02128	.00035	.00029
M_2	.00000	.00000	.01212	.07469	.01052	.00281	.00000	.00052	.00000
M_3	.00167	.00387	.05181	.01055	.01816	.02471	.20471	.00369	.00135
M_4	.00124	.00075	.00372	.00181	.01658	.20493	.08251	.00163	.00011
C	.00001	.00000	.00006	.00000	.00000	.00000	.00000	.00000	.00000
S_1	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
S_2	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000

TABLE NO. 4

PROPORTIONS OF DIFFERENT TYPES OF CAPITAL GOODS IN SECTORAL INVESTMENTS

Supplying Sector \ Receiving Sector	A_1	A_2	M_1	M_2	M_3	M_4	C	S_1	S_2
Machinery Capital goods sector (M_4)	.591236	.526378	.722531	.586585	.599064	.659695	.933333	.455808	.037594
Construction Sector (C)	.408764	.473622	.277469	.413415	.400936	.340305	.066667	.544192	.962406
Incremental Annual capital-output ratio	.764529	.421768	2.013829	.570617	.309815	.845088	.327750	4.339595	1.512320
Incremental capital-output ratio per period (5 year)	.152906	.084354	.402765	.114123	.061963	.169017	.065555	.867919	.302464

TABLE NO. 5

NON-COMPETITIVE IMPORT COEFFICIENTS

	A_1	A_2	M_1	M_2	M_3	M_4	C	S_1	S_2	Final Demand
A_1	.013507	.000000	.028872	.000000	.007443	.000000	.000000	.00000	.00000	.0016
A_2	.000000	.010000	.000000	.034040	.000000	.000000	---	---	---	.0004
M_1	.01193	.00971	.100995	.00100	.004000	.00200	---	---	---	.0016
M_2	.00000	.00000	.000000	.054525	.000000	.00000	---	---	---	.0009
M_3	.00000	.00000	.000000	.00000	.165302	.00000	---	---	---	.0003
M_4	.01193	.00971	.06981	.04041	.02679	.23325	---	.00010	.02240	---
C	---	---	---	---	---	---	---	---	---	---
S_1	-	---	---	---	---	---	---	.01200	---	---
S_2	---	---	---	---	---	---	---	---	.00178	---

TABLE NO. 6

Sector	Marginal Consumption Proportions	CIF Price of Import	Tariff on Imports	Domestic Price
A_1	.4141	.930417	.069583	1
A_2	.0556	.940217	.059783	1
M_1	.0851	.92103	.07970	1
M_2	.0938	.60000	.400000	1
M_3	.0210	.878857	.121143	1
M_4	.0000	.716194	.283806	1
C	.0450	---	---	
S_1	.0450	---	---	
S_2	.2346	---	---	

TABLE NO. 7

SECTORAL INVESTMENTS IN THE BASE PERIOD (t = 0)

	Base Year Output 1976-77	Assumed Annual Rate of Growth (%)	New Capacity for Period 1 I(0)	Investment in Machinery Capital Sector M_4	Investment in Construction Capital Sector C
A_1	45591.7	4.0	49387.8	4463.1	308.2
A_2	24000.6	4.0	25998.9	1293.8	899.2
M_1	11703.9	8.0	27464.8	7992.5	3069.3
M_2	10095.1	10.0	30815.5	2062.8	1453.8
M_3	15226.4	8.0	35729.9	1326.4	887.5
M_4	4673.2	10.0	14264.5	1591.0	820.1
C	11444.7	10.0	34935.5	2138.5	151.6
S_1	17092.0	7.0	34402.1	13609.5	1624.8
S_2	24052.5	5.5	36915.7	594.9	105.70

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