RURAL-URBAN INTERACTIONS IN ECONOMIC DEVELOPMENT:
A TWO-SECTOR MODEL FOR BANGLADESH

RURAL-URBAN INTERACTIONS IN ECONOMIC DEVELOPMENT: A TWO-SECTOR MODEL FOR BANGLADESH

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ABSTRACT

In the present study, a neoclassical general equilibrium model is developed to study the dualistic economic development of a predominantly agrarian economy, Bangladesh. Quantitative analysis is undertaken in order to make assessments of several development strategies within the framework of the model. The linkages between the agricultural (rural) and the manufacturing (urban) sectors via the output and labour markets are incorporated in the model and empirical analysis.

In specifying the aggregate relations in the model especially those of the rural sector, the analysis is based on the microeconomic relations of a 'representative peasant household'.

The approach is to first estimate the structural parameters of the model (simultaneous system) and then to perform simulation exercises. These simulations permit us to move beyond the restrictions of growth theory, since the direction of influences on different variables and their quantitative dimensions may be assessed.

The aim is to determine the differential impact of exogenous investments and related public policy measures on the two sectors, especially on the level of employment, output and wages. Within a disequilibrium growth process which allows for differences in wages in the two sectors, the impact of rural-urban migration of people on the economy of Bangladesh and its policy implications are assessed.

The policy simulations suggest that strategies which favour agricultural rather than industrial development have a more positive impact on output, employment, and the reduction of rural-to-urban migration of people.

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CHAPTER I

OBJECTIVES OF THE PRESENT STUDY

It has become increasingly evident that the task of increasing the income and employment of the less developed countries is exceedingly difficult. During the 1940's and 1950's, there was a renewed interest in analyzing the process of economic development of the less developed countries, and in the formulation of appropriate development policies for those countries. At that time, it was widely believed that industrialization was the key to development and that the industrial sector, as the leading sector, would pull with it the backward agricultural sector.

The theoretical literature on economic development had, to a large extent, evolved from a two-sector model which analyzes the relationships between the agriculture and non-agriculture sectors and/or between the traditional (rural) sector and the advanced (urban) sector. In these two-sector models, agriculture was assigned a passive role, as a potential source of 'unlimited labour' and 'agricultural surplus' for the rest of the economy. It was assumed that agricultural labourers could be released in large numbers for industrialization without a consequent reduction in agricultural output, and also that the 'agricultural surplus' could be transferred to the industrial sector by altering the terms of trade against agriculture, without adversely affecting the agricultural sector. However, this approach, with its heavy emphasis on industrialization, can cause stagnation in the agricultural sector thereby making it unable to perform its desired role in the process of industrialization.

During the 1960's, as the dual economy (two-sector) models became more sophisticated, it was increasingly admitted that both the agricultural and industrial sectors have important, active and interdependent developmental roles. The process of release-cum-absorption of labour and other resources occurs simultaneously in both sectors. The interactions between the agricultural and non-agricultural sectors change over time in the process of development. In the early stages, agriculture is of crucial importance as a source of employment for the majority of the population and as the source of a major portion of total national income. As development proceeds, however, the relative importance of agriculture may diminish while there is a secular increase in the relative importance of industry. Analysis of the interactions between the agricultural and other sectors of the economy is therefore, of central importance for shaping appropriate development theories and policies.

I.1. Objectives of the Present Study

This study will analyze the roles and interactions of agriculture and industry in economic development in a predominantly agrarian economy like Bangladesh. In order to understand and better analyze the interactions between the two sectors, the sectoral markets which act as the linkages connecting the agricultural and non-agricultural sectors through product and factor markets are examined.

It is reasonable to expect that the government will play a key role in the process of economic development of low income countries such as Bangladesh. It is, therefore, important to assess the impact of various exogenous government policy measures on the development process. More specifically, we would like to examine the effects of government investment on the levels of employment, output and wages in the two sectors of the economy, the agricultural and industrial sectors. To isolate these effects, capital in both the agricultural and manufacturing sectors is treated exogenously. Aggregate capital investment in both sectors are directly and indirectly influenced by national government policies and also by foreign sources on which Bangladesh is dependent for supplementing its domestic resources for economic development.[1] By changing capital in each sector through alternative government policies, we can analyze the impact on the variable in which we are interested.

To achieve our objective, a theoretically consistent and empirically applicable aggregate general equilibrium model for Bangladesh is developed. Its parameters are estimated from the data of the Bangladesh economy. The basic analysis is done in a general equilibrium comparative static framework. Next, a dynamic-type analysis is undertaken by simulating successive equilibrium solutions which would result from particular values of the exogenous variables under governmental control. Within this framework, various government policies involving injections of capital into the agricultural and/or manufacturing sectors are analyzed.

The approach, of first estimating the structural parameters of

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1 Thus the capital formation by private entrepreneurs tends to be determined by government policy. More on this in Chapter III.

the model and then doing simulation exercises, allows us to move beyond the restrictions of growth theory. We can identify not only the direction of influences of development but also their quantitative dimensions. Our approach departs from the growth-development theoretic literature which is concerned mainly with qualitative results. In the context of the Bangladesh economy, it may well be asked whether larger capital injections into agriculture by the government will have a greater effect on total output, employment and wages than an equal capital injection into the manufacturing sector. To discover these overall effects, it is necessary to consider the linkages between the two sectors and their interdependence within the policy simulation exercises.

The present study also focusses on the process of rural-urban migration of the population. Due to heavy pressure of population on scarce land in the agricultural sector, and due to the higher urban wage rate, Bangladesh has been experiencing large movement of rural people to the urban region. However, the relatively small urban manufacturing and service sectors have not been able to absorb all of these new workers. Moreover, given the limited capacity to increase urban employment due to the scarcity of capital resources, the manufacturing sector's ability to absorb this influx of workers is severely restricted. An implication of this phenomenon is that government may consider policy measures to make the rural sector more attractive in the sense of increasing the real incomes of the rural people by overall rural development. The aspect of rural-urban migration and its policy implication is examined through policy simulation.

Before attempting to develop a model for the Bangladesh economy, some of the major characteristics of the Bangladesh economy are presented.

I.2. Characteristics of the Bangladesh Economy

I.2.1. Introduction

Bangladesh emerged as an independent nation in 1971. It was previously the Eastern Wing of Pakistan. Culture and language difference between East and West Pakistan, coupled with unequal economic development in favour of West Pakistan, led to the break-up of Pakistan and to the creation of Bangladesh as an independent nation.

Bangladesh has an area of 55,126 square miles with an estimated population of about 76 million.[2] The density of population is roughly 1378 per square mile which is the highest for all countries in the world.[3] The density of the population becomes an important feature if we consider the fact that in most cases dense populations are highly correlated with urbanization, whereas 90% of the population of Bangladesh is in rural areas, and about 75% of the labour force is engaged in agriculture. For every person depending almost exclusively on land as a source of income (that is, for each member of the farming families) the average available cultivable land is about four-tenths of an acre.[4]

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2 The nation is approximately one-quarter the size of France. If France had the same population density as in Bangladesh, it would have 280 million people instead of the present 50 million.

3 The 'city states' of Hong Kong (10,547 per square mile in 1968) and Singapore (9506 in 1968) are excluded from comparison because of their small sizes.

4 A. Maddison (1970). Per capita acreage in West Pakistan in 1970 was approximately 4 acres. Though the distribution of land in West Pakistan is very uneven, per capita acreage is higher in West Pakistan than in Bangladesh.

The major portion of the population is living at an extremely low standard.[5] The picture is the worst for the vast majority of the rural population. A study by Bose (1968) found that real per capita rural incomes fell from Rupees 275 in the early 1950's to Rupees 268 in the early 1960's. The study shows that over the same period, urban real incomes grew from Rupees 619 to Rupees 677. Low per capita income is only a proxy for many kinds of deprivation. A vast portion of people suffer from malnutrition. Inadequate housing facilities abound both in the rural and urban areas and fewer than 20% of the people are literate.[6]

However, there are a few positive aspects which may be conducive to long-term economic development. The nation consists of a continuous land-mass with remarkable linguistic, ethnic and cultural homogeneity. This means that the problem of inter-regional differences in socio-economic indicators is absent. Feudal interests, though still in existence in rural areas, are in no way as prominent as in Latin America or in the Middle East.[7] The government is not likely to be influenced unduly by some vested interest groups in the rural sector to adopt policies which benefit them at the expense of national welfare.

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5 Per capita annual income in 1969/70 prices is about US $63.00. Of course, such quantification should not be interpreted in the usual sense since goods and services are, in fact, exchanged in domestic currency. See A.R. Khan (1972), for an analysis of such quantification of poverty.

6 World Bank (IBRD) Report (1974) Vol. I.

7 A.R. Khan (1972).

The seriousness of the demographic features as barriers to development becomes even more apparent when one considers the growth of the population. According to the Planning Commission data, the crude birth rate in 1973 was 47 per thousand. The estimated crude death rate was 17 per thousand. Bangladesh experienced a growth rate of population of about 3% per annum during 1973.[8] If the population continues to grow at this rate, then according to a moderate projection done by the World Bank, the population in the year 2003 A.D. will be about 163 million.[9] The demographic situation aptly shows that "it is impossible to be optimistic about the economic prosperity of Bangladesh as long as one is confined to the conventional ideas of demographic transition and industrial development".[10]

I.2.2. Labour Force

Constraining demographic features, especially the past and prospective growth in population and the structure of the labour supply vis-a-vis employment opportunities may be the most pressing problems in the process of development of the Bangladesh economy. For that reason, the question of employment creation is stressed.

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[8] R.R. Faruqee (1975). This may be compared with population growth of roughly 1.3% and 0.8% in Japan and the U.S.A., respectively, between 1969 and 1971. Source: U.N. Demographic Yearbook, 1970.

[9] World Bank Report (1974), Vol. II.

[10] A.R. Khan (1972, p. 13).

Labour force estimates available for Bangladesh are crude.[11] Yet, some pictures, though sketchy, can be drawn about the labour force situation from the Table below:

Table 1

Labour Force Projection

	1961	1973	1983	1993	2003
Population (million)	55.3	74.0	99.9	129.4	161.7
Labour Force (million)	18.9	26.2	35.1	48.1	64.2
Annual average rate of increase in labour force	--	2.8	2.9	3.3	2.8
Labour force/population (%)	34.2	35.4	35.1	37.2	39.7

SOURCE: World Bank Report (1974), Vol. I.

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11 Any attempt to obtain statistically reliable estimates of rural and urban unemployment faces the trickiest of problems, especially in the agricultural sector where self-employed persons and 'seasonality' of employment are the dominant features of agricultural operations. It is argued that at least two dimensions, time and income, should be linked together in the definition of unemployment in Bangladesh. Thus, the unemployed will include all working adults employed for less than the accepted minimum number of days (irrespective of their earnings) and those employed for more than the accepted number of days but earning income on the poverty line or below it. See Alam, Alamgir and Choudhury (1976), for further analysis of unemployment in Bangladesh.

It can be seen that the labour force will increase by about 9 million between 1973 and 1983. Given these projections, additional employment equal to the increase in labour force has to be created annually if existing unemployment is not to worsen.

It is difficult to say definitely whether the prospective sectoral pattern of labour force allocation will change or not. Of the 7.3 million increment in the labour force over 12 years between 1961 and 1973, 6.3 million or nearly 90% were absorbed in the rural sector. An important observation which can be made from the available data is that, even with the growth of employment in the urban sector being almost twice that in the rural sector (5% as against 2.6%), the share of urban employment in the total only rose from 5.4% to 6.9% between 1961 and 1973.[12] The essential point is that, for the next generation and beyond, development of Bangladesh may well be dependent upon the enhancement of employment and income opportunities in the rural sector.

I.2.3. Conditions of Agriculture

Agriculture contributes more than 55% of the Gross Domestic Product and absorbs more than 75% of the labour force.[13] When ancilliary activities such as transporting and marketing of agricultural products are included, the sector's contribution to the GDP exceeds 66%. Furthermore, the processing of domestically produced agricultural goods accounts for more than 50% of the total value added in the manufacturing sector.

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12 World Bank Report (1974), Vol. I.

13 A.R. Khan (1972).

For the last three decades, there has been some structural change and the share of agricultural sector has declined; nevertheless, the sector's contribution to national output has been a most significant one.

Despite the fact that about 75% of the people are dependent on farming or agricultural labour for their income and that 90% of the cultivated land is used to grow rice, Bangladesh cannot produce enough food for its own requirements. Even in a normal year, some 10% of food grain supply is imported, while in the years when crops are damaged by flood, pests, or drought, the proportion of imported foods is as high as 30%. The remainder of the land is used mainly to grow jute which provides about 75% of the country's export earnings. Depending on the price-relationships, between one-third and two-thirds of these earnings from jute must be spent on importing the balance of foodgrain requirements. For that reason, one of the main objectives of the government policy is to increase the production of food.[14]

To eliminate the food deficit and to meet the incremental domestic demand, increased production of basic food grains and other foodstuffs is essential.[15] At the same time, on the basis of comparative advantage,

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14 The First Five Year Plan 1973-78, Bangladesh.

15 During the 1950's and 1960's, the agricultural sector in Bangladesh was not even able to provide enough food for its growing population, let alone take a leading role in the economy. While the policy-makers increasingly emphasized the importance of agriculture, the sector as a whole grew by only about 2% per year, causing foodgrain imports to grow from less than 0.2 million tons in 1955/56 to over 1.5 million tons by 1969/70. Source: Pakistan Economic Survey, 1969-70.

increased production of cash crops (mainly jute) would contribute to the country's export earnings.

I.2.4. Conditions of the Manufacturing Sector

Bangladesh is one of the least industrially developed nations in the world. Its annual per capita consumption of steel is about 4 kg. (compared to 11 kg. in India), cement 9 kg. (27 kg. in India), and power 30 kwh (112 kwh in India).[16] The history of industrial activity in Bangladesh has been influenced by two important factors: lack of resources other than water, natural gas, some agricultural raw materials and a large unskilled labour force; and the peripheral status of the region as related first to Indian manufacturing in Calcutta and then to West Pakistan. It was estimated that in 1949/50, the share of this sector to the GDP (in 1959/60 prices) was about 4%. In the subsequent decades, important changes took place in the structure of industrial production. Overall, the sector grew at over 6% per annum, twice the growth rate of the GDP; and, as a result, the share of value added in manufacturing in total GDP (in 1959/60 prices) more than doubled to 8.9% in 1970.[17] The notable features in the overall trend were, the rapid expansion of the production of various textile mills and the shift within manufacture towards large-scale production. In addition to various textile mills, other important local resource based industries included the production

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[16] World Bank Report (1974), Vol. I.

[17] A.R. Khan (1972).

of sugar, tea, leather, paper and newsprint, fish preserving and processing, wood manufacture, glass and ceramics and nitrogen fertilizer. Of these, leather, tea, paper and newsprint were meant primarily for the West Pakistan market, fish for exports to other countries, and the rest for local requirements.

The other notable feature of industrial growth in Bangladesh was the rapid expansion of large-scale industries relative to small-scale and cottage industries. A consequence of this trend was a continuing shift in income from the rural to the urban areas. The traditional small and cottage industries declined through the government policies in favour of large-scale industries. As a result, many indigenous skills died out. The contrast is between a stagnant traditional cottage industry in the rural areas using small capital on the one hand, and an expanding 'enclave' group of urban industries with inadequate levels of capacity utilization on the other hand.

I.3. Some Observations about Pakistan's Strategy of Economic Development

The strategy of development in Pakistan involved promotion of rapid industrialization under the ownership and control of private entrepreneurs, with all possible assistance from the government, irrespective of its consequences on the regional and personal income distributions. The essence of this approach is captured by a Pakistani economist: "It is well to recognize that economic growth is a brutal, sordid process. There are no short cuts to it. The essence of it lies in making the labourer produce more than he is allowed to consume for his immediate needs, and to invest and reinvest the surplus thus obtained. ... The underdeveloped countries must consciously accept a philosophy of growth and shelve for the distant future all ideas of equitable distribution and welfare state".[18]

This strategy was pursued both through the pattern of investment allocation and the pricing systems and government incentives. The allocation of investment funds was characterized by heavy emphasis on the industrial sector, as the following Table indicates.

Table 2

Sectoral Priorities in Development Expenditure in Pakistan
Percentage of total allocation

Sector	Pre-Plan 1950-55	First Plan 1955-60	Second Plan 1960-65	Third Plan 1965-70
Agriculture	6.0	7.0	13.3	15.3
Industry, fuels, and minerals	36.0	31.0	27.6	24.8

SOURCE: Planning Commission, Pakistan.

The impact of the strategy was different for the East and West wings of Pakistan. The economy of the East wing (Bangladesh) was not looked upon as a separate problem for which a special approach had to be devised. The national strategy was essentially geared to the needs of West Pakistan from which most of the political leadership came. The growth strategy of Pakistan effectively discriminated against the highly

18 M. Haq (1963), pp. 1,30.

agrarian economy of Bangladesh with its limited resource base for industrialization. Even so, whatever industrial base Bangladesh had, well over 50% of the industrial assets was owned by the West Pakistani entrepreneurs.[19]

In view of the importance of agriculture for the Bangladesh economy, the progress in West Pakistan's agriculture marked a critical point in the economic history of regional disparity. An additional acreage four times higher than that in Bangladesh was brought under cultivation in West Pakistan through irrigation, drainage and embankment, and twice the volume of fertilizers, together with supplies of improved seed, credit facilities were put at the disposal of the West Pakistani farmers.

I.4. The Plan of the Present Study

Having specified the objectives of the present study and the characteristics of the Bangladesh economy in this chapter, the analytical base of the present study is set out in Chapter II, and a comparison with other similar works is made.

In Chapter III, the theoretical 'basic' model which highlights the interactions between the rural and urban sectors through the product markets only, is presented.

In Chapter IV, the parameters of the 'basic' model are estimated with data from Bangladesh. These estimates as well as policy simulation analysis are presented in that chapter.

In Chapter V, we modify the 'basic' model presented in Chapter III

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19 A.R. Khan (1972).

to incorporate interactions between the rural and urban sectors through the labour markets (along with the output markets interaction) in the form of rural-urban migration.

In Chapter VI, the 'modified' model of Chapter V is empirically implemented and the empirical results along with a new set of policy simulations are presented.

Finally, Chapter VII provides a brief summary and some major conclusions.

CHAPTER II

METHODOLOGY AND THE ANALYTIC BASIS OF THE PRESENT STUDY

In this chapter, the fundamental ideas on economic development and migration which constitute the analytic basis of the present study are presented. The central theme in this body of literature is the transformation of a traditional agricultural economy into a modern, industrialized economy.

II.1. Methodology and the Analytic Basis

The present study develops a model containing specific interrelationships between the product and factor markets of the rural and urban sectors. The approach of developing a two sector model is similar to that of a 'dual economy' model.[1]

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1 The concept of the 'dual economy' was introduced by Boeke (1910). Boeke's central point is that there exist differences in the social systems as well as organizational elements between the economically less coordinated traditional indigenous sector and the advanced capitalist sector. A vast amount of literature supporting and criticizing Boeke's analysis has emerged. For a good discussion, see Y. Itagaki (1968). Higgins (1955,1956), believes that familiar economic tools such as marginal analysis can be applied for the study of a dualistic society, an idea which Boeke severely attacked. The 'dual economy' models have provided a useful framework, for the analysis of the process of economic development. The classic example of the application of such an approach dates back to 1920's in the U.S.S.R. in the formulation of the New Economic Policy.

The modern development of the models of the dual economy can be attributed to W.A. Lewis (1954). With the works of Fei and Ranis (1964), Jorgenson (1961, 1969), and Kelley, Williamson and Cheetham (1972), the approach became familiar in the economic development literature.

Two broad categories of general equilibrium 'dual economy' models have emerged; (a) The Classical models of Lewis (1954) and Fei and Ranis (1964), and (b) The Neoclassical models of Jorgenson (1961,1969) and Kelley, Williamson and Cheetham (1972). The main difference between the classical and the neoclassical models derives from conditions governing the supply of labour to the advanced (urban) sector. In the classical models the real rural wage rate is assumed to be fixed. This means that from the point of view of the industrial sector labour is available in unlimited amounts at a fixed real wage. In the neoclassical models, on the other hand, the real wage in the rural sector is not fixed and an increasing supply price of labour for the industrial sector is possible.

In the present study, a neoclassical general equilibrium model is developed to study the dualistic economic development in Bangladesh. It is assumed that the real rural wage rate is not exogenously given, rather we postulate that wages in the rural and urban sectors are both determined endogenously. Both theoretical and empirical considerations prompted us to follow the neoclassical approach to labour supply. Jones (1975) in his study of dualistic economic development has shown that the neoclassical labour assumption based on marginal product pricing may be a more useful assumption for a dualistic model, because the rural people behave as rational optimizers.

Several writers have challenged the concept of 'surplus labour' in the rural sector, on empirical grounds. Schultz (1964) gives a detailed summary of two anthropological studies, one of Panajachel in Guatemala by Sol Tax and the other of Senapur in India by W.D. Hopper. Schultz [(1964), p. 52] concludes "that no part of the labor force working in agriculture in these communities has a marginal productivity of zero". Another study in India by Wellisz, Munk and others (1970) finds no conclusive evidence of surplus labour in the rural sector. The study confirms Schultz's (1964) argument that Indian agriculture is "primitive but efficient".

The assumption of rational optimizing behaviour of the rural people both as consumers and producers allows the derivation of the aggregate supply and demand relationships with better theoretical foundation. Moreover, the neoclassical models appear to have been able to better predict the process of economic development than the classical type growth models.[2]

An overview of the present study can be spelled out by giving the salient steps:

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[2] Kelley, Williamson and Cheetham (1972) show that their neoclassical assumptions explain the development process quite aptly. A later work by Kelley and Williamson (1974) on the economic history of Japan shows the better predictive power of a model based on neoclassical assumptions.

(a) An attempt is made to specify certain economic relationships between the rural and urban sectors of Bangladesh. For this reason, an aggregate general equilibrium model for Bangladesh is developed in Chapter III. We call this the 'basic model' since the interactions between the sectors are via the output markets only. Migration from the rural to the urban sector is not isolated and explained (this is discussed further in Chapters III and V).

(b) The 'basic model' is estimated by econometric techniques using time-series data for Bangladesh, and the parameters so derived are utilized in several policy simulations. This exercise facilitates evaluation of the effects of exogenous government investment in the agricultural and manufacturing sectors on their respective output levels, employment levels and real wage rates. The results are presented in Chapter IV.

(c) In Chapter V, the 'basic model' is modified to incorporate labour market interactions between the sectors. One implication of this change is that rural-urban migration of population is determined and treated as an endogenous variable. The model is called the 'modified model'.

(d) The parameters of the 'modified model' are then derived by estimating the model by econometric techniques and policy simulations are once again performed. In addition to the impact of various government policies on the output, employment and wage rates, the impact of specified policies on rural-urban migration is also investigated. These results are presented in Chapter VI.

None of the existing studies of the development of a 'dual economy' followed the methodology outlined in the present study. The following section also highlights some salient features of the present study compared to some of the existing models.[3]

II.2. Economic Models of Development and Migration

The group of models (classical and neoclassical) which describe the process of dualistic economic development of the less developed countries, are highly aggregative and explicitly dynamic. There are other kinds of aggregative models which are designed to explain the process of economic growth. In this section, some important features (especially the operational aspects) of these studies will be compared with those of the present study.

In the classical models of Fei and Ranis (1964) as well as in the neoclassical models of Jorgenson (1961,1969), capital is omitted from the agricultural production function. However, the exclusion of capital from the agricultural production function robs these models of a key allocation decision relevant to the current policy debate in the low income countries; that is, should agriculture or industry be given preference in the allocation of scarce capital resources. The present study, within a quantitative framework, tries to assess the impact of such key allocation decision of capital investment in the rural and urban

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3 The literature in this area is vast and deals with a wide range of issues including rural-urban migration. A good survey of such models is provided by Dixit (1969).

sectors, thus capital appears as an input in production functions of both the sectors.

The work of Kelley, Williamson and Cheetham (1972) is a major contribution to the literature on dualistic economic development, in that it introduces to the development literature the use of simulation for policy analysis and evaluation.[4] However, the parameter values in their model are collected from other comparable works in this field and not obtained by econometric estimation of a model for a particular economy. In their model, land is not introduced as a factor of production in the agricultural sector. However, a later work by Kelley and Williamson (1974) introduces land in the model to study the economic history of Japan.

The present study includes land as an input in the production function of the agricultural crops. The role of land is examined through relevant hypotheses relating to its allocation among the food and cash crops, and its impact on other variables such as demand for labour in both sectors.

It has been noted earlier that rural-urban migration and urban unemployment have been receiving increasing attention in the development literature. For example, Todaro (1969) formulated a probabilistic model incorporating rural-urban income differentials as an explanation of the process of rural-urban migration. These studies do not utilize

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4 The study also explicitly analyzes the process of migration of population between the agricultural and industrial sectors.

an aggregative general equilibrium model and are unsuitable for broad policy analysis.[5]

It has been mentioned that the approach of general equilibrium analysis is followed here to study the development process of the Bangladesh economy. A general equilibrium study of migration and urban employment in Bangladesh has been done by F. Ahmed (1974). No structural equations are estimated for the purpose of the derivation of the parameter values. His model is essentially a seven-sector simulation model of the neo-classical type. Although a multi-sectoral model is desirable, lack of adequate data for Bangladesh makes it difficult to develop such a model and derive meaningful and reliable results.

Both the 'basic' and 'modified' models of our study are simultaneous equation models consisting of behavioural, technological, and institutional relationships. The parameters of such models are usually estimated statistically from the time-series and/or cross-section data. A good survey of some of these aggregative economic models developed for various countries has been made by Nerlove (1966).

An aggregate model of the type mentioned in the above paragraph, has been developed by Islam (1965) for the economy of Pakistan mainly for the purpose of short-term forecasting. There are several shortcomings in his work. The study does not carry out any separate analysis of the Bangladesh economy. The method of parameter estimation is ordinary

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5 Some of the studies of rural-urban migration in Bangladesh will be discussed in Chapter V.

least squares which may give biased estimates because of simultaneity between the relations. The task of creating more employment in Bangladesh is a very important one, but Islam's model is incapable of employment analysis because it does not have any employment equation. The model developed by Islam was not used for any kind of policy analysis and as such could not be used as a guide for the purpose of making policy decisions by the government.

A long-term growth model containing some behavioural and technological relationships (similar to the present study) for Pakistan as a whole, has been developed by Haq (1963). Though he did not present his model in terms of formal equations or mathematical expressions, it can be presented as a formal macroeconomic model. The parameters of his model are not derived by any formal econometric technique and can best be described as 'ad hoc'.

The studies on Pakistan and Bangladesh which have been discussed above, lack another important aspect of economic development - the process of disequilibrium growth which essentially refers to the lack of instantaneous adjustment in the economic system. This study explicitly takes into account of some features of nonproportional rates of change in the relevant economic variables as a result of the lack of instantaneous adjustment in the economy.

II.3. The Process of Disequilibrium Growth

There have been arguments by various economists that the factor markets in low income countries are so imperfect that the assumption of smooth adjustments to factor-price differentials embodied in the neoclassical analysis, should be relaxed. The persistence of sectoral inequalities in factor prices and productivities is an important aspect of the development process of low income countries wherein governments try to cope with the rural-urban income differentials and high rates of internal migration of population. For this reason economists argue that economic development is not an equilibrium process, but rather a process of continuous change due to disequilibrating forces.[6]

The present study makes an attempt to incorporate the phenomena of disequilibrium process in the labour markets where rural-urban migration is viewed as a disequilibrium process since the migration process is not expected to give equilibrium population in the two sectors. By incorporating such limitations on the instantaneous adjustment process in the labour markets, an analytical framework is provided to capture regional disparities in wages, and the implications and policy options to remove it may be analyzed. The 'modified' model, which is capable of generating persistent wage gaps is simulated with its set of parameter values.[7] Thus,

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[6] For a detailed discussion on the process of disequilibrium growth, see B. Higgins (1959).

[7] Strictly speaking, when both the 'basic' and 'modified' models are used in policy simulation analysis, the solutions of the endogenous variables are not the type given by pure Walrasian general equilibrium model. The computer program for simulation is designed in such a way that the generated lagged endogenous variables affect the solutions of the current endogenous variables which, though the markets are cleared at each period, link the variables with different time periods. This process will be further discussed in Chapter IV.

the 'modified' model (when empirically implemented for Bangladesh) supports the views expressed by Yotopoulos and Nugent [(1976), p. 235], "The direction of migration and most of the observed characteristics of the migrants are consistent with simple neoclassical model of migration as investment in the human agent".

It remains now to develop the theoretical 'basic' model which is to be estimated for the economy of Bangladesh. This is the task of the next chapter.

CHAPTER III

THE 'BASIC' MODEL FOR THE BANGLADESH ECONOMY

The objective of this chapter is to describe an empirically applicable model of Bangladesh, the parameters of which can be empirically estimated. In this basic model, the interactions between the rural and urban sectors occur within the output markets only.[1] In this model, the rural and urban populations are taken as parameters.

While it is recognized that policy simulations based on the basic model are not likely to be reliable because of the assumption of exogenously determined migration, there are a number of valid reasons for developing and estimating the basic model. First, it is an intermediate step in the development of a more realistic model which allows for the interaction between the rural and urban sectors through both product and factor markets. Second, the simulation results provide a sensitivity test of the structure of the model as well as the parameter values. If the policy conclusion of the basic and modified models are of the same nature, then it is less likely that the results are very sensitive to the specification of the model and parameter estimates.

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1 In Chapter V, the labour markets interactions are incorporated and the 'modified' model is estimated again in Chapter VI.

When the parameters of the basic model are estimated, the values of the rural and urban populations implicitly account for migration of people, but the process of migration is not modelled as an endogenous variable. In the modified model, migration is taken as an endogenous variable and the effects of various policies on migration are examined.

III.1. The Agricultural Sector

The general approach followed here for the agricultural sector is based on the work by Yotopoulos and Lau (1974), with the following special assumptions relevant to the Bangladesh economy.

It is assumed that the agricultural (rural) sector produces two agricultural outputs only, a food crop (rice) and a cash crop (jute).

The urban sector is assumed to produce the manufactured good. The urban service sector is not considered because the sector's output constitutes a small portion of the urban sector output.[2]

The foreign sector enters the model only in connection with export demand for the cash crop (jute). This factor influences the

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2 The contribution of the service sector to GDP in current prices amounted to 4.29% in 1969/70. Source: Alamgir and Berlage (1974). Here the service sector includes only professional and other services as well as ownership of dwellings.

formulation of total demand for jute because jute is the major export item of Bangladesh.

In Appendix B, and also in Chapter V, a theoretical framework is provided which guides the choice of variables to be entered in the functional relations of the 'basic' and 'modified' models. Specification of the aggregate equations for the agricultural sector is based on the aggregation of individual peasant household relations. This procedure is not followed in deriving the aggregate relations for the manufacturing sector. Instead, the relevant explanatory variables identified for the rural sector are used as guides for the formulation of the aggregate relations for the urban sector.[3]

Appendix B examines the decision process of the 'representative household', the basic decision-making unit of the rural sector, in order to derive empirical specifications of the individual supply and demand relations in the agricultural sector, which are then used to develop the aggregate relations. The household relations in the agricultural

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[3] The aggregate relations of the urban sectors could be derived by aggregating individual decision-making units in this sector by following the approach similar to that for the rural sector, which is presented in this chapter. However, without going to the same approach, we specify the aggregate relations of the urban sector in a straightforward way.

sector are derived in the spirit of conventional economic analysis of utility and profit maximization by the peasant household.[4]

Capital, in household production of both the food and cash crops, K_f and K_c, respectively, is assumed to be exogenous; as a result, aggregate capital in the food and cash crops is exogenous as well.[5] In the manufacturing sector, aggregate capital is also assumed to be exogenous.[6]

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[4] In an interesting study of supply response in the agricultural sector of less developed economies, Behrman (1968) has shown that, in the short-run, farmers in Thailand respond rationally to economic incentives. Behrman [(1968), p. 337] points out that "The burden of proof, thus, now lies with those who maintain that the supply behaviour of farmers in underdeveloped agriculture cannot be understood predominantly within the framework of traditional economic analysis." Thus, there is some empirical justification for the assumption of utility and profit maximization behaviour used here in the context of Bangladesh.

[5] In the agricultural sector of Bangladesh, capital expenditures for irrigation scheme, food-grain warehouses, fertilizers and pesticides are controlled to a large extent by various government agencies such as the Agricultural Development Corporation (ADC), the Agricultural Development Band (ADB) and the Bangladesh Water Development Board (BWDB).

[6] Many of the industrial enterprises and all the commercial banks are directly controlled by the government. Moreover, capital imported from abroad is exclusively controlled by the government exchange control policies which essentially affects the allocation of foreign capital. Thus, capital in both the rural and urban sectors are important policy variables from the point of view of the government and so it has been assumed to be exogenous.

Throughout this study, competitive behaviour in the economy is assumed in the output and labour markets. Given the price of agricultural output and the wage rate, labour demand and supply need not be identical for any particular household. However, the total labour demanded is equated with total labour supplied to derive equilibrium values of the wage rate and employment.

The relations specifying the input demand functions, output supply functions and the labour supply function for the peasant 'representative household' are discussed in detail in Appendix B. However, for the purpose of estimation and policy analysis, the aggregate relations for the whole economy are used, and it is to these relations that we now turn. A complete list of symbols and their definitions can be found in Appendix A.

III.2. Aggregate Relations of the Rural Sector

The 'basic' model consists of the aggregate relations of both the agricultural and manufacturing sectors. Ideally, the aggregate relations can be derived by summing over the rural household relations. However, the aggregate relations in this study are approximated by using relevant variables identified in the microeconomic analysis of the rural sector which is done on the basis of the assumption of the 'representative household'.

The equations presented below are estimated using data from Bangladesh; the results will be presented in the next chapter.[7]

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[7] In numbering the equations, we have denoted each theoretical equation in this chapter by T for 'theoretical' along with its number. The estimated equations will appear in Chapter IV with same number but denoted by EB [for 'estimated basic model' equations] and in Chapter VI with same number but denoted by EM [for 'estimated modified model' equations].

(a) Aggregate labour demand functions

From equations (B.39) and (B.40) in Appendix B, the aggregate functions for the demand for labour in the production of the food and cash crops can be expressed as follows:

$$\log \bar{L}_f = \text{constant} + b_{11} \log P^*_{CL} + b_{12} \log W^*_a + b_{13} \log \bar{K}_f + b_{14} \log \bar{K}_c + b_{15} \log \bar{R} + b_{16} D + b_{17} \log F \quad (1T)$$

$$\log \bar{L}_c = \text{constant} + b_{21} \log P^*_{CL} + b_{22} \log W^*_a + b_{23} \log \bar{K}_f + b_{24} \log \bar{K}_c + b_{25} \log \bar{R} + b_{26} D \quad (2T)$$

A bar on a variable represents an aggregate. In both equations, we have chosen to use the one year lagged relative price of the cash crop (P^*_{CL}) instead of the current relative price (P^*_C). The same procedure is followed for both the labour and land allocation functions for the rural sector as a whole. This procedure has been prompted by the 'crop cycle' and the nature of data available in Bangladesh as explained below.

Rice crops are of three basic types: Aus, Aman and Boro. Both the Aus and Aman types are usually planted around May, and Boro rice is usually planted in December. Jute, the cash crop is usually planted in April and May. Usually if jute is planted, Aus or Aman rice can not be planted except on about 7% of total cultivable land which can be double cropped.[8] The data on prices are usually 12 month averages (from July to

8 The Aus rice is usually planted in early rainy season, whereas the Aman variety is planted in main rainy season and the Boro rice is planted usually in dry season. The cash crop jute is planted in early rainy season.

June). Thus, current-year prices are known only in July of each year, after the planting season for all crops is over. It is assumed therefore that the expected price on which the production decisions of the farms are taken is the lagged relative price of the cash crop.

F denotes the amount of fertilizer used in food production, and is included as a proxy variable for technological change. The new varieties (high yield varieties) of seeds for rice production are responsive to the increased amount of fertilizers used.

In equations (1T) and (2T) and also in all the subsequent aggregate equations, a dummy variable (D) has been used to capture the effects of the nine month liberation war in 1971 and the emergence of Bangladesh in that same year. It is assumed that these effects were distributed over the years 1971 to 1973 and as such, the values of the dummy variable are as follows: 1971 = 0.4, 1972 = 0.4 and 1973 = 0.2, all add up to unity, and zero for all the other years between 1947-1975, the period for which the model is estimated.

(b) Aggregate land allocation functions

The aggregate relations which determine allocation of land in the food and cash are derived following equations (B.41) and (B.42) in Appendix B, and are expressed as follows:

$$\log \bar{R}_f = \text{constant} + b_{31} \log P^*_{CL} + b_{32} \log W^*_a + b_{33} \log \bar{K}_f + b_{34} \log \bar{K}_c + b_{35} \log \bar{R} + b_{36} D + b_{37} \log F \qquad (3T)$$

$$\log \bar{R}_c = \text{constant} + b_{41} \log P^*_{CL} + b_{42} \log W^*_a + b_{43} \log \bar{K}_f + b_{44} \log \bar{K}_c$$

$$+ b_{45} \log \bar{R} + b_{46} D \qquad (4T)$$

Note that we have used the one year lagged relative price of the cash crop (P^*_{CL}) in both the equations, the justification of which has already been discussed.

(c) Aggregate output supply functions

The aggregate supply functions for the food and cash crops derived from equations (B.43) and (B.44) in Appendix B are expressed as follows:

$$\log \bar{Q}_f = \text{constant} + b_{51} \log \bar{K}_f + b_{52} \log \bar{K}_c + b_{53} \log W^*_a + b_{54} \log P^*_{CL}$$

$$+ b_{55} \log \bar{R} + b_{56} D + b_{57} \log F \qquad (5T)$$

$$\log \bar{Q}_c = \text{constant} + b_{61} \log \bar{K}_f + b_{62} \log \bar{K}_c + b_{63} \log W^*_a + b_{64} \log P^*_{CL}$$

$$+ b_{65} \log \bar{R} + b_{66} D \qquad (6T)$$

F denotes the amount of ferilizer used in food production, which is included as a proxy variable for technological change, the so-called 'green revolution' in food production.

(d) Aggregate labour supply function

The arguments which explain household labour supply in the agricultural sector are given in (B.46) in Appendix B, and give rise to an aggregate labour supply function which may be expressed as follows:

$$\log \bar{L}^S_A = \text{constant} + b_{71} \log \bar{K}_f + b_{72} \log \bar{K}_c + b_{73} \log \bar{R} + b_{74} \log P^*_m$$

$$+ b_{75} \log P^*_C + b_{76} \log W^*_a + b_{77} \log N_R + b_{78} D \qquad (7T)$$

Note that, in the aggregate rural labour supply function, the total number of people in the rural sector (N_R) has been used as an explanatory variable. This is because the number of people in the household (N_A) appears as a variable to explain household labour supply function.

It is difficult to assign 'a priori' signs to the coefficients of the variables and so the question is largely left for the empirical determination. In the subsequent equations where relevant, 'a priori' sign expectations will be noted.

(e) Aggregate demand function for food

Since one cannot readily specify the forms of the utility functions for the rural and urban households, the aggregate function for demand for food has been formulated on somewhat pragmatic grounds. Two separate aggregate functions, one for each sector, would be preferable to a single function. However, due to restrictions imposed by the data, an aggregate function consisting of demand by both sectors is postulated as follows:[9]

$$\log \overline{Q}_f^D = \text{constant} + b_{81} \log W_a^* + b_{82} \log W_m^* + b_{83} \log P_m^* + b_{84} \log \overline{K}_f$$
$$+ b_{85} \log \overline{K}_c + b_{86} \log \overline{R} + b_{87} \log N_R + b_{88} \log N_U + b_{89} D \qquad (8T)$$

where

$$W_m^* = \frac{W_m}{P_f}$$

[9] The time-series data on the sectoral demand for both the food and manufactured goods are not readily available for the economy of Bangladesh.

It is assumed that all profits from exogenous capital in the urban sector are reinvested and, thus the aggregate capital of that sector ($\overline{K}_m$) does not appear as an explanatory variable in this equation.[10]

(f) Aggregate demand function for the cash crop

In the world jute and allied fibre crops markets, Bangladesh is a major exporter. While raw jute is the major export item, domestically produced jute goods such as bags, jute cloth, carpet backing, and rope are also exported.[11] There are mainly two components of jute demand; one is the demand of the domestic jute mills and the other is the demand by foreign users. Combining these two components, the total demand for raw jute may be represented as:

$$\log \overline{Q}_c^D = \text{constant} + b_{91} \log \overline{Q}_m - b_{92} \log \frac{P_c}{P_s} + b_{93} \log Y_F + b_{94} \log \overline{Q}_{CL}^D + b_{95} D \qquad (9T)$$

$\overline{Q}_m$ is the aggregate output of the domestic manufacturing sector, which consists of a large number of jute mills as well as other industrial units which is related to the domestic component of the demand for jute. The sign of the coefficient $\overline{Q}_m$ is expected to be positive.

P_s is the price of jute substitutes such as nylon, polypropelene and other synthetic fibres in the world market. The coefficient of the

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10 Profits in each period are assumed to be reinvested in the next period and thus build up the capital stock.

11 For a detailed statistical study of jute, see Rabbani (1964).

price of jute relative to that of substitutes is expected to be negative, because an increase in that relative price may reduce the foreign demand for jute.

Y_F is a weighted average index of the real national incomes of the U.K., U.S.A., Japan, European Economic Community (EEC) countries, and the rest of the countries in the world, all of which import raw jute as well as jute goods. This composite variable serves as a proxy for the industrial activities and incomes of the jute importing countries; the coefficient of Y_F may have a positive sign.

The variables which affect the demand for jute may have lagged effects for a number of reasons, such as technological and institutional rigidities as well as uncertainty about the future. The logic of an adjustment mechanism, whether of the stock-adjustment or adaptive expectations types, justifies the inclusion of the lagged demand for jute ($\bar{Q}^D_{CL}$).[12] The coefficient of $\bar{Q}^D_{CL}$, which reflects the speed of market adjustment, is expected to be positive.

III.3. Aggregate Relations of the Urban Sector

For this sector, we depart from presenting the microeconomic analysis as was done for the agricultural sector. The assumptions of profit and utility maximization by the urban manufacturing firms and urban labourers are also implied in the analysis of this sector. However, as indicated earlier, the disaggregated supply and demand relations will not be derived,

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[12] For a discussion of the demand for agricultural commodities, based on adjustment mechanisms due to technological, institutional and other reasons, see Nerlove (1958).

but aggregate relations will be formulated on the basis of the foregoing analysis of the rural sector.

It is assumed that the factors of production used in this sector are labour and capital. Labour and capital are assumed to be homogeneous. The aggregate production function is assumed to be of the Cobb-Douglas type.[13]

The aggregate relations for this sector are specified in the following sections.

(a) Aggregate labour demand function

The aggregate labour demand for the urban sector is based on the specification of the labour demand functions for the rural sector and is represented as follows:

$$\log \bar{L}_m = \text{constant} + g_{11} \log P_m^* + g_{12} \log W_m^* + g_{13} \log \bar{K}_m + g_{14} \log TT + g_{15} D + g_{16} D_m \log P_m^* \qquad (10T)$$

We have introduced the time trend (TT) in this equation. It has been already mentioned that, there is a gradual shift from the small scale industries to large scale industries in Bangladesh. Moreover, a study by Rahman (1973) shows great variation in the elasticity of substitution between labour and capital of various industries of Bangladesh. Thus, to capture the effects of these and other features, a time trend (TT) is

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[13] Data collected for the purpose of the present study suggest that the elasticity of substitution between labour and capital is approximately unity in the manufacturing sector of Bangladesh.

introduced in both the output supply and the labour demand functions.

D_m is the dummy variable which affects the price (P_m^*) entering into the labour demand and output supply functions of the manufacturing sector. After the emergence of Bangladesh, many industrial units were nationalized which may have shifted the slopes of both the above-mentioned functions with respect to the price variable. The values of D_m are equal to unity for the years 1972 to 1975 and it is introduced to capture the changes in slopes (changes in the price-behaviour) of the labour demand and output supply functions.

(b) Aggregate output supply function

The aggregate output supply function can be represented as follows:

$$\log \overline{Q}_m = \text{constant} + g_{21} \log \overline{K}_m + g_{22} \log P_m^* + g_{23} \log W_m^* + g_{24} \log TT + g_{25} D + g_{26} D_m \log P_m^* \qquad (11T)$$

Note that the time trend (TT) and dummy variable (D_m) are included here on the basis of the discussion in connection with the labour demand function.

(c) Aggregate labour supply function

By analogy to the labour supply equation (7T) for the rural sector, the urban labour supply function is expressed as:

$$\log \overline{L}_m^s = \text{constant} + g_{31} \log W_m^* + g_{32} \log P_m^* + g_{33} \log N_U + g_{34} D \qquad (12T)$$

The coefficient of the urban population variable (N_U) may well have a positive sign.

(d) Aggregate demand function for the manufactured good

The manufactured good is demanded by the people of both the rural and urban sectors; however, as in the case of the rural sector, an aggregate function for the whole economy is postulated as follows:

$$\log \overline{Q}_m^D = \text{constant} + g_{41} \log W_a^* + g_{42} \log W_m^* + g_{43} \log P_m^* + g_{44} \log \overline{K}_f$$

$$+ g_{45} \log \overline{K}_c + g_{46} \log \overline{R} + g_{47} \log N_R + g_{48} \log N_U + g_{49} D \qquad (13T)$$

The task of determination of actual signs of the coefficients is left to empirical implementation of the model.

III.4. Summary of the 'Basic' Model

The model has 13 equations, (1T) - (13T) for both the rural and urban sectors, the estimated forms of which are presented in the next chapter. The number of endogenous and exogenous variables are 17 and 12, respectively, as indicated below.

Endogenous variables: $\overline{L}_f$, $\overline{L}_c$, $\overline{R}_f$, $\overline{R}_c$, $\overline{Q}_f$, $\overline{Q}_c$, $\overline{L}_A^S$, $\overline{Q}_c^D$, $\overline{Q}_f^D$, W_a^*, P_c^*, $\overline{L}_m$, $\overline{L}_m^S$, $\overline{Q}_m$, $\overline{Q}_m^D$, P_m^*, W_m^* (17)

Exogenous variables: $\overline{K}_f$, $\overline{K}_c$, $\overline{R}$, N_R, N_U, Y_F, $\frac{P_c}{P_s}$, $\overline{K}_m$, F, D, TT, D_m (12)

Lagged endogenous variables: $\overline{Q}_{CL}^D$, P_{CL}^* (2)

The model has five market clearing conditions:

(i) $\overline{Q}_f = \overline{Q}_f^D$ (supply of the food product = demand for the food product)

(ii) $\overline{Q}_c = \overline{Q}_c^D$ (supply of the cash crop = demand for the cash crop)

(iii) $\overline{L}_f + \overline{L}_c = \overline{L}_A^S$ (total rural labour demand = total rural labour supply)

(iv) $\overline{Q}_m = \overline{Q}_m^D$ (supply of the manufactured good = demand for the good)

(v) $\overline{L}_m = \overline{L}_m^S$ (demand for urban labour = supply of urban labour)

The 'basic' model, which is a simultaneous equation model, has 18 relations in 17 unknowns. Since all prices are expressed in terms of the price of food, it follows from Walras Law, that one of the market clearing conditions is redundant. We have chosen arbitrarily, the market clearing condition (iii) as redundant and so $\bar{L}_f$, $\bar{L}_c$, $\bar{L}_A^S$ are all estimated in terms of other variables.

CHAPTER IV

EMPIRICAL IMPLEMENTATION OF THE 'BASIC' MODEL

IV.1. Introduction

The 'basic' model of Chapter III is estimated for the Bangladesh economy using annual data for the period 1947-1975,[1] and the estimates of the various structural equations are presented in this chapter. The method of two-stage least-squares (2SLS) is used to estimate the simultaneous system consisting of 13 equations in the 'basic' model.[2] The estimated structural equations are presented in Table 3. The residuals in equations (1EB), (2EB), (4EB), (5EB), (7EB) and (12EB), when estimated by 2SLS, were seriously autocorrelated.[3] These equations are therefore, estimated using the two-stage Cochrane-Orcutt iterative technique to reduce the extent of autocorrelations in the residuals.[4]

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1 The nature and sources of the data employed are discussed in Appendix C.

2 For a concise discussion on the two-stage least-squares method see Johnston (1972).

3 In simultaneous equation context, the derivation and use of the Durbin-Watson d statistic to test autocorrelation, is described by Durbin (1957). Again, in the case where the lagged endogenous explanatory variable is used, the conventional d statistic should be modified as shown by Durbin (1970). However, in such cases, the naive test provided by Durbin is asymptotically the same as the conventional d test. For more on this, see Johnston (1972).

4 In this method of 2SLS, starting with an arbitrary value of autocorrelation coefficient, we minimize the sum of squares of residuals with respect to the parameters, obtaining the estimated values of the parameters. Then keeping the values of parameters at the estimated values, we minimize the sum of squares of residuals with respect to the autocorrelation coefficient, getting a new value of the autocorrelation coefficient. The process is continued until successive estimates differ by arbitrarily small amounts, in our model by less than .005. By this method of estimation, the extent of autocorrelation is reduced in above equations. For a detailed discussion on the Cochrane-Orcutt iterative technique, see Johnston (1972).

To study the response of some endogenous variables due to change in some exogenous variables within the data period, both the impact and dynamic multipliers are derived. Later, the model is used for projecting the values of some endogenous variables for the period 1976-1985. Finally, the effects of various policies on these variables are examined in the policy simulation analysis.

IV.2. Interpretations of the Estimated Coefficients

In this section, interpretations of some of the coefficients of various equations are provided. For definitions of all the variables, see Appendix A.

Note that the absolute values of the t-ratios are given in parentheses and that S.E. is the standard error of estimate. In order to be satisfied with the model's predictive power of the real world situation, we have calculated Theil's inequality coefficient U, for each equation. These are presented in Table 3. The values of U for all the equations suggest adequate predictive ability of the model.[5]

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[5] The development of statistical measures to examine the predictive performance of models is mainly due to Theil (1961). He defines the inequality coefficient as

$$U = \frac{\sqrt{\frac{1}{n}\Sigma(P_i - A_i)^2}}{\sqrt{\frac{1}{n}\Sigma P_i^2} + \sqrt{\frac{1}{n}\Sigma A_i^2}}$$

where P_i = predicted values; A_i = actual values; n = number of observations.

Theil's U coefficient has been extensively used to test the forecasting ability of econometric models within the sample period. The coefficient is restricted to the closed interval between 0 and 1, with 0 showing perfect forecasts and 1 bad forecasts. Theil [(1961), Appendix to Chapter III] calculated the values of U for various equations in connection with the macroeconomic forecasts of Netherlands and 3 Scandinavian countries for the period 1948-1953, and among the values the maximum and minimum values of U were 0.91 and 0.04, respectively. According to Theil, the value 0.04 for U indicates best forecasting ability for the particular equation in question. It should be pointed out here that the U coefficient is not a perfect measure of the predictive ability of the model. In section 4 of this chapter, we have performed historical simulation in order to examine the predictive power of the model.

(a) Estimated labour demand functions for the rural sector

$$\log \bar{L}_f = \underset{(.74)}{-1.5034} + \underset{(.20)}{.0037} \log P^*_{CL} - \underset{(.46)}{.0211} \log W^*_a + \underset{(2.80)}{.1221} \log \bar{K}_f - \underset{(2.68)}{.0998} \log \bar{K}_c$$

$$+ \underset{(2.31)}{.3575} \log \bar{R} + \underset{(2.47)}{.0960} D + \underset{(9.55)}{.0640} \log F \qquad (1EB)$$

$R^2 = .98$ d = 1.77 S.E. = .02

$$\log \bar{L}_c = \underset{(1.19)}{2.0051} + \underset{(.38)}{.0032} \log P^*_{CL} - \underset{(.22)}{.0080} \log W^*_a - \underset{(9.20)}{.8929} \log \bar{K}_f + \underset{(11.12)}{.9018} \log \bar{K}_c$$

$$+ \underset{(2.72)}{.0938} \log \bar{R} + \underset{(.32)}{.0147} D \qquad (2EB)$$

$R^2 = .99$ d = 1.83 S.E. = .01

In the labour demand function for the food crop production (1EB), the statistically significant variables, namely land, capital, fertilizers and the dummy variable have consistent signs for their respective coefficients. For the labour demand function for the cash crop production (2EB), capital and land have statistically significant.

(b) Estimated land allocation functions for the rural sector

$$\log \bar{R}_f = \underset{(.03)}{-.0305} - \underset{(2.35)}{.0280} \log P^*_{CL} - \underset{(2.28)}{.0534} \log W^*_a + \underset{(3.05)}{.1664} \log \bar{K}_f + \underset{(.92)}{.0394} \log \bar{K}_c$$

$$+ \underset{(11.14)}{.8279} \log \bar{R} + \underset{(6.05)}{.0144} \log F + \underset{(3.03)}{.0727} D \qquad (3EB)$$

$R^2 = .98$ d = 1.77 S.E. = .01

$$\log \bar{R}_c = \underset{(.63)}{-8.8225} + \underset{(4.15)}{.5024} \log P^*_{CL} - \underset{(.48)}{.1741} \log W^*_a - \underset{(1.28)}{.4916} \log \bar{K}_f + \underset{(2.78)}{.1663} \log \bar{K}_c$$

$$+ \underset{(2.13)}{1.2030} \log \bar{R} - \underset{(.98)}{.0475} D \qquad (4EB)$$

$R^2 = .69$ $\qquad$ $d = 1.68$ $\qquad$ S.E. = .17 .

In the land allocation function for the food crop (3EB), the variables which are statistically significant are: the price variable, the wage rate, capital in the food crop production, land, fertilizers and the dummy variable. In the land allocation function for the cash crop production (4EB), the significant variables are: the price variable, capital in the cash crop production and land. The signs of all these coefficients are consistent when examined along with the coefficients in (1EB) and (2EB).

The dummy variable (D) has positive coefficient in equation (3EB) which is consistent with the fact that after the emergence of Bangladesh, for a few initial years, farmers devoted more land to the food crop in order to produce adequate food to sustain themselves.

Some interesting implications emerge when equations (1EB) - (4EB) are viewed together. Capital in the respective crops ($\bar{K}_f$ in the food crop and $\bar{K}_c$ in the cash crop) exert positive influences on the allocation of labour and land in the food and cash crop production, respectively. This may be due to the reason that in a peasant economy with three factors (land, labour and capital), the inputs perform different functions. There has rarely been any capital investment (for sophisticated mechanized agriculture) in Bangladesh, which could have both labour and land saving bias.

The capital expenditures in Bangladesh may well have been labour using and/or land using in the sense that increased investment in the agricultural sector may have increased labour absorption and/or increased cropping intensity (thereby increasing total cropped area).

(c) Estimated output supply functions for the rural sector

$$\log \bar{Q}_f = \underset{(1.69)}{-8.4693} + \underset{(3.02)}{.1850} \log \bar{K}_f + \underset{(1.01)}{.0229} \log \bar{K}_c - \underset{(2.37)}{.2678} \log W_a^* - \underset{(2.69)}{.0657} \log P_{CL}^*$$

$$+ \underset{(3.41)}{1.4515} \log \bar{R} + \underset{(.26)}{.0514} D + \underset{(2.12)}{.0356} \log F \qquad (5EB)$$

$R^2 = .88$ $d = 1.95$ $S.E. = .07$

$$\log \bar{Q}_c = \underset{(.74)}{-4.6090} - \underset{(2.15)}{.0956} \log \bar{K}_f + \underset{(2.62)}{.1209} \log \bar{K}_c - \underset{(2.67)}{.3075} \log W_a^* + \underset{(3.39)}{.4128} \log P_{CL}^*$$

$$+ \underset{(2.53)}{.7543} \log \bar{R} - \underset{(.58)}{.2015} D \qquad (6EB)$$

$R^2 = .52$ $d = 2.05$ $S.E. = .15$

In the supply function of the food crop (5EB), the variables which are statistically significant, are: capital in the production of the food crop, the wage rate, the price variable, land, and fertilizers. In the supply function of the cash crop (6EB) the variables which are significant, are: capital, the wage rate, the price variable and land.

The coefficients of the wage rate (W_a^*) in both the equations reveal an interesting feature. Notice that the increase in W_a^* leads to the reduction of output in both the food and cash crops. This may be due to the fact that in equations (1EB) and (2EB), an increase in W_a^* leads to the reduction of labour used. Thus, the reduction of output due to an increase in the wage rate (W_a^*) may be due to the reduction in the labour used. This means that labour has non-zero marginal productivity in the agricultural sector (which supports the neoclassical assumption of 'no surplus labour' in the rural sector).

In equation (1EB), the coefficient of fertilizers (F) is positive and significant, which may result in an increase in output due to an increase in (F) as shown by equation (5EB). The increase in fertilizers and use of high-yield varieties of seeds are positively correlated in Bangladesh where it is seen that the adoption of the improved seeds involve increased labour-use in the rural sector.

(d) Estimated agricultural labour supply function

$$\log \overline{L}_A^S = \underset{(1.33)}{-1.3245} - \underset{(1.17)}{.0768} \log \overline{K}_f + \underset{(.57)}{.0260} \log \overline{K}_c + \underset{(1.02)}{.1013} \log \overline{R} - \underset{(2.31)}{.1389} \log P_m^*$$

$$- \underset{(.70)}{.0124} \log P_c^* + \underset{(2.42)}{.1559} \log W_a^* + \underset{(12.50)}{.9109} \log N_R + \underset{(1.01)}{.1347} D \qquad (7EB)$$

$R^2 = .99$ $\qquad$ $d = 1.80$ $\qquad$ S.E. = .02

The rural wage (W_a^*), the relative price of the manufactured good and rural population (N_R) are statistically significant variables in determining agricultural labour.

The positive coefficient of the wage rate (W_a^*) implies that the rural sector has an upward sloping labour supply schedule with respect to the wage rate. This is contrary to the labour-surplus assumption where the supply function of the rural labour is taken as horizontal.

(e) Estimated food demand function

$$\log \bar{Q}_f^D = \underset{(1.20)}{7.6063} - \underset{(1.01)}{.5354} \log W_a^* + \underset{(2.66)}{.7155} \log W_m^* - \underset{(.66)}{.2657} \log P_m^* - \underset{(1.39)}{.5325} \log \bar{K}_f.$$

$$+ \underset{(1.05)}{.2780} \log \bar{K}_c + \underset{(.45)}{.2132} \log \bar{R} + \underset{(2.85)}{.3511} \log N_R + \underset{(2.78)}{.3741} \log N_U + \underset{(.39)}{.1412} D \quad (8EB)$$

$R^2 = .96$ d = 1.72 S.E. = .08

The urban wage rate (W_m^*), rural and urban populations (N_R and N_U) are statistically significant variables in the above function. The elasticity of demand for food with respect to the urban wage rate is positive which is not unexpected because it is recognized that in the initial stage of economic development, the consumption level may rise due to the increase in the 'standard of living', especially in the urban areas. On the other hand, the per capita consumption in the rural areas does not change much and as such, the rural wage rate (W_a^*) is not a significant variable. Data on rural consumption is consistent with this result.

(f) Estimated demand function for the cash crop (Jute)

$$\log \bar{Q}_c^D = \underset{(3.00)}{3.3883} + \underset{(2.64)}{.5492} \log \bar{Q}_m - \underset{(2.90)}{.1719} \log \frac{P_c}{P_s} + \underset{(1.06)}{.1666} \log Y_F + \underset{(1.16)}{1.1179} D$$

$$+ \underset{(1.58)}{.2180} \log \bar{Q}_{CL}^D \quad (9EB)$$

$R^2 = .56$ d = 2.02 S.E. = .14

The coefficients of the domestic output ($\bar{Q}_m$) and the relative price ($\frac{P_c}{P_s}$) are significant and their signs are consistent with 'a priori' expectations.

(g) Estimated labour demand function for the urban sector

$$\log \bar{L}_m = \underset{(3.26)}{-18.3147} - \underset{(.74)}{.7981} \log P_m^* - \underset{(1.12)}{.9459} D_m \log P_m^* - \underset{(2.28)}{.3189} \log W_m^*$$

$$+ \underset{(3.13)}{2.4763} \log \bar{K}_m - \underset{(1.35)}{.3120} \log TT + \underset{(1.64)}{.4422} D \qquad (10EB)$$

$R^2 = .81$ $\qquad$ $d = 2.18$ $\qquad$ $S.E. = .26$

The wage rate and capital are statistically significant variables in determining employment in the urban sector. The dummy variable (D_m) in this equation is used in order to take into account the behaviour of the industries which were nationalized after the emergence of Bangladesh.

(h) Estimated supply function of the manufactured good

$$\log \bar{Q}_m = \underset{(.49)}{.9762} + \underset{(2.92)}{.8164} \log \bar{K}_m - \underset{(1.01)}{.4933} \log P_m^* - \underset{(.25)}{.2026} D_m \log P_m^*$$

$$- \underset{(2.15)}{.0196} \log W_m^* + \underset{(1.15)}{.0940} \log TT - \underset{(5.55)}{1.7205} D \qquad (11EB)$$

$R^2 = .95$ $\qquad$ $d = 1.92$ $\qquad$ $S.E. = .09$

The coefficients of the wage rate (W_m^*), the dummy variable (D) and capital ($\bar{K}_m$) are statistically significant. After the emergence of Bangladesh, many industrial units were nationalized and so, apart from price, various other factors such as political, institutional, may have influenced the output and price behaviour of the manufacturing sector, and so the dummy variable (D_m) is used in equations (10EB) and (11EB). The coefficients of the wage rate (W_m^*) and capital ($\bar{K}_m$) in equations (10EB) and (11EB) are consistent, with the nature of the economy.

Assume that W_m^* increases, everything else remains unchanged. This will reduce the output and the demand for labour which is consistent with the profit maximizing behaviour of the firms. Now consider the situation after the emergence of Bangladesh when many firms were nationalized. An increase in W_m^* in the nationalized firms will reduce output and labour demand because these firms will be reluctant to raise the price of their products due to the increase in W_m^*; instead, employment and output will be reduced. This behaviour is thus consistent with the behaviour of the nationalized firms.

An increase in ($\bar{K}_m$), everything remaining constant, will result in an increase in the demand for labour (due to higher marginal productivity of labour) and in supply of the manufactured good. This is consistent with the profit maximizing behaviour of the firms. Since the nationalized industry will always be willing to increase the level of employment and output whenever possible, the results of equations (10EB) and (11EB) are also consistent with the behaviour of the nationalized firms.

The negative coefficient of the dummy variable (D) is consistent with the fact that after Bangladesh became independent in 1971, output of the manufacturing sector actually declined due to serious dislocation in transport, communication and energy sectors of the economy.

(i) Estimated urban labour supply function

$$\log \bar{L}_m^S = \underset{(3.55)}{2.9544} + \underset{(2.78)}{.0561} \log W_m^* - \underset{(.85)}{.0728} \log P_m^* + \underset{(2.87)}{.2335} \log N_U + \underset{(1.66)}{.0692} D \qquad (12EB)$$

$R^2 = .99$ $\qquad$ $d = 1.26$ $\qquad$ S.E. = .04

The coefficients of the wage rate, and urban population are statistically significant. The positive coefficient of the wage rate (W_m^*) suggests an upward sloping supply curve for the labourer in the urban sector, as is the case for the labourer in the rural sector.

(j) Estimated demand function for the manufactured good

$$\log \bar{Q}_m^D = \underset{(1.61)}{7.6594} - \underset{(1.14)}{.3738} \log W_a^* + \underset{(2.89)}{.2828} \log W_m^* - \underset{(1.13)}{.0385} \log P_m^* - \underset{(.31)}{.0895} \log \bar{K}_f$$

$$+ \underset{(.43)}{.0847} \log \bar{K}_c - \underset{(1.41)}{.4996} \log \bar{R} + \underset{(2.60)}{1.4566} \log N_R + \underset{(2.96)}{.2814} \log N_U - \underset{(.91)}{.2437} D \qquad (13EB)$$

$R^2 = .96$ $\qquad$ $d = 1.83$ $\qquad$ S.E. = .06

The coefficients of the urban wage rate (W_m^*), rural population (N_R) and urban population (N_U) are statistically significant as with the case of the estimated demand function for the food crop.

Though the rural people (N_R) consume relatively much less manufactured good than the urban people (N_U), the elasticity of demand with respect to N_R is much higher than the elasticity with respect to N_U. This is very difficult to rationalize. If two separate demand functions for the two sectors could be estimated, then the real effects of the sectoral populations could be analyzed. This is an inherent weakness of using an aggregate demand function for the manufactured good for both the sectors. Similar comments could be made in connection with the demand function for food (equation (8EB)). Thus, no conclusive observation can be made about the coefficients of the population variables in equations (8EB) and (12EB).

The elasticity of demand with respect to the urban wage rate (W_m^*) is positive which is consistent with the fact that the major portion of the manufactured good is consumed in the urban areas and the consumption level increases with the increase in income of the urban people. Thus, the result is consistent with that for the demand function for food. It means that the demand for both food and the manufactured good increases due to an increase in the urban wage rate.

IV.3.1. Multipliers of the system

To examine the induced change in a current endogenous variable, given a unit change in an exogenous variable, the multipliers of the system are calculated.

The impact multipliers are the reduced form coefficients of the exogenous variables, some of which are given by the coefficients of Table 4, which give the immediate change in the endogenous variables due to a unit change in an exogenous variable. Subsequently, a maintained change in an exogenous variable beginning at a particular time has continuing effects which work through the system by the operation of the combined effects of both the coefficients in Table 4 and the coefficients of the lagged endogenous variables. The total long-run effect is given by dynamic multipliers[6] some of which are presented in Table 5.

IV.3.2. Interpretation of multipliers

The values of the impact multipliers can be read from Table 4. Let us take the effects of a unit change in capital in food crop ($\overline{K}_f$) on labour demand and the wage rate. If there is a unit change in ($\overline{K}_f$), labour in the production of the food crop ($\overline{L}_f$) will increase by .2055 units, output ($\overline{Q}_f$) will increase by .7734 units and the wage rate in the rural sector will increase by .7129 units.[7] The same unit change in $\overline{K}_f$ will increase labour demand and output in the manufacturing sector by .0580 and .5014 units, respectively. The situation may be shown graphically, as given below.

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[6] The dynamic multipliers can be expressed as a matrix; Dynamic multipliers (equilibrium multipliers) = $(I - \pi_1)^{-1}\pi_2$, where π_1 and π_2 are the reduced form coefficient matrices of the lagged endogenous and the exogenous variables, respectively, of the whole system; and I is an Identity matrix. Before calculating the dynamic multipliers, one should examine whether the system is stable or not. The stability condition of the model is that all the eigenvalues of the matrix π_1, have modulus less than unity. Since our model consists of only two lagged endogenous variables ($\overline{Q}^D_{CL}$ and P^*_{CL}), there are two characteristic roots (eigenvalues) which are calculated as -.0927 and -.7823, both of which have modulus less than unity. The model is, therefore, stable. For a detailed exposition of the calculation of eigenvalues, see Dernberg and Dernberg (1969).

[7] Since all the variables are expressed in natural logarithm, from now on, a change in a variable will mean change in the logarithm of a variable.

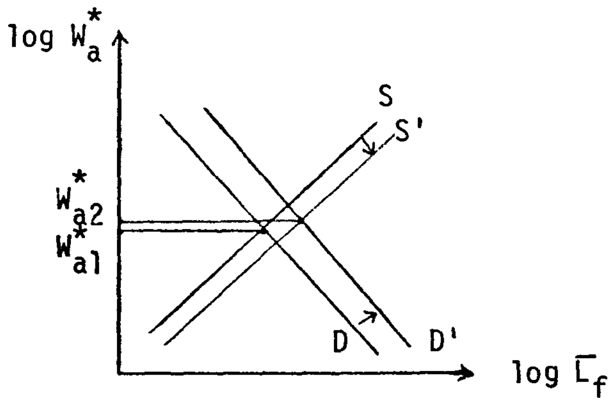

Figure 3. Multiplier in the Rural Sector.

From the estimates of the structural equations, we see that the elasticity of labour demand in the food crop ($\bar{L}_f$) is negative with respect to the wage rate (W_a^*) and the elasticity of the agricultural labour supply with respect to the wage rate (W_a^*) is positive. The initial labour demand and supply schedules are D and S, respectively, and the wave rate W_{a1}^*. When $\bar{K}_f$ increases, D shifts to the right to D' and supply to the right S' resulting in higher equilibrium wage rate W_{a2}^*.

Now compare the above situation to that in which capital in the manufacturing sector ($\bar{K}_m$) is increased by a unit. This will reduce labour demand in the food crop production by .1164 units, reduce output of the food crop by .1797 units and also reduce labour demand and output supply in the manufacturing sector by .1396 and .9487 units, respectively; the manufacturing sector wage rate (W_m^*) increases by 2.3567 units. This case can also be shown graphically. From the estimates of the structural

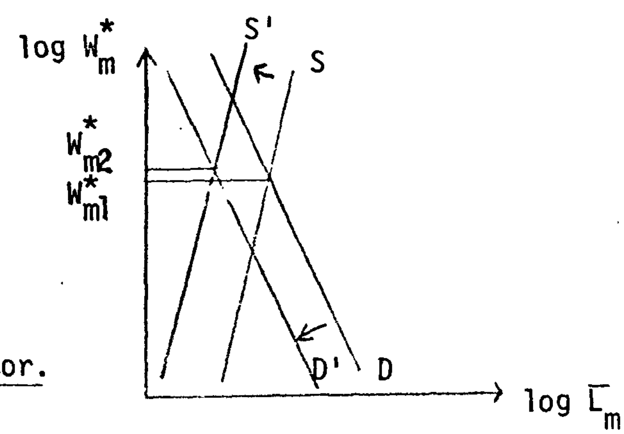

Figure 4. Multiplier in the Urban Sector.

equations, we find that the elasticities of labour demand and supply with respect to the wage rate in this sector are negative and positive, respectively. The initial labour demand and supply schedules are D and S, respectively, with equilibrium wage rate at W_{m1}^{*}. When $\overline{K}_m$ increases, both the demand and supply schedules shift leftward to D' and S', respectively, yielding a higher equilibrium wage rate W_{m2}^{*}.

Thus, the relative impact in a unit change in $\overline{K}_f$ on labour demand in both sectors and output in both sectors is higher than that for a unit change in $\overline{K}_m$. From the table of dynamic multipliers (Table 5), it is evident that the multipliers for a unit change in $\overline{K}_f$ are higher than the impact multipliers on the variables mentioned above, whereas the dynamic multipliers in a unit of change in $\overline{K}_m$ result in further reduction of the variables mentioned above. The impact of $\overline{K}_c$ is somewhat similar to that of $\overline{K}_f$. The impact of $\overline{K}_c$ on $\overline{L}_c$ and $\overline{Q}_c$ is positive. Again, an increase in $\overline{K}_c$ (capital in the cash crop) increases the output and labour employed in the urban sector. So, we can infer that the relative impact of the investment increase in the rural sector, is higher than that of the investment increase in the manufacturing sector with respect to output and employment in both sectors.

The impact and dynamic multipliers for a unit change in land ($\overline{R}$) on $\overline{L}_f$, $\overline{Q}_f$, $\overline{L}_m$ and $\overline{Q}_m$, indicate the positive impacts on all these variables. Dynamic multipliers are usually larger than impact multipliers, for all these variables. Conceptually an increase in $\overline{R}$ can come about through land reclamation, by irrigation facilities, adoption of improved varieties of seeds, or the use of increased amounts of fertilizers which increase the 'yield per acre' which, in other words, implies an increase in the acreage of land ($\overline{R}$). An increase in the fertilizer used (F) results in the positive impact on $\overline{L}_f$, $\overline{Q}_f$, $\overline{L}_c$, $\overline{Q}_c$, $\overline{L}_m$ and $\overline{Q}_m$, which can be seen in the case of both impact and dynamic multipliers given in Tables 4 and 5.

The interactions which give rise to a higher positive impact of the change in investment in the rural sector may be explained intuitively as follows: Rural development may increase the sector's demand for intermediate inputs such as pesticides, fertilizers, and agricultural implements which are provided by the manufacturing sector, and at the same time, the rural sector may provide an increasing amount of supply of raw materials to the manufacturing sector. As employment and output increase in the agricultural sector, rural income may rise which may further increase the demand for the manufacturing good, thereby increasing output and employment in the manufacturing sector.

On the other hand, an injection of more capital into the manufacturing sector reduces employment (shown in Figure (4)) and also output $\overline{Q}_m$ (in Table 4 of multipliers). An explanation for this kind of situation may be that the provision of subsidized capital and raw materials by the government and other agencies in Bangladesh, especially during the Pakistan period, resulted in the adoption of capital intensive techniques,[8]

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[8] Bangladesh industries are more capital intensive than Japanese industries excepting basic metals and equally capital intensive as the U.S. industries. Ahmed (1972) pointed out that in some industries such as machinery, the capacity utilization was as low as 15%. A recent study by Gul Afroz and Roy (1976) shows that the phenomena persist even in recent times.

with consequent reduction in the absorption of labour in the manufacturing sector. Thus, the protected and encouraged manufacturing sector did not produce the desired result of increasing employment and income for the vast majority of the people.

IV.4.1. Simulations with the 'basic' model

An attempt is now made to compare several economic policies in terms of their effects on some important endogenous variables of the model.

Three alternative approaches have been suggested by economists for using macro-econometric models to evaluate the effects of various economic policies on the behaviour of an economic system: (a) the Theil approach, (b) the Tinbergen approach, and (c) the policy simulation approach.[9]

Theil assumes that the social welfare function W of the policy maker is known which may be expressed as a function of the endogenous (target) variables and the policy instruments. However, in general, the search for a general social welfare function has not been very successful.

In the Tinbergen approach, instead of the policy maker's welfare function, it is assumed that the policy maker has specified a fixed target value for each of the endogenous variables. But, it is rather unlikely that the policy maker will reveal in a precise manner, the values of his target variables. Again, the problem of balancing the number of equations and the number of policy variables is also a serious limitation

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9 For an excellent discussion of policy evaluation approaches, see T.H. Naylor (1971).

of the Tinbergen approach.

The third approach, simulation analysis, does not assume prior knowledge of either the social welfare function or the targets of the policy maker. With this approach, a set of simultaneous equations can be solved in terms of the exogenous (including policy variables), lagged endogenous variables and the disturbance terms in the equations and we can generate the time path of the endogenous variables. Holland and Gillespie [(1963), P. vii) observe that simulation experiments, "... show some of the complex ways in which the different processes in the economic system interact with each other, with consequences that could not have been foretold by comparative statics".

In simulation approach, the policy maker is asked two questions. First, what variables are of particular interest to him and second, what sets of policy variables appear to be feasible to him. With simulation, the consequences of the proposed policies can be shown. Therefore, the aim of simulation studies is not only to forecast in absolute terms the values of some endogeous variables but also to provide operational solutions to formulate policy strategies.

In the present study, the simulation approach is followed to compare the effects of several policies on employment, output and the wage rates in the context of the economy of Bangladesh. Our approach in this study has been to combine the methods of the econometrician and the systems analyst since we do not simulate with a 'pure' mechanical (mathematical) model but with an econometric model whose parameters are estimated from the data of a particular economy.

IV.4.2. Historical simulations

Before introducing the policy simulations, we perform a historical simulation with the model of the 24 years period 1952-1975 with the historical data for the sample period.[10] The results of the historical simulation are provided in Table 6 in which we provide the percentage deviations of the simulated values from the actual values of the endogenous variables within a subset of the sample period.

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[10] The design of experiments in the present study is based on non-stochastic simulation approach in the sense that the stochastic disturbances are not generated by a computer subroutine.

In the simulation exercise, an initial period (t) is chosen for which a solution is desired. Then, for the next period, (t + 1), the solution value of the initial period (t) is used as the lagged endogenous variable for the solution of period (t + 1). The iteration goes to the next period (t + 2) and so on, until for each of the endogenous variables, the terminal period (the year 1985 in our case) is reached. Thus, in the general equilibrium model used in the present study, the endogenous variables are interlinked within the simulation period, through the lagged endogenous variables, although the market clearing conditions are satisfied at each period. It is postulated here that, given some dynamic adjustment mechanisms, static equilibrium values at different periods of time are determined for the endogenous variables. This conception of the growth process as a movement by the economy through a series of short-run equilibria is similar to the position taken by Higgins (1959) who argued that economic development consists of some disequilibrium processes.

From the historical simulation results, we see how the model predicts the historical behaviour of the endogenous variables. There are divergences between the actual and the solution values for the endogenous variables in any given year. Goodness of fit is difficult to infer in simulation experiments where the 'test' is usually formulated with reference to the specific problem at hand. The percentage deviation between the actual and solution values in each period and also the mean absolute percentage deviation for the entire simulation period, all give some ideas on the predictive power of the model.[11]

The historical simulations have been done for a fairly long period of time within which many forces acted upon the economic system; the model may not be able to pick up all of these effects.

There may have been some structural disequilibrium in the economy, for example, in the labour and output markets where perfect competition and smooth adjustments may not have operated fully.[12] Again, simplifying assumptions such as absence of the foreign trade sector as a separate entity may have caused some discrepancies in the simulated values. However, on the whole, the historical behaviour of the endogenous variables is adequately explained by our model.

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[11] In Table 3, Theil's U coefficient for each equation is given. However, the values of U are calculated by taking each equation individually, whereas in historical simulation, the interactions of the equations are allowed because the whole model is used.

[12] Bruno (1968) discusses the method of derivation of labour demand functions under structural disequilibrium.

IV.5. Projections for Policy Analysis

The model presented in this chapter can be used for two purposes: forecasting of the endogenous variables and policy analysis. However, these two purposes are related. In forecasting 'per se', the economists try to make the best possible guess about all the exogenous variables including the policy variables. Policy analysis is a sort of conditional forecasting in which forecasts under alternative conditions of the exogenous variables are made.

For the purpose of the present analysis, forecasts for the period 1976-1985 were carried out for the variables in which we are interested, namely: labour demand, output supply and the wage rates in both the sectors.[13] The projected values are presented in Table 7. Given the projections of the endogenous variables in Table 7, the effects of several different government policy options are now analyzed.

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[13] For the purpose of forecasting for the period 1976-1985, the values of the exogenous variables are calculated on the basis of information provided by various sources of data which are listed in Appendix C. IBRD (1974) publications provide with projections of many aggregate variables. The number of people in the rural and urban sectors are calculated on the basis of data provided by IBRD (1974), Alamgir and Berlage (1974) and census data on Bangladesh. The values on capital and land have been calculated on the basis of sectoral projections made by IBRD, First Five Year Plan (1973-1978) of the Bangladesh government. The projections on the level of fertilizer in the agricultural crop done by Kahnert and others (1970) and by the Planning Commission of Bangladesh provided the basis of our information. The price of jute relative to that of substitutes has been derived from the data on various price series provided by IBRD (1974), Five Year Plan of Bangladesh and other sources listed in Appendix C. The weighted average index of the national incomes of jute importing countries are calculated from the data provided by United Nations Yearbooks (various issues).

IV.6. Policy Simulation Experiments

In the present study, the effects of three potential government strategies on the levels of employment, output and wage rates in both the rural and urban sectors are examined. The three basic strategies are discussed below:

Strategy I: In this strategy, the major impetus is given to the rural sector in the form of higher additional capital. In order to be realistic, the availability of the additional capital is considered. The First Five Year Plan (1973-1978) of the Bangladesh government gives the year-to-year phasing of the foreign capital inflow up to 1977-78. On the basis of that, the foreign capital inflow has been projected up to 1985. In this policy option, these funds are allocated in the proportion 50% to the food crop. 10% to the cash crop, and the rest in the manufacturing sector in each year from 1976 to 1985. Thus, capital in the agricultural sector increases by 60% of the foreign capital inflow and in the manufacturing sector increases by 40% of the foreign capital in each year, under this strategy.[14]

Strategy II: This strategy puts greater emphasis on the manufacturing sector. The same amount of capital envisaged for Strategy I is now allocated in the different proportions: 20% to the agricultural food crop, 5% to the cash crop, and 75% to the manufacturing sector in each year between 1976 and 1985.

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[14] The total amount of the foreign capital inflow over ten years from 1976-1985 is estimated to be about 27650 million Taka. It should be pointed out that the profits in the manufacturing sector (returns to exogenous capital stock) which is assumed to be reinvested are included in the capital stock in the two sectors under the 'status quo' situation.

Strategy III: In this strategy, land ($\bar{R}$) and fertilizers (F) both are increased in such a way that it may result in the increase of yield per acre of land by 10% over the 'status quo' situation in each year in the production of food and the cash crop. This objective might be attained by increasing irrigation facilities, or by land reclamation, or by facilitating a double cropping system, or by providing improved varieties of seeds, increased amount of fertilizers and pesticides.[15]

Additional Strategies: Two other strategies can be postulated with a different assumption than that under the above strategies. It is assumed that the additional capital available to the government is extremely limited based on somewhat pessimistic view of the policy maker about the foreign capital inflow. For comparison, two symmetric policies are used, one which allocates the additional

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[15] The adoption of modern technology of using improved seeds, large amounts of fertilizers (which is associated with increased yields per acre) and irrigation, flood control, land reclamation (which increases the supply of land by increasing the cropping intensity) both are believed to have the essentially equivalent effects on removing extreme scarcity of land. On the basis of costs data provided by the U.N. Food and Agricultural Organization (May, 1975), and sources listed in Appendix C, it has been calculated that Strategy III will require approximately the same amount of funds as envisaged under Strategies I and II.

funds (which is for example, only 25% of the additional fund envisaged under policies I, II and III) to the manufacturing sector and the other which allocates the additional funds to the production of the food crop in the agricultural sector.

Since we are increasing either capital in the manufacturing sector ($\overline{K}_m$) or capital in the production of food crop ($\overline{K}_f$), but not both at the same time, the relative impacts can be examined by looking at multipliers in Tables 4 and 5. Ths discussion of some of these multipliers has been given earlier in this chapter. The relative impact of the increase in ($\overline{K}_f$) is higher than that of the increase in ($\overline{K}_m$) with respect to output, employment in both the sectors and the wage rate in the rural sector. Thus, without going to the policy simulation exercises the impact of these additional policy options can be readily examined from multipliers.

In each simulation experiment, all other exogenous variables except the ones to be changed, were maintained at the levels assumed under the 'status quo' situation for the period 1976-1985.[16] The change in the policy is assumed to occur in each case, at the beginning of 1976 and the predicted impact of the policy change is measured as the percentage difference between the solutions with and without the change in the policies. The results are presented in Table 8.

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[16] It is assumed that the change in the aggregate policy of the government does not have any impact on the distribution of capital and land between the farms in the rural sector as well as capital between the industrial enterprises in the urban sector. Since there is no adjustment through the labour markets, the redistribution in the sectoral populations are not envisaged during the simulation period. In Chapter VI, the effects of various policies on rural-urban migration are examined where the redistribution in the rural-urban populations are analyzed through the process of migration.

IV.7. Evaluation of Policy Simulation Results

In the evaluation of the performances of different alternative policies, the task of the policy makers is rendered extremely complicated by the fact that there are a very few rules for policy evaluation and they are often of very limited scope, imperfect and often contradictory. However, there should be some attepmts in the evaluation of policy measures.

It has been mentioned earlier that with the simulation approach, the effects of various policies on some important variables are examined. In Table 8, the percentage changes (positive or negative) of the simulated value, under various strategies from those of the 'status quo' situation (as indicated in Table 7) have been presented.

From Table 8, it can be seen that Strategy I consistently yields larger values for labour employment, the rural wage rate and output levels. However, strategy I does not seem to be very effective in raising urban wage rates.

Strategy III also performs well with respect to the increase in output and employment in all sectors and the wage rate in the rural sector. However, it does not perform well with respect to the urban wage rate. Under strategy II, the increase in the urban wage rate is higher than that under strategies I and III; the impact of strategy II on employment and output levels is lower than that under strategies I and III.

In Bangladesh, the rural wage rate has been persistently lower than the urban wage rate and since policies I and III do not increase the urban wage rate substantially, the gap between the sectoral wages are lower under these policies than that under policy II. This wage gap among other things, induces migration to the urban areas; the process will be analyzed under the 'modified' model in Chapters V and VI.

Considering Strategies I, II and III which cost the same amount of money, the percentage increase in output, employment under policies I and III are larger than those under policy II. It is also seen that under policies I and III, the extent of reduction of the disparity between the rural and urban wage rates is higher than that under policy II. These features can be readily seen from Figure 5 where the time path of the various endogenous variables under various policies with reference to the 'status quo' assumptions are depicted. From these results, it is evident that there is certain truth in the assertion that a greater emphasis on the agricultural development in a country like Bangladesh relative to industrial development will have a greater impact on overall development of the economy.

Table 3

ESTIMATED STRUCTURAL EQUATIONS OF THE 'BASIC' MODEL

<u>Labour demand in the food crop production</u>

(1EB)

$$\log \bar{L}_f = \underset{(.74)}{-1.5034} + \underset{(.20)}{.0037} \log P^*_{CL} - \underset{(.46)}{.0211} \log W^*_a + \underset{(2.80)}{.1221} \log \bar{K}_f - \underset{(2.68)}{.0998} \log \bar{K}_c + \underset{(2.31)}{.3575} \log \bar{R} + \underset{(2.47)}{.0960} D + \underset{(9.55)}{.0640} \log F$$

<u>Labour demand in the cash crop production</u>

(2EB)

$$\log \bar{L}_c = \underset{(1.19)}{2.0051} + \underset{(.38)}{.0032} \log P^*_{CL} - \underset{(.22)}{.0080} \log W^*_a - \underset{(9.20)}{.8929} \log \bar{K}_f + \underset{(11.12)}{.9018} \log \bar{K}_c + \underset{(2.72)}{.0938} \log \bar{R} + \underset{(.32)}{.0147} D$$

<u>Land allocation in the food crop production</u>

(3EB)

$$\log \bar{R}_f = \underset{(.03)}{-.0305} - \underset{(2.35)}{.0280} \log P^*_{CL} - \underset{(2.28)}{.0534} \log W^*_a + \underset{(3.05)}{.1664} \log \bar{K}_f + \underset{(.92)}{.0394} \log \bar{K}_c + \underset{(11.14)}{.8279} \log \bar{R} + \underset{(6.05)}{.0144} \log F + \underset{(3.03)}{.0727} D$$

<u>Land allocation in the cash crop production</u>

(4EB)

$$\log \bar{R}_c = \underset{(.63)}{-8.8225} + \underset{(4.15)}{.5024} \log P^*_{CL} - \underset{(.48)}{.1741} \log W^*_a - \underset{(1.28)}{.4916} \log \bar{K}_f + \underset{(2.78)}{.1663} \log \bar{K}_c + \underset{(2.13)}{1.2030} \log \bar{R} - \underset{(.98)}{.0475} D$$

Equation	R^2	S.E.	d	U
(1EB)	.98	.02	1.77	.024
(2EB)	.99	.01	1.83	.012
(3EB)	.98	.01	1.77	.021
(4EB)	.69	.17	1.60	.013

Continued......

Table 3 (Continued)

		R^2	S.E.	d	U
	Output of the food crop				
(5EB)	$\log \bar{Q}_f = \underset{(1.69)}{-8.4693} + \underset{(3.02)}{.1850} \log \bar{K}_f + \underset{(1.01)}{.0229} \log \bar{K}_c - \underset{(2.37)}{.2678} \log W_a^*$				
	$- \underset{(2.69)}{.0657} \log P_{CL}^* + \underset{(3.41)}{1.4515} \log \bar{R} + \underset{(.26)}{.0514} D + \underset{(2.12)}{.0356} \log F$	.88	.07	1.95	.045
	Output of the cash crop				
(6EB)	$\log \bar{Q}_c = \underset{(.74)}{-4.6090} - \underset{(2.15)}{.0956} \log \bar{K}_f + \underset{(2.62)}{.1209} \log \bar{K}_c - \underset{(2.67)}{.3075} \log W_a^*$				
	$+ \underset{(3.39)}{.4128} \log P_{CL}^* + \underset{(2.53)}{.7543} \log \bar{R} - \underset{(.58)}{.2015} D$	.52	.15	2.05	.038
	Rural labour supply				
(7EB)	$\log \bar{L}_A^S = \underset{(1.33)}{-1.3245} - \underset{(1.17)}{.0768} \log \bar{K}_f + \underset{(.57)}{.0260} \log \bar{K}_c + \underset{(1.02)}{.1013} \log \bar{R}$				
	$- \underset{(2.31)}{.1389} \log P_m^* - \underset{(.70)}{.0124} \log P_c^* + \underset{(2.42)}{.1559} \log W_a^* + \underset{(12.50)}{.9109} \log N_R$				
	$+ \underset{(1.01)}{.1347} D$	.99	.02	1.80	.021
	Food demand				
(8EB)	$\log \bar{Q}_f^D = \underset{(1.20)}{7.6063} - \underset{(1.01)}{.5354} \log W_a^* + \underset{(2.66)}{.7155} \log W_m^* - \underset{(.66)}{.2657} \log P_m^*$				
	$- \underset{(1.39)}{.5325} \log \bar{K}_f + \underset{(1.05)}{.2780} \log \bar{K}_c + \underset{(.45)}{.2132} \log \bar{R} + \underset{(2.85)}{.3511} \log N_R$				
	$+ \underset{(2.78)}{.3741} \log N_U + \underset{(.39)}{.1412} D$	.96	.08	1.72	.018

Continued......

Table 3 (Continued)

	Equation	R^2	S.E.	d	U
	<u>Cash crop demand</u>				
(9EB)	$\log \bar{Q}_c^D = \underset{(3.00)}{3.3883} + \underset{(2.64)}{.5492} \log \bar{Q}_m - \underset{(2.90)}{.1719} \log \frac{P_c}{P_S} + \underset{(1.06)}{.1666} \log Y_F + \underset{(1.16)}{1.1179} D + \underset{(1.58)}{.2180} \log \bar{Q}_{CL}^D$	.56	.14	2.02	.011
	<u>Urban labour demand</u>				
(10EB)	$\log \bar{L}_m = \underset{(3.26)}{-18.3147} - \underset{(.74)}{.7981} \log P_m^* - \underset{(1.12)}{.9459} D_m \log P_m^* - \underset{(2.28)}{.3189} \log W_m^* + \underset{(3.13)}{2.4763} \log \bar{K}_m - \underset{(1.35)}{.3120} \log TT + \underset{(1.64)}{.4422} D$	.81	.26	2.18	.061
	<u>Output of the manufactured good</u>				
(11EB)	$\log \bar{Q}_m = \underset{(.49)}{.9762} + \underset{(2.92)}{.8164} \log \bar{K}_m - \underset{(1.01)}{.4933} \log P_m^* - \underset{(.25)}{.2026} D_m \log P_m^* - \underset{(2.15)}{.0196} \log W_m^* + \underset{(1.15)}{.0940} \log TT - \underset{(5.55)}{1.7205} D$	.95	.09	1.92	.016
	<u>Urban labour supply</u>				
(12EB)	$\log \bar{L}_m^S = \underset{(3.55)}{2.9544} + \underset{(2.78)}{.0561} \log W_m^* - \underset{(.85)}{.0728} \log P_m^* + \underset{(2.87)}{.2335} \log N_U + \underset{(1.66)}{.0692} D$	.99	.04	1.26	.059

Continued......

Table 3 (Continued)

		R^2	S.E.	d	U
	Demand for the manufactured good				
(13EB)	$\log \bar{Q}_m^D = \underset{(1.61)}{7.6594} - \underset{(1.14)}{.3738} \log W_a^* + \underset{(2.89)}{.2828} \log W_m^* - \underset{(1.13)}{.0385} \log P_m^*$				
	$- \underset{(.31)}{.0895} \log \bar{K}_f + \underset{(.43)}{.0847} \log \bar{K}_c - \underset{(1.41)}{.4996} \log \bar{R} + \underset{(2.60)}{1.4566} \log N_R$				
	$+ \underset{(2.96)}{.2814} \log N_U - \underset{(.91)}{.2437} D$	.96	.06	1.83	.035

NOTES:

Absolute t values are in parentheses

R^2 = coefficient of multiple determination

d = Durbin-Watson statistic

U = Theil's inequality coefficient

S.E. = standard error of estimate

Definitions of all the variables are given in Appendix A.

Sources and nature of data are discussed in Appendix C.

Table 4

IMPACT MULTIPLIERS OF THE 'BASIC' MODEL

Exogenous Variables							
$\overline{K}_f$	$\overline{K}_c$	$\overline{R}$	N_R	N_U	$\overline{K}_m$	F	[Y]
.2055	-.0857	.3610	.0658	-.0063	-.1164	.0034	$\overline{L}_f$
-.8066	.9151	.3256	.0608	-.0058	-.1076	.0031	$\overline{L}_c$
.0442	-.0104	.7014	.0289	.0028	.0512	.0015	$\overline{R}_f$
-.3936	.7383	.3720	.4781	.0457	.8460	.0247	$\overline{R}_c$
.7734	-.4782	2.9903	.6667	-.0637	-.1797	.0687	$\overline{Q}_f$
.3319	.7107	.4896	.2183	-.0209	-.3863	.0113	$\overline{Q}_c$
.0445	.0045	.0728	1.0248	-.0031	-.0763	.0003	$\overline{L}_A^S$
.7734	-.4782	2.9903	.6667	-.0637	-.1797	.0687	$\overline{Q}_f^D$
.3319	.7107	.4896	.2183	-.0209	-.3863	.0113	$\overline{Q}_c^D$
.0580	.0424	.1231	.1691	.1846	-.1396	.0040	$\overline{L}_m$
.5014	.3669	1.0647	.4625	.3304	-.9487	.0345	$\overline{Q}_m$
.0580	.0424	.1231	.1691	.1846	-.1396	.0040	$\overline{L}_m^S$
.5014	.3668	1.0647	.4625	.3304	-.9487	.0345	$\overline{Q}_m^D$
.7129	.2985	.4426	-.9813	.1893	.5058	.1022	W_a^*
-.3891	2.3360	-4.1509	-1.8867	.7267	3.4850	-.1148	P_c^*
.0453	.0331	.0962	-.1321	-.1588	2.3567	.0031	W_m^*
-.4383	-.3206	-.9307	-1.2785	.0246	2.6021	-.0301	P_m^*

NOTE:

(1) Each element in the table represents the induced change in the row item given a unit change in the column item.

(2) All variables are in natural logarithms.

(3) [Y] denotes the vector of 17 endogenous variables.

(4) Definitions of all the variables are given in Appendix A.

Table 5

DYNAMIC MULTIPLIERS OF THE 'BASIC' MODEL

Exogenous Variables							
$\bar{K}_f$	$\bar{K}_c$	$\bar{R}$	N_R	N_U	$\bar{K}_m$	F	[Y]
.2059	-.0861	.3617	.0655	-.0064	-.1170	.0034	$\bar{L}_f$
-.8058	.9143	.3270	.0602	-.0062	-.1088	.0031	$\bar{L}_c$
.0880	-.0508	.7785	.0592	-.0100	.0532	.0026	$\bar{R}_f$
.6338	.7987	.5408	-.0319	.6043	-.9128	.1405	$\bar{R}_c$
.9056	-.3562	3.2229	.5752	-.1023	-.3742	.0751	$\bar{Q}_f$
.3340	.8334	.5141	.5730	.1182	-.2879	.0109	$\bar{Q}_c$
.0283	.0205	.0446	1.0116	.0019	-.0526	-.0005	$\bar{L}_A^S$
.9056	-.3562	3.2229	.5752	-.1023	-.3742	.0751	$\bar{Q}_f^D$
.3340	.8334	.5141	.5730	.1182	.2879	.0109	$\bar{Q}_c^D$
.0656	.0353	.1365	.1744	.1824	-.1508	.0044	$\bar{L}_m$
.5678	.3055	1.1816	.5085	.3498	-1.0465	.0377	$\bar{Q}_m$
.0656	.0353	.1365	.1744	.1824	-.1508	.0044	$\bar{L}_m^S$
.5678	.3055	1.1816	.5085	.3498	-1.0465	.0377	$\bar{Q}_m^D$
.9096	.3169	.7888	-.8451	.2468	.7952	.1117	W_a^*
-.4640	1.2590	-2.4006	-.9446	.3987	3.5073	-.0656	P_c^*
.0513	.0376	.1068	-.1362	-.1570	2.3655	.0034	W_m^*
-.4963	-.2671	-1.0327	-1.3186	.0415	2.6874	-.0329	P_m^*

NOTE:

(1) Each element in the table represents the induced change in the row item given a unit change in the column item.

(2) All variables are in natural logarithms.

(3) [Y] denotes the vector of 17 endogenous variables.

(4) Definitions of all the variables are given in Appendix A.

TABLE 6

HISTORICAL SIMULATION OF THE 'BASIC' MODEL : Percentage Deviations of the Simulated values from the actual values of the endogenous variable within the sample period.

Years	LF	LC	RF	RC	Years
1952	25.87	15.94	.23	-5.44	1952
1953	24.45	14.34	.13	-2.24	1953
1954	23.23	12.77	.17	-9.86	1954
1955	20.90	11.32	.38	-2.14	1955
1956	19.93	10.40	.15	-1.00	1956
1957	18.55	9.380	.25	-3.93	1957
1958	16.93	8.350	.44	-2.70	1958
1959	16.99	8.050	.09	-2.92	1959
1960	16.87	6.550	-.03	-2.66	1960
1961	15.17	5.030	.06	1.26	1961
1962	13.26	6.280	.21	1.83	1962
1963	11.89	4.910	.15	.67	1963
1964	10.04	4.060	-.05	2.50	1964
1965	9.65	2.890	-.11	.88	1965
1966	9.38	4.410	.15	2.65	1966
1967	8.85	3.400	-.02	1.17	1967
1968	7.42	2.790	.17	5.51	1968
1969	6.70	2.450	-.03	2.35	1969
1970	4.26	1.590	-.05	6.55	1970
1971	4.17	1.360	-.09	9.19	1971
1972	4.09	1.450	-.14	3.66	1972
1973	4.31	1.490	-.05	4.59	1973
1974	3.75	1.010	.28	5.63	1974
1975	2.58	.9200	.43	7.11	1975
Mean Absolute Percentage Deviation	12.47	5.88	.16	3.68	

Notes:

(a) The positive values of the percentage deviations denote that the simulated values are higher than the actual values and conversely.

(b) LF and LC denote amount of labour in the production of the food and cash crops respectively.

(c) RF and RC denote allocation of land in the production of the food and cash crops respectively.

TABLE 6 (continued)

Years	QF	QC	LAS	WA	Years
1952	22.54	-14.53	1.58	-2.074	1952
1953	20.35	-.90	1.01	-1.695	1953
1954	18.08	-5.99	.90	-.883	1954
1955	18.59	-11.21	.75	-.849	1955
1956	16.36	-7.36	.62	-1.046	1956
1957	16.01	-5.15	-.06	-.593	1957
1958	15.09	-4.80	-.16	-.107	1958
1959	13.61	-3.69	.38	-.152	1959
1960	13.10	-.79	.72	-.045	1960
1961	11.48	-9.71	1.82	.348	1961
1962	11.50	-5.45	.74	.591	1962
1963	9.21	-4.53	-.06	.830	1963
1964	8.83	-1.13	-1.51	.950	1964
1965	10.24	-6.13	-1.32	.885	1965
1966	9.65	-3.15	-.60	.924	1966
1967	9.42	-3.02	-.80	1.097	1967
1968	8.86	1.79	-1.38	1.185	1968
1969	9.00	-1.46	-1.55	1.208	1969
1970	5.73	-2.50	9.11	2.250	1970
1971	6.10	-6.83	.38	2.101	1971
1972	8.26	-11.60	.39	1.570	1972
1973	10.09	-8.94	.46	.705	1973
1974	11.95	-.32	-1.03	.755	1974
1975	8.51	-1.24	.29	1.629	1975
Mean Absolute Percentage Deviation	12.19	5.09	1.15	1.02	

Notes:

(a) QF and QC are the production level of the output of the food and cash crops respectively.

(b) LAS and WA are the aggregate labour supply and the wage rate in the rural sector respectively. The rural wage rate WA is expressed in index form relative to the food price index with 1959 as base year.

TABLE 6(continued)

Years	PC	LMD	WM	PM	QM	Years
1952	-3.185	9.54	-.420	-1.381	21.35	1952
1953	-1.835	9.10	-.142	-1.079	20.11	1953
1954	-1.634	8.56	.279	-.605	15.13	1954
1955	-2.177	8.16	-.126	-.795	13.45	1955
1956	-2.115	7.55	-.327	-.931	14.46	1956
1957	-.838	7.15	-.138	-.642	12.36	1957
1958	-.510	6.49	.055	-.403	10.30	1958
1959	-.646	6.41	.095	-.361	10.59	1959
1960	-.560	6.43	.186	-.317	12.05	1960
1961	-.870	5.85	.271	-.178	10.35	1961
1962	-.306	3.40	.381	.041	7.56	1962
1963	.255	2.34	.536	.241	5.92	1963
1964	.340	1.37	.418	.303	4.42	1964
1965	.313	.610	.369	.242	4.17	1965
1966	.175	.110	.232	.243	1.49	1966
1967	.677	-.590	.608	.499	1.18	1967
1968	1.299	-1.22	.569	.508	-.10	1968
1969	1.346	-1.76	.676	.589	2.34	1969
1970	1.430	-1.92	.792	.402	9.22	1970
1971	-.247	-1.92	.874	.347	13.21	1971
1972	-.782	-2.18	.542	.085	17.35	1972
1973	-1.392	-2.50	-.046	-.414	9.29	1973
1974	-.191	-2.83	.005	-.418	10.76	1974
1975	.372	-2.78	.693	.220	5.96	1975
Mean Absolute Percentage Deviations	.98	4.20	.36	.45	9.71	

Notes:

(a) PC and PM are the indice of the cash crop price and the manufactured good price respectively, relative to the food crop price, with base year 1959.

(b) LMD and QM are the total amount of labour and output in the manufacturing respectively.

(c) WM is the index of the rural wage rate relative to the food price index with 1959 as base year.

TABLE 7

PROJECTED VALUES OF SOME ENDOGENOUS VARIABLES UNDER THE 'STATUS QUO' SITUATION IN THE 'BASIC' MODEL

Years	LFO	LCO	LMO	QFO
1976.	21.9800	2.43000	3.56000	10193.5
1977.	22.9449	2.49245	3.60130	10487.2
1978.	23.0321	2.52769	3.64629	10514.7
1979.	23.1405	2.55976	3.70596	10789.0
1980.	23.6922	2.57313	3.75046	11117.4
1981.	24.3912	2.61201	3.81525	11445.8
1982.	24.7912	2.63169	3.85118	11575.3
1983.	24.9979	2.65210	3.91173	11830.3
1984.	25.1495	2.67616	3.94484	12231.1
1985.	25.4089	2.74007	4.00002	12600.3

Years	QCO	QMO	WAO	WMO
1976.	454.260	2440.60	.750000	.980000
1977.	455.588	2472.08	.751500	.982646
1978.	460.318	2519.92	.747525	1.02841
1979.	465.276	2538.99	.755475	1.05301
1980.	470.098	2652.44	.763275	1.06399
1981.	473.145	2715.17	.762600	1.09309
1982.	474.646	2759.34	.764100	1.12908
1983.	485.720	2813.04	.772125	1.15611
1984.	492.396	2845.74	.774000	1.17120
1985.	511.263	2913.96	.780000	1.20481

NOTES:

(a) LFO,LCO,LMO are the total amount of labour in million men in the food,cash and manufactured products respectively under the 'status quo' assumptions.

(b) QFO,QCO,QMO are the total amount of the output in million taka in 1959/60 prices of the food,cash and manufactured products respectively under the 'status quo' assumptions.

(c) WAO,WMO are the indices of the rural and urban wages relative to the food price with 1959/60 as the base year, under the 'status quo' assumptions.

TABLE 8 SIMULATION RESULTS IN THE 'BASIC' MODEL: PERCENTAGE CHANGES IN SOME ENDOGENOUS VARIABLES UNDER VARIOUS POLICIES

Years	PCLF1	PCLF2	PCLF3
1976.	4.50000	1.25000	3.00000
1977.	2.29907	.354020	1.08249
1978.	3.20115	1.34735	2.97181
1979.	4.25532	2.49810	3.90308
1980.	3.80369	1.39232	3.80369
1981.	2.80256	2.29792	2.80256
1982.	2.67754	1.46290	3.63507
1983.	4.42276	2.47076	4.49310
1984.	4.09019	3.53085	4.87677
1985.	6.12457	4.55017	6.12457

Years	PCLC1	PCLC2	PCLC3
1976.	8.59000	7.00000	8.10000
1977.	3.83153	2.56410	3.53905
1978.	3.36474	2.74947	2.66483
1979.	2.99931	1.67079	2.42073
1980.	.198319	.330975	.198319
1981.	1.01405	.474463	.707043
1982.	1.55125	.646353	1.15420
1983.	3.47260	1.01704	1.79586
1984.	2.66501	.405609	2.15200
1985.	1.54310	-.673999	.212841

Years	PCLM1	PCLM2	PCLM3
1976.	1.29000	.510000	1.13000
1977.	1.22601	.335413E-01	.553578
1978.	1.41491	.107338	.693060
1979.	.951009	.553218	.701249
1980.	2.05031	.545457	1.26246
1981.	.302463	.690492	.961690
1982.	1.42910	.350350	.349659
1983.	1.61175	.235522	.932890
1984.	1.52513	.215597	.929519
1985.	2.25169	.302599	1.50669

NOTES: (a) PCLF1, PCLC1, PCLM1 are the percentage changes from the original situation ('status quo') in labour in the food, cash and manufactured products respectively under policy I.

(b) Similarly PCLF2, PCLC2, PCLM2 denote the percentage changes in labour in the production of the food, cash and manufactured products respectively under policy II, and so on.

(c) The symbol E-01 after any value means that the decimal point should be taken one place to the left while reading the particular value.

TABLE 8 (continued)

Years	PCQF1	PCQF2	PCQF3
1976	4.64000	2.42000	3.31000
1977	3.97047	.476515	1.37120
1978	4.84966	1.64988	2.24054
1979	3.72436	.264675	1.24775
1980	2.10072	.939909	1.19255
1981	1.06923	.534616	1.15834
1982	1.24913	.375611	1.14430
1983	1.04310	.431034	1.04310
1984	2.09289	.733791	1.09230
1985	1.53784	.493727	1.06839

Years	PCQC1	PCQC2	PCQC3
1976	.670000	.640000	1.98000
1977	1.72724	1.05831	2.10663
1978	2.76630	1.39723	3.04349
1979	3.57806	2.43426	3.01105
1980	3.51234	1.56749	1.99323
1981	3.73025	.855219	1.99962
1982	3.92938	2.35745	3.93992
1983	3.37142	.552539	2.57507
1984	2.70670	-.129330	1.92148
1985	2.06456	-2.62456	-.918505

Years	PCQM1	PCQM2	PCQM3
1976	5.32000	.730000	3.13000
1977	4.54747	.957646	2.15224
1978	4.00397	.164649	1.09475
1979	3.89329	.920135	.838999
1980	3.38609	.156423	.478469
1981	3.27191	.674157	1.03674
1982	4.94428	.106133	.990624
1983	2.58545	.242929	1.84600
1984	3.59348	.634648	1.83961
1985	1.73913	.234114	1.03679

NOTE: PCQF1,PCQC1,PCQM1 are the percentage changes from the original situation. ('status quo') in the output of the food and cash crops and the manufactured product respectively under policy I, and so on.

TABLE 8 (continued)

Years	PCWA1	PCWA2	PCWA3
1976.	1.00000	.400000	.850000
1977.	2.79441	.798403	.798403
1978.	3.14036	1.43473	1.83606
1979.	2.25355	1.06225	1.25080
1980.	3.17382	.717304	1.20861
1981.	3.51101	1.23819	1.54406
1982.	4.04397	1.34472	2.09038
1983.	3.20544	.534240	1.50559
1984.	4.16667	1.35659	2.71318
1985.	4.61538	2.40395	3.36538

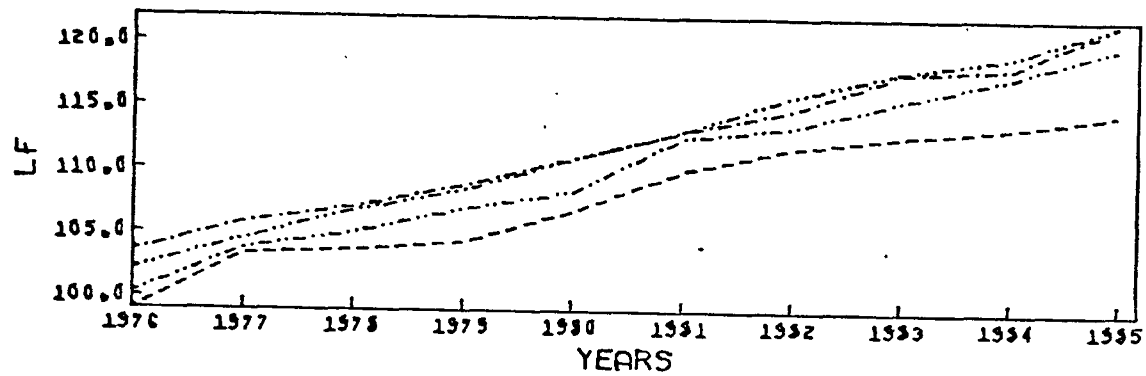
Years	PCWM1	PCWM2	PCWM3
1976.	1.00000	4.00000	.200000
1977.	2.12426	4.71726	.977361
1978.	.381170E-01	.533633	.571755E-01
1979.	.597999	.977199	.511866
1980.	.856590	1.31712	.396058
1981.	.347836	1.56183	.669344
1982.	2.16315	2.29346	1.42472
1983.	.254302E-01	.254302E-01	.010199
1984.	.535520	.823383	.410039
1985.	.599526	.852209	.292826

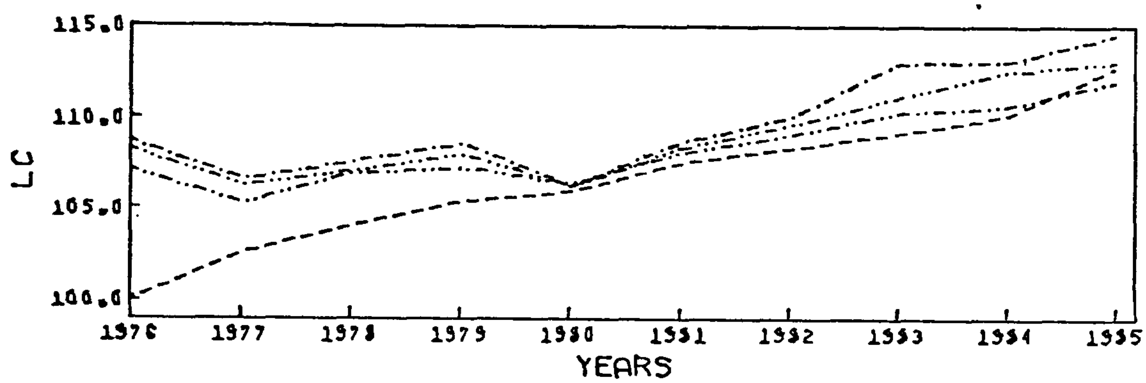
NOTE:

PCWA1,PCWM1 are the percentage changes from the 'status quo' situation of the rural and urban wages respectively under policy I, and so on.

FIGURE 5

GRAPHICAL REPRESENTATION OF VARIOUS ENDOGENOUS VARIABLES UNDER THE 'STATUS QUO' SITUATION AND 3 POLICY STRATEGIES





NOTE:
(a) LF and LC are labour in the food and cash crops respectively

(b) The vertical axis represents the indices of all the variables with the index base of the value for 1976 under the 'status quo' situation.

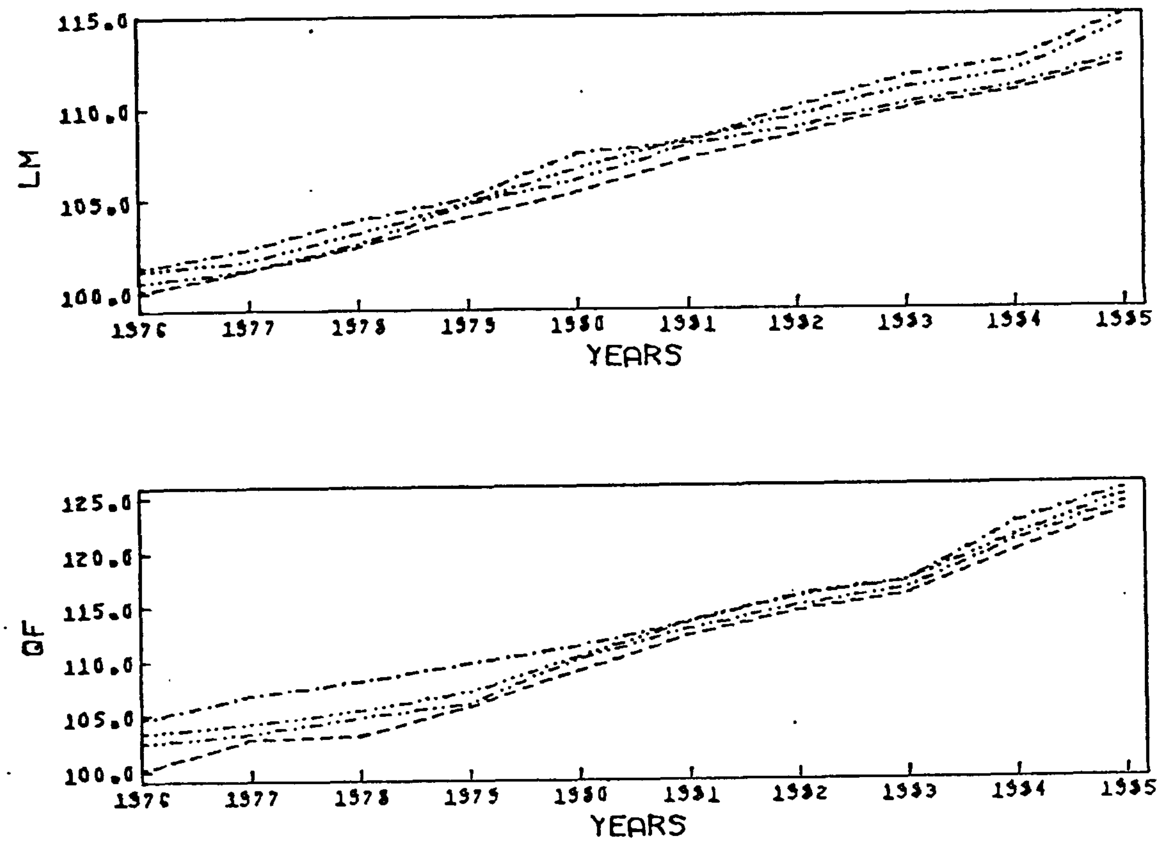
(c) ---- represents values under the 'status quo' situation

-.-.-. represents values under policy I

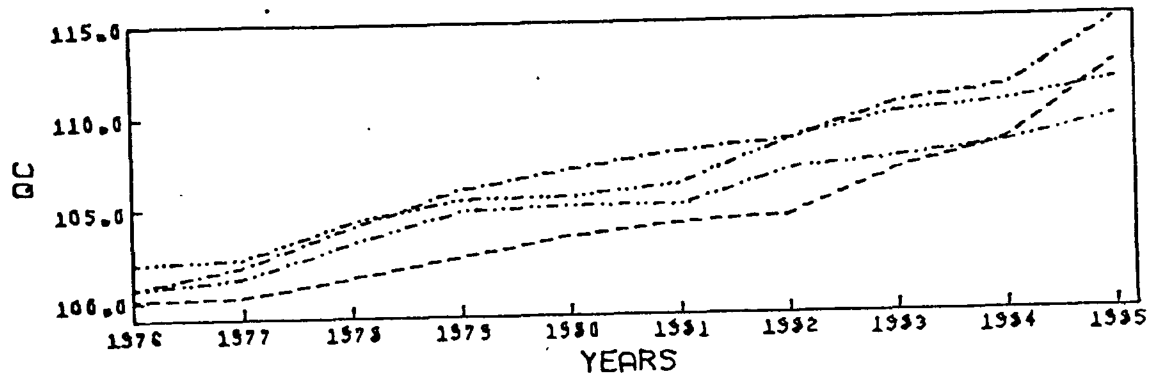
-..-..-.. represents values under policy II

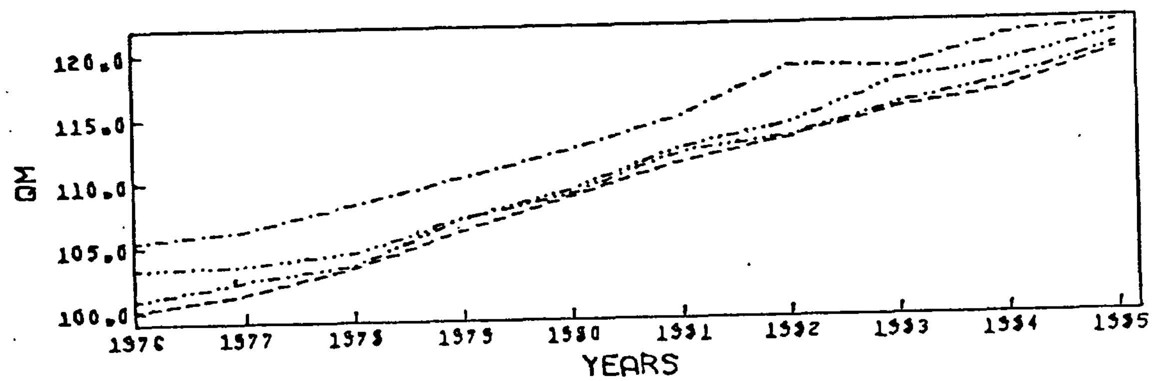
-...-...- represents values under policy III

FIGURE 5(continued)



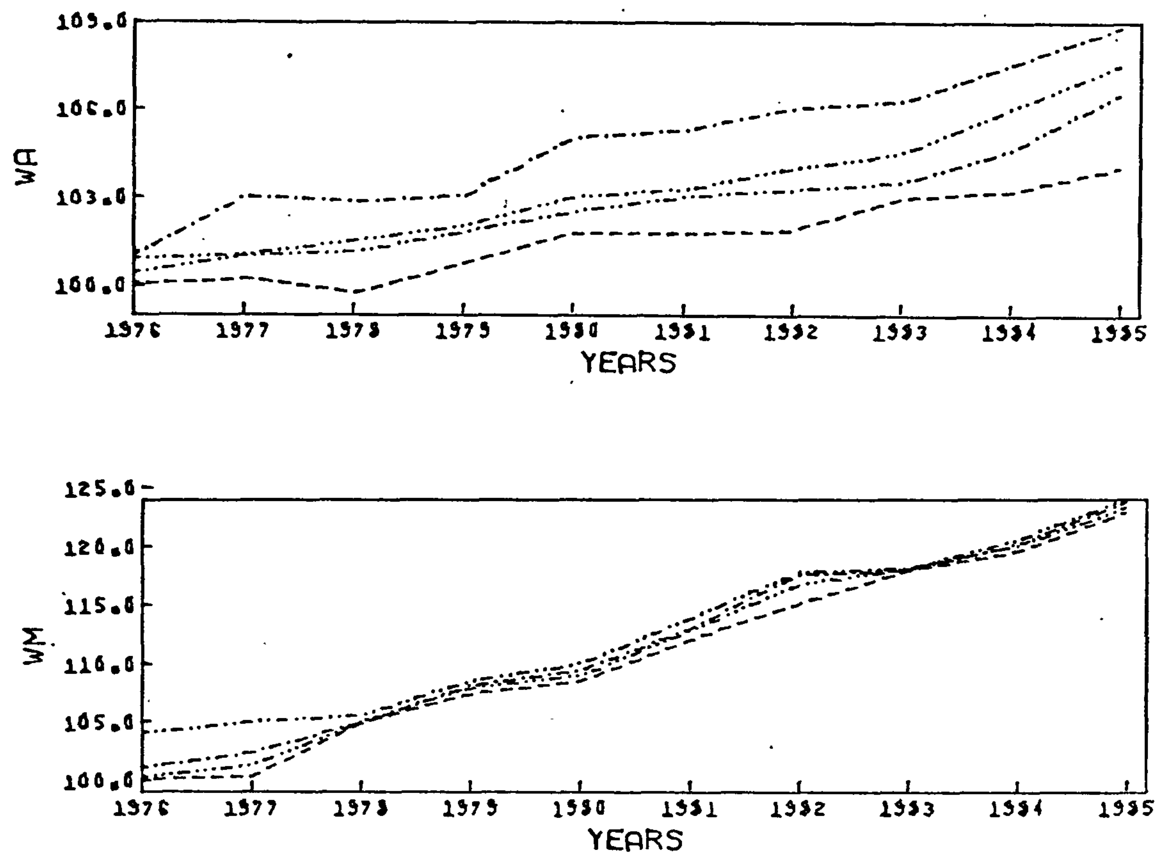
NOTE: LM and QF represent labour in the production of manufactured good and the output of the food crop





NOTE:
QC and QM are the output of the cash crop and the manufactured good respectively

FIGURE 5(continued)



NOTE:
WA and WM represent the rural and urban wages respectively

CHAPTER V

THE 'MODIFIED' MODEL WITH RURAL-URBAN MIGRATION

V.1. Introduction

The theoretical analysis of the present study has been given in Chapter III where the 'basic' model was developed. In that model, the interactions between the rural and urban sectors occur only through the output markets. To provide an additional link between the two sectors, the process of rural-urban migration of people is introduced to develop the 'modified' model in this chapter. In the modified model migration will be modelled and estimated as an endogenous variable. It has already been pointed out that in the basic model, exogenously given migration flows were included in the rural and urban population figures. Making migration an endogenous variable facilitates the examination of the effects on migration induced by various policies under consideration.

In the late sixties, economists tried to answer the perplexing question of increasing flows of people from the rural to urban areas in spite of growing urban unemployment in developing countries. Todaro (1969) formulated a model in which workers migrate from the rural to urban areas in response to differences in the actual earnings in the rural areas and expected earnings in the urban areas. A good survey of migration literature has been provided by Y.L. Yap (1977) with special reference to the empirical studies and policy implications of migration.

An important assumption of all theoretical and empirical studies on internal migration is that migration is a result of economically rational optimizing behaviour on the part of the individual or household decision making units. Formulation of appropriate strategies for economic development requires an understanding of migration to the urban area - in both its quantitative significance and its behavioural features. However, the policy prescriptions of the existing migration literature are somewhat narrow and tentative, due to data, design and methodological problems.

The high labour migration rate from the rural to urban sectors poses many problems for developing countries. It leads to increasing urban unemployment, creation of urban slum areas and other associated problems. Rapid urbanization in the low income countries is said to hamper economic development because of increasing demand for less productive projects (urban socio-economic services) on the scarce capital resources. The process of economic development in the less developed countries often does not consist of a rapid equilibrating mechanism; the persistence of sectoral inequalities in productivities and prices as mentioned earlier, is an important feature of the process of economic development of the low income countries. Wrage's (1977) empirical study of economic efficiency of migration in the context of the Canadian economy where fewer structural rigidities than those in Bangladesh are present, suggests that migration adjustment may be an ineffective mechanism for narrowing regional income and unemployment gaps in Canada.

In this study, a broad policy analysis is carried out analyzing the diverse aspects of the development process. Obaidullah (1967) in his study of internal migration in Bangladesh, does not explicitly analyze rural-urban migration or carry out policy analysis. Stoeckel and others (1972) in a study of migration from a rural area in Bangladesh, emphasized the need for proper policy in regulating the spatial distribution of population through migration, but the study itself does not carry out any policy analysis.

The process of migration is considered in a simultaneous equations general equilibrium model in this study and as such the direct policy variables are not restricted to wages and employment. A set of other exogenous variables, namely capital investment by the government in the rural and urban sectors, may be taken as policy variables and their effects examined. This approach gives a broader dimension to policy analysis for economic development. As Todaro [(1976), p. 77] indicated

> The linkage between migration policy and general development policy can be best revealed by knowledge of how diverse development policies directly or indirectly affect urban and rural real incomes and job opportunities and, therefore, influence the magnitude and spatial distribution of national and regional population.

V.2. The Migration Function

The first step in the specification of the migration function is to identify the important determinants of rural to urban migration. There have been three major approaches to the study of rural-urban (internal) migration:

(a) The "push-pull" theory of internal migration;

(b) The theory of human capital formation; and,

(c) The theory of consumer demand.

In the 'push-pull' theory, the 'push' factors such as poverty, population growth, a declining land-man ratio, and income inequality drive people out of the rural sector. The 'pull' factors, such as higher urban wage rate, employment opportunities and urban amenities (the generic name of which is the 'city lights'), attracts people to the urban areas.[1]

In the human capital theoretic approach, the economic aspects of migration decision are viewed in the framework of costs and returns to human capital formation as in the case of general investment theory. The Todaro (1969) formulation mentioned at the beginning of this chapter falls in this category.

In the third approach of the consumer theory of migration,[2] the worker's choice of a place of movement is affected by the amounts of work-related income. Specifically, the workers maximize benefits or income net of costs; the costs being the search cost of a job, income foregone during travelling.

The most important economic factor for rural-urban migration is the urban-rural income disparity. However, the wage differential is not the only determinant of migration, and not all determinants are economic. To formulate the 'aggregate' migration function, used in the present study, two important variables have been used; one is the urban-rural wage ratio $(\frac{W_m^*}{W_a^*})$ and the other is the land-man ratio $(\frac{\overline{R}}{N_R^*})$ in the rural sector.

Some empirical studies on migration in Bangladesh suggest that the population density, apart from the wage gap is an important variable which affects rural-urban migration (Chaudhury et al. (1975)). They also found tha

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[1] Haq (1974) in his study found that the 'push-pull' theory of internal migration is validated in Bangladesh. However, his study does not analyze rural-urban migration specifically, and various policy implications were not examined.

[2] Gallaway et al. (1967, 1968).

about 80% of the rural-to-urban migrants were landless. The finding of the study suggests that those who have some land are less likely to move out from the rural areas. This finding is not entirely unexpected when we consider the fact that the skill of farmers would be least acceptable or would be of the most limited applicability for work in the urban areas.

A survey[3] conducted in 1976 in Dacca city (the capital of Bangladesh) found that the rural agrarian landless people constituted the major portion of the migrated people within the last few years. These empirical studies suggest that the density of population affects rural-urban migration in Bangladesh.

Following Sen (1966), the density variable $(\frac{\bar{R}}{N_R^*})$ can be incorporated along with the labour-leisure choice and migration decision into our model of the 'representative' peasant household discussed in Appendix B. It may be argued that the density variable enters into the utility function of the rural household. The increase in the density of the rural sector affects the quality of life in the rural sector because, at present, most of the socio-economic services and modern amenities of life are concentrated in the urban areas.[4]

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3 Dacca University, Bureau of Economic Research (1976).

4 It has been estimated that until June 1973, of the total hospital beds in the country, 82% were in the urban areas. Of the total medical doctors, over 75% were working in the urban areas only. The rural areas were also in desparate need of pure drinking water and adequate schooling. Most of the rural areas are without any access to electricity. (For details, see Government of Bangladesh, The First Five Year Plan, 1973-1978). It may also be pointed out that the growth of per capita public expenditures in the rural areas is much lower than that in the urban areas of Bangladesh. A policy of greater emphasis on the provision of rural infrastructure may lay the foundation for improved rural productivity, to encourage the growth of intra-rural sectoral linkages and to reduce migration of the rural people to the urban areas.

It may be assumed that in the utility function of a person, leisure, the amount of food and the manufactured good consumed, and a parameter (reflecting the population density) enter as the arguments. Then, the ratio of the utility of an individual (if he remains in the rural area) to the utility (if he migrates to the urban area) is a function of the sectoral wage rates and the population densities.[5] Therefore, the inclusion of the density variable is also consistent with the theoretical analysis of the peasant household given in Appendix B.

Thus, the 'aggregate' migration function can be written as

$$\log NM = a_1 + a_2 \log \left(\frac{W_m^*}{W_a^*}\right)_L - a_3 \log \left(\frac{\overline{R}}{N_R^*}\right)_L + a_4 D \qquad (14TM)^6$$

where NM is the number of people migrating from the rural to urban areas,

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[5] It is assumed that the urban population density does not affect the migration decision of the rural people, while the rural population density, affects the migration decision. It has been found that a vast portion of the migrated people in the urban areas depend on the government help to get the services, such as electricity, drinking water, housing improvement, sewage facilities, schooling and so on. For details, see, Dacca University, Centre for Urban Studies (1974).

[6] (TM) denotes theoretical equations of the 'modified' model. The equations which are different from those of Chapter III, are also denoted by (TM).

$(\frac{\bar{R}}{N_R^*})_L$ is the land-man ratio in the rural sector, and $(\frac{W_m^*}{W_a^*})_L$ is the urban-rural wage rate ratio, both lagged one year.

Note that the rural population is now defined as $N_R^* = N_{RL}(1 + g) - NM$, because in the 'modified' model, population in the rural sector at a particular period consists of population of the previous period (N_{RL}), addition due to the natural growth (g) of population less the number of people migrating to the urban areas. It may be recalled that in the 'basic' model where the process of migration was not incorporated, rural population at a particular period (N_R) was defined implicitly as $N_R = N_{RL}(1 + g)$. The following sections will carry further discussion on this aspect.

The number of people migrating (NM) in a particular time period (period 1) is affected by the flow of people between a specified interval (between period 0 and 1). The method of derivation of (NM) is discussed later in footnote 8. Thus, for simplification, the wage rate ratio and the land-man ratio are taken with a one year lag.[7]

The coefficient of the ratio of the lagged urban wage $(\frac{W_m^*}{W_a^*})_L$ is expected to be positive. The coefficient of ratio of the lagged land to the rural population $(\frac{\bar{R}}{N_R^*})_L$ is expected to be negative, because higher amount of land ($\bar{R}$) will reduce the pressure on land, thus reduce rural to urban migration.

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[7] Annable, Jr. (1972) in a simultaneous equations approach uses a different formulation in the line of push-pull factors. The study, however, has only two equations; one is the migration function and the other is urban labour market tightness function.

The second step in formulating the migration function is to get the information on number of people migrating from the rural to the urban areas. In the absence of more direct information on the place of birth of the migrants, an indirect measure of net internal migration known as 'Vital Statistics Method (VS)' is used.[8]

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[8] United Nations, Dept. of Economics and Social Affairs (1970). Methods of Measuring Internal Migration. In the context of our model, we can see that growth in population in the two sectors can be attributed to natural growth rate g and redistribution through migration. Thus, we can write,

$$NM = NU_1 - NU_0 - gNU_0$$
$$= NU_1 - NU_0(1 + g) \qquad (1)$$

where NM = net migration to the urban area, NU_1 = number of urban people at the end of a specified interval, NU_0 = number of urban people at the start of a specified interval. Thus,

$$NU_1 = NM + NU_0(1 + g) \qquad (2)$$

The migration rate MG is defined as:

$$MG = \frac{NM}{N_R} \times 100 \qquad (3)$$

where N_R is the total rural population who are exposed to the likelihood of migration during the interval. Thus,

$$NR_1 = NR_0(1 + g) - NM$$
$$= NR_0(1 + g) - \frac{MG \times NR}{100} \qquad (4)$$

and $$NU_1 = \frac{MG \times NR}{100} + NU_0(1 + g) \qquad (5)$$

An empirical study by Chaudhury and Curlin (1975) done for a period of five years from 1968-69 to 1972-73 for 101 villages of Bangladesh provides useful information on internal migration in Bangladesh. The values of migration calculated for the present study seem consistent for the same period of time.

V.3. Modifications of Some Functional Relations

Since migration affects the number of people in the two sectors (N_R and N_U), these variables are to be redefined integrating the process of migration between the two sectors. These modifications are discussed below.

V.3.1. Labour supply functions

The labour supply functions for the urban and rural sectors have to be modified now.

In the labour supply functions in Chapter III, there was no adjustment mechanism in the sectoral populations. Due to the process of migration and the natural growth rate of population, there are redistributions of population between the rural and urban sectors. The modified rural and urban labour supply function can be written as:

$$\log \bar{L}_A^S = \text{constant} + b'_{71} \log \bar{K}_f + b'_{72} \log \bar{K}_c + b'_{73} \log \bar{R} + b'_{74} \log P_m^* + b'_{75} \log P_c^* + b'_{76} \log W_a^* + b'_{77} \log N_R^* + b'_{78} D \qquad (7TM)$$

$$\log \bar{L}_m^S = \text{constant} + g'_{31} \log W_m^* + g'_{32} \log P_m^* + g'_{33} \log N_U + g'_{34} D + g'_{35} \log NM \qquad (12TM)$$

The migration variable (NM) affects the two labour supply functions in different ways. In calculating the rural population (N_R^*) in the 'modified' model, we have already taken account of the migrated people (NM) and, as such, the variable (NM) does not appear in equation (7TM). The number of people in the urban sector in the 'modified' model consists of two different components; one is $N_U = N_{UL}(1 + g)$ which gives the number of people in the previous period, plus the natural increase in population (which is the same as that in the 'basic' model) and the other is NM, the people who are different from the existing urban people and who have migrated from the rural areas over the period.

When the variable NM is positive, it means that people moved from the rural to the urban areas and so it is deducted from $N_{RL}(1 + g)$ to get the variable N_R^*. On the other hand, when NM is negative, the migration is from the urban to the rural areas and as such it is added to $N_{RL}(1 + g)$ to get the variable N_R^*. In Bangladesh, for most of the years in our data period, NM was positive and so, it is expected that the coefficient of NM for equation (12TM) is positive, because migration may increase urban labour supply.

V.3.2. Demand functions of food and the manufactured good

The rural-urban populations (N_R and N_U) also appear as the explanatory variables for the demand functions for the food crop and the manufactured good and so following the discussion in the previous section, two functions are modified and written as:

$$\log \bar{Q}_f^D = \text{constant} + b'_{81} \log W_a^* + b'_{82} \log W_m^* + b'_{83} \log P_m^* + b'_{84} \log \bar{K}_f + b'_{85} \log \bar{K}_c + b'_{86} \log \bar{R} + b'_{87} \log N_R^* + b'_{88} \log N_U + b'_{89} D + b'_{80} \log NM \quad (8TM$$

$$\log \bar{Q}_m^D = \text{constant} + g_{41}' \log W_a^* + g_{42}' \log W_m^* + g_{43}' \log P_m^* + g_{44}' \log \bar{K}_f + g_{45}' \log \bar{K}_c$$
$$+ g_{46}' \log \bar{R} + g_{47}' \log N_R^* + g_{48}' \log N_U + g_{49}' D + g_{40}' \log NM \qquad (13TM)$$

V.4. Summary of the 'Modified' Model

The 'modified' model now consists of 14 equations (1T) - (6T), (9T) - (11T) given in Chapter III and euqations (14TM), (7TM), (12TM), (8TM) and (13TM) given in this chapter. Along with 5 market clearing conditions (in Chapter III), we have 19 relations in 18 unknowns;[9] one relation (market clearing condition (iii) in Chapter III) termed redundant as before,according to Walras Law.

The estimated 'modified' model and the policy analysis are presented in Chapter VI.

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9 The endogenous variables (17 in number) which are listed in Chapter III, along with the endogenous migration variable (NM) give us 18 endogenous variables for the 'modified' model.

CHAPTER VI

EMPIRICAL IMPLEMENTATION OF THE 'MODIFIED' MODEL

VI.1. Introduction

The consideration of the process of rural-urban migration as an adjustment mechanism has resulted in a number of modifications to the 'basic' model. The rural and urban labour supply functions are modified to take account of the migrated labour. The migration function is estimated along with the other equations of the model. An important feature of the 'modified' model is that both the rural and urban populations are no longer strictly exogenous because migration affects the number of people in each sector.

VI.2. Two-Stage Least-Squares Estimates of the 'Modified' Model

The 'modified' model is estimated for the Bangladesh economy using annual data for the period 1947-1975. There are 14 equations in the model each of which is denoted by (EM) for estimated 'modified' model equations. Equations (1EM) - (13EM) are estimated by the two-stage least-squares (2SLS) method. The residuals in equations (1EM), (2EM), (4EM), (5EM), (7EM) and (12EM), when estimated by 2SLS, were seriously autocorrelated. Thus, for these equations, the two-stage Cochrane-Orcutt iterative technique is used for estimation. The migration function (14EM) consists of lagged variables and so this equation is estimated separately by the ordinary least-squares (OLS) Cochrane-Orcutt iterative technique. The estimated structural 'modified' model is presented in Table 9.

The coefficients of the 'modified' model are not much different than those in the 'basic' model. However, as the rural and urban populations have been redefined, there are a few equations which should be examined in detail, in particular, the labour supply, output demand and migration equations.

(a) <u>Estimated agricultural labour supply function</u>

$$\log \bar{L}_A^S = \underset{(2.34)}{-1.8936} - \underset{(1.01)}{0.0691} \log \bar{K}_f + \underset{(0.79)}{0.0413} \log \bar{K}_c + \underset{(1.79)}{0.1566} \log \bar{R} - \underset{(2.28)}{0.1096} \log P_m^*$$

$$- \underset{(0.29)}{0.0016} \log P_c^* + \underset{(2.78)}{0.1095} \log W_a^* + \underset{(20.07)}{0.8763} \log N_R^* + \underset{(2.49)}{0.1586}\, D \qquad (7EM)$$

$R^2 = 0.99$ $\quad$ $d = 1.68$ $\quad$ S.E. = 0.03

Population in the rural sector (NR*) is defined as $NR^* = NR_L(1+g) - NM$, where NR_L is the rural population lagged one year, g is the growth rate of population and NM, the number of people migrating to the urban areas.

The rural wage rate (W_a^*) has a positive coefficient which is statistically significant. As in the case of the 'basic' model equation (7EB) in Chapter IV, this result suggests an upward sloping supply curve because with the increase in the wage rate, the supply of rural labour increases. The coefficients of the rural population (N_R^*) and the dummy variable (D) are statistically significant. It may be pointed out that the elasticity of the rural labour supply with respect to N_R^* (in the 'modified' model) is less than that with respect to N_R (in the 'basic' model). In the 'basic' model, the rural population consisted of a 'permanent' stock of labour supply and a portion of 'mobile' labour who could possibly migrate to the urban areas.[1] On the other hand, in the 'modified' model, N_R^* is net of migration which means that it consists of mainly the 'permanent' stock of labour. Thus, the 'permanent' stock of labour has a lower elasticity than that of the labour force which also includes the transitory (mobile) portion of the labour supply.

(b) Estimated food demand function

$$\log \bar{Q}_f^D = \underset{(1.80)}{10.9561} - \underset{(1.02)}{0.6540} \log W_a^* + \underset{(3.16)}{0.9156} \log W_m^* - \underset{(0.55)}{0.2442} \log P_m^* - \underset{(1.24)}{0.5335} \log \bar{K}_f$$

$$+ \underset{(0.48)}{0.1506} \log \bar{K}_c + \underset{(0.17)}{0.0977} \log \bar{R} + \underset{(2.89)}{0.0566} \log N_R^* + \underset{(5.67)}{0.4018} \log N_U$$

$$- \underset{(0.23)}{0.0176} \log NM + \underset{(0.02)}{0.0049} D \qquad (8EM)$$

$R^2 = 0.95$ $\qquad$ $d = 1.75$ $\qquad$ S.E. = 0.09

Population in the urban sector consists of two parts, one part determined by the natural growth of population given by $NU = NU_L(1 + g)$ where NU_L is the urban population lagged one year, and the other part determined by the number of migrants (NM) from the rural sector.

The urban wage rate (W_m^*), rural and urban populations (N_R^*, N_U) are the statistically significant variables. The coefficient of N_R^* here is less than that of N_R in the 'basic' model. On the other hand, N_U has a larger coefficient when compared with the 'basic' model. These

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1 The concept of 'permanent' stock of labour for the two sectors has also been used by F. Ahmed (1974).

with our 'a priori' expectation that the people migrating from the rural to urban areas will add to the urban stock of labour supply. The coefficient of the urban population (N_U) is positive and statistically significant which is consistent with our earlier results.

(d) Estimated demand function for the manufactured good

$$\log \bar{Q}_m^D = \underset{(1.83)}{7.7368} - \underset{(1.08)}{0.5728} \log W_a^* + \underset{(3.03)}{0.7363} \log W_m^* - \underset{(1.23)}{0.0881} \log P_m^* - \underset{(1.24)}{0.0454} \log \bar{K}_f$$

$$+ \underset{(0.21)}{0.0542} \log \bar{K}_c - \underset{(1.27)}{0.4971} \log \bar{R} + \underset{(2.89)}{1.0156} \log N_R^* + \underset{(3.40)}{0.4076} \log N_U$$

$$+ \underset{(0.54)}{0.0110} \log NM - \underset{(0.79)}{0.2809} D \qquad (13EM)$$

$R^2 = 0.93$ $d = 1.84$ $S.E. = 0.08$

The coefficients of the urban wage (W_m^*) and rural and urban populations (N_R^* and N_U) are statistically significant. The elasticity of demand with respect to the rural population (N_R^*) is lower than that of the 'basic' model, however, the elasticity of demand with respect to the urban population (N_U) is higher than that in the 'basic' model. The results are therefore similar to those for the demand function for the food crop (8EM).

Though the coefficient of migration (NM) is not statistically significant, nevertheless it reflects an interesting aspect of the economy of Bangladesh. The positive coefficient of (NM) shows some positive effect of urbanization on the demand for the manufactured good, an effect which is not uncommon in the developing countries.

(e) Estimated Migration function

$$\log NM = \underset{(0.56)}{0.0004} + \underset{(2.39)}{0.5588} \log \left(\frac{W_m^*}{W_a^*}\right)_L - \underset{(5.28)}{0.2186} \log \left(\frac{\bar{R}}{N_R^*}\right)_L + \underset{(1.92)}{1.3047}\, D \qquad (14EM)$$

$R^2 = 0.55$ $\qquad$ $d = 2.61$ $\qquad$ S.E. = 0.74

The variable NM is the total number of people migrating from the rural to the urban sector (net migration). The migration decision in the current period is influenced by the ratio of the lagged wage rates and the land-rural population ratio. For simplification, a one year interval between the initial period and the current period has been assumed.

The coefficients of both the relative wage rates and the land-man ratio are positive and negative, respectively, in accordance with the 'a priori' reasoning given in Chapter V. Both coefficients are statistically significant.

As was discussed in Chapter V, the continuous migration from the rural to the urban areas in Bangladesh has serious implications on the provision of urban social services. The urban areas of Bangladesh are already facing shortages in housing, employment, electricity, pure drinking water and sewage services. The various policy implications of the 'modified' model will now be discussed.

VI.3.1. Policy simulation with the 'modified' model

In Chapter IV, the effects of three different strategies on the employment, output and wage rates were presented. In this chapter, in addition to the effects on the above variables, the effects of the same policies on rural-urban migration are examined within the context of the 'modified' model.

The assumptions underlying the exogenous variables over the period 1976-1985 are the same as those for the 'basic' model forecasts discussed in Chapter IV. The basic forecasts (projections) without any policy simulation are somewhat similar to that in Chapter IV. The set of forecasts for the employment, output, wage rates and rural-urban migration is presented in Table 10.

The simulation results under different policy strategies are presented in Table 11, where the percentage change (positive or negative) of the simulated values under different strategies from the projected values under the 'status quo' situation are presented. The percentage changes for the output, employment for strategies I and III (emphasizing agricultural development) are in general higher than those for strategy II (emphasizing industrial development). However, for these variables, strategy I generally gives higher percentage changes. As for the wage rates, the gaps between the two wage rates under strategies I and III are smaller than those under strategy II. For this reason, the percentage changes in rural-urban migration under strategies I and III are lower (higher negative values) which means that rural-to-urban migration is reduced more under these strategies than with strategy II.

It is evident from the 'modified' model that the gap between the wage rates in the two sectors persists over time even with the adjustment mechanism of rural-urban migration. The ratio of the urban to the rural wages in Bangladesh is found to be greater than unity, a phenomenon which, among other things, induces further migration to the urban areas. Thus, the process of migration is indeed only a partial adjustment mechanism and can be viewed as a disequilibrium adjustment process.

The results of the simulation exercises in this chapter suggest that strategies emphasizing the rural development (strategies I and III) have, in general, larger effect on the employment and output in both of the sectors. At the same time, the overall rural development programme by creating more employment opportunities in the rural sector and by narrowing the gap between the rural and urban wages, reduces the outflux of people from the rural sector. This is shown in Figure 6 where it can be seen that over the whole simulated period, the effect of overall rural development through strategies I and III is to reduce migration, whereas strategy II emphasizing industrial development, is not as effective in reducing migration to the urban areas. Again, the simulation results tend to favour an emphasis on rural development in Bangladesh.

VI.3.2. The 'basic' and 'modified' models compared

In the 'basic' model, in the 'status quo' situation, the sectoral productivity differentials persist over the period from 1976-1985. For example, from Table 7 it is observed that the growth in the output of food, the cash crop and the manufactured good between 1976 and 1977 have been 2.83%, 0.16% and 1.33%, respectively. Between the years 1984 and 1985, the growth rates have been 3.02%, 3.83% and 2.57%, respectively. Strategies favouring agriculture have an overall higher impact on the relevant variables than that under strategy favouring industry, which can be seen from the simulation results of Table 8. For example, in 1984, output of food increases from that under the 'status quo' situation, under strategies I, II and III, by 2.09%, 0.78% and 1.09%, respectively. The impact on other variables is similarly higher under strategies I and III, than that under strategy II, as can be seen from Table 8. These results are due to the combined effects of more rapid increases in capital intensity in agriculture and due to the differential rates of technical progress throughout.

The results relating to relative sectoral productivity differentials are also generated by the 'modified' model as can be seen from Table 10. The policy simulation exercises with the 'modified' model validates the emphasis placed by the development economists on agriculture as a potential labour absorbing sector.

Much has been said of the wage differential between agriculture and industry. The 'basic' model is quite capable of capturing the differentials in the wage rates that persist in a growing economy. The 'modified' model in which the rural and urban populations are 'mobile' through the process of migration, reproduces differentials in the wage rates in the rural and urban sectors that remain throughout the period covered in this study.

In the past, there were several reasons for the more rapid increase in the urban wage rate in Bangladesh. Rapid capital accumulation was taken as the key to economic development during the Pakistani period. The government policies of overvalued exchange rates, accelerated capital depreciation allowances and tax holidays led to the adoption of capital-intensive techniques in the manufacturing sector. Because of the increase in the marginal productivity of labour in the manufacturing sector, the urban wage rate has increased. On the other hand, due to the lower priority given to the agricultural development, rural incomes and wages did not increase appreciably, resulting in an increasing gap between the rural and urban wages. It may be argued that the urban wage is often above the competitive level due to the pressure from the labour unions and due to various government policies.

In the 'basic' and 'modified' models, the absolute and relative wage gaps both increase in the 'status quo' situations. The urban wage (W_m^*) was 30% higher than the agricultural wage (W_a^*) in 1976, in the 'status quo' situation in the 'basic' model; by 1985, this difference increased to about 52%. This kind of increasing wage gap is also reproduced by the 'modified' model in the 'status quo' situation given in Table 10. For example, in 1976, the urban wage (W_m^*) was 12.3% higher than the rural wage (W_a^*), and in 1985, this difference increased to about 33.3%. These results are in contrast to Jorgenson's (1961) framework where he assumes that the absolute differential is constant over time so that the wages grow at the same rate in each sector implicitly assuming that the rate of migration is sufficiently responsive, to prevent a widening of the wage gap in a developing economy.

We have already noted some of the causes of such continuing gap in the wages. It has already been pointed out that migration may not be an effective mechanism in closing the gap. The wage gap is sensitive to parameters and variables exogenous to the labour market itself; for example, changes in investment, cultivable land in the rural sector, and changes in the rate of technical progress all play important roles in influencing the magnitude of the wage gap.

In the 'basic' model, different strategies reduce the wage gap by different amounts. For example, if strategies I and III are taken, then in 1985, the urban wage is about 46% higher than the rural wage, that means the gap is reduced by 6% from the level of 52% in the 'status quo' situation. Strategy II reduces the wage gap by only 1% in 1985, that means the urban wage rate is 51% higher than the rural wage.

In the 'modified' model, if strategies I and III are taken, then in 1976, the urban wage rate is about 11.8% and 10.6% higher, respectively, than the rural wage rate, which means that the gap is reduced by 0.5% and 1.7%, respectively. On the other hand, under strategy II, the gap increases from 12.3% to 20%, that is the urban wage is about 7.7% higher compared to the 'status quo' situation. In 1985, in the 'modified' model, the urban-rural wage gap is reduced to 29% and 31%, under strategies I and III, respectively. Under strategy II, this gap is reduced to 31.2% in 1985.

The policy simulation in this study was done only for 10 years which was not long enough to close the gap between the sectoral wages totally, however, an aggressive rural development programme for a long period of time, may reduce the wage gap to a great extent and significantly lower the rate of the rural-to-urban migration.

The policy simulation results in this study suggest that the rural development efforts may reduce the wage gap between the two sectors and may make the rural sector more attractive, reducing migration of people from the rural to the urban areas (as represented by Figure 6). Thus, rural development policy may reduce the problem of urban unemployment resulting, to a great extent, from large-scale migration of people from the rural areas. In a recent article, Blomqvist (1978) has argued that instead of adopting the policy of urban job creation (by wage subsidy to the manufacturing sector), higher investment in the rural sector may result in the reduction of rural-to-urban migration and thus reduce urban unemployment. The results of this study confirm the validity of Blomqvist's argument in the context of the economy of Bangladesh.

Table 9

ESTIMATED STRUCTURAL EQUATIONS OF THE 'MODIFIED' MODEL

	Equation	R^2	S.E.	d	U
	<u>Labour demand in the food crop production</u>				
(1EM)	$\log \bar{L}_f = \underset{(.57)}{1.2915} + \underset{(.27)}{.0053} \log P^*_{CL} - \underset{(1.01)}{.0528} \log W^*_a + \underset{(2.05)}{.0307} \log \bar{K}_f - \underset{(1.90)}{.1177} \log \bar{K}_c + \underset{(2.09)}{.2091} \log \bar{R} + \underset{(.75)}{.0585} D + \underset{(7.75)}{.0699} \log F$	.98	.03	1.68	.026
	<u>Labour demand in the cash crop production</u>				
(2EM)	$\log \bar{L}_c = \underset{(1.95)}{2.8967} + \underset{(.47)}{.0038} \log P^*_{CL} - \underset{(.74)}{.0196} \log W^*_a - \underset{(12.50)}{.9139} \log \bar{K}_f + \underset{(15.60)}{.8838} \log \bar{K}_c + \underset{(2.85)}{.0328} \log \bar{R} + \underset{(.09)}{.0039} D$	.99	.01	1.81	.011
	<u>Land allocation in the food crop production</u>				
(3EM)	$\log \bar{R}_f = \underset{(.81)}{.4657} - \underset{(4.20)}{.0335} \log P^*_{CL} - \underset{(1.91)}{.0111} \log W^*_a + \underset{(2.31)}{.0613} \log \bar{K}_f + \underset{(1.06)}{.0481} \log \bar{K}_c + \underset{(17.16)}{.8550} \log \bar{R} + \underset{(7.90)}{.0129} \log F + \underset{(5.68)}{.1382} D$	.99	.01	2.08	.017
	<u>Land allocation in the cash crop production</u>				
(4EM)	$\log \bar{R}_c = \underset{(1.02)}{-13.1341} + \underset{(4.01)}{.4959} \log P^*_{CL} - \underset{(1.00)}{.3059} \log W^*_a - \underset{(1.31)}{.5043} \log \bar{K}_f + \underset{(2.20)}{.9673} \log \bar{K}_c + \underset{(2.46)}{1.4836} \log \bar{R} + \underset{(.09)}{.4291} D$	.67	.17	1.64	.014

Continued......

Table 9 (Continued)

		R^2	S.E.	d	U
	<u>Output of the food crop</u>				
(5EM)	$\log \bar{Q}_f = \underset{(1.58)}{-6.8813} + \underset{(3.05)}{.1891} \log \bar{K}_f + \underset{(1.05)}{.2767} \log \bar{K}_c - \underset{(2.03)}{.1928} \log W_a^*$				
	$- \underset{(1.80)}{.0575} \log P_{CL}^* + \underset{(3.62)}{1.3553} \log \bar{R} + \underset{(.26)}{.0456} D + \underset{(2.73)}{.0391} \log F$	.89	.07	1.95	.040
	<u>Output of the cash crop</u>				
(6EM)	$\log \bar{Q}_c = \underset{(.77)}{-4.8211} - \underset{(1.59)}{.6888} \log \bar{K}_f + \underset{(2.31)}{.9384} \log \bar{K}_c - \underset{(1.79)}{.3302} \log W_a^*$				
	$+ \underset{(3.37)}{.4108} \log P_{CL}^* + \underset{(2.52)}{.7586} \log \bar{R} - \underset{(.59)}{.2040} D$	.47	.16	2.06	.045
	<u>Rural labour supply</u>				
(7EM)	$\log \bar{L}_A^S = \underset{(2.34)}{-1.8936} - \underset{(1.01)}{.0691} \log \bar{K}_f + \underset{(.79)}{.0413} \log \bar{K}_c + \underset{(1.79)}{.1566} \log \bar{R}$				
	$- \underset{(2.28)}{.1096} \log P_m^* - \underset{(.29)}{.0016} \log P_c^* + \underset{(2.78)}{.1095} \log W_a^* + \underset{(20.07)}{.8763} \log N_R^*$				
	$+ \underset{(2.49)}{.1586} D$	.99	.02	1.40	.012
	<u>Food demand</u>				
(8EM)	$\log \bar{Q}_f^D = \underset{(1.80)}{10.9561} - \underset{(1.02)}{.6540} \log W_a^* + \underset{(3.16)}{.9156} \log W_m^* - \underset{(.55)}{.2442} \log P_m^*$				
	$- \underset{(1.24)}{.5335} \log \bar{K}_f + \underset{(.48)}{.1506} \log \bar{K}_c + \underset{(.17)}{.0977} \log \bar{R} + \underset{(2.89)}{.0566} \log N_R^*$				
	$+ \underset{(5.67)}{.4018} \log N_U - \underset{(.23)}{.0176} \log NM + \underset{(.02)}{.0049} D$	.95	.09	1.75	.015

Continued......

Table 9 (Continued)

		R^2	S.E.	d	U
	<u>Cash crop demand</u>				
(9EM)	$\log \bar{Q}_c^D = \underset{(3.26)}{3.6333} + \underset{(2.62)}{.5196} \log \bar{Q}_m - \underset{(2.50)}{.1403} \log \frac{P_c}{P_S} + \underset{(1.16)}{.0766} \log Y_F + \underset{(1.78)}{1.0411} D + \underset{(1.50)}{.1888} \log \bar{Q}_{CL}^D$	.52	.16	2.20	.012
	<u>Urban labour demand</u>				
(10EM)	$\log \bar{L}_m = \underset{(3.28)}{-18.2019} - \underset{(.90)}{.8217} \log P_m^* - \underset{(1.90)}{.9037} D_m \log P_m^* + \underset{(.35)}{.3266} \log W_m^* + \underset{(3.15)}{2.4604} \log \bar{K}_m - \underset{(1.34)}{.3077} \log TT + \underset{(1.87)}{.4458} D$	.82	.26	2.19	.060
	<u>Output of the manufactured good</u>				
(11EM)	$\log \bar{Q}_m = \underset{(.55)}{1.2302} + \underset{(2.51)}{.7847} \log \bar{K}_m - \underset{(.79)}{.2065} \log P_m^* - \underset{(.31)}{.1825} D_m \log P_m^* - \underset{(.73)}{.0714} \log W_m^* + \underset{(1.09)}{.0950} \log TT - \underset{(6.09)}{1.7800} D$	.93	.10	2.19	.018
	<u>Urban labour supply</u>				
(12EM)	$\log \bar{L}_m^S = \underset{(4.54)}{2.2141} + \underset{(2.21)}{.1009} \log W_m^* - \underset{(1.26)}{.1268} \log P_m^* + \underset{(2.96)}{.1860} \log N_U + \underset{(2.85)}{.1510} \log NM + \underset{(.32)}{.0200} D$	.99	.05	1.44	.065

Continued......

Table 9 (Continued)

Demand for the manufactured good

(13EM)

$$\log \bar{Q}_m^D = \underset{(1.83)}{7.7368} - \underset{(1.08)}{.5728}\log W_a^* + \underset{(3.03)}{.7363}\log W_m^* - \underset{(1.23)}{.0881}\log P_m^*$$

$$- \underset{(1.24)}{.0454}\log \bar{K}_f + \underset{(.21)}{.0542}\log \bar{K}_c - \underset{(1.27)}{.4971}\log \bar{R} + \underset{(2.89)}{1.1056}\log N_R^*$$

$$+ \underset{(3.40)}{.4076}\log N_U + \underset{(.54)}{.0110}\log NM - \underset{(.79)}{.2809}\,D$$

R^2	S.E.	d	U
.93	.08	1.84	.042

Rural-urban migration function

(14EM)

$$\log NM = \underset{(.56)}{.0004} + \underset{(2.39)}{.5588}\log \left(\frac{W_m^*}{W_a^*}\right)_L - \underset{(5.28)}{.2186}\log \left(\frac{\bar{R}}{N_R^*}\right)_L + \underset{(1.92)}{1.3047}\,D$$

R^2	S.E.	d	U
.55	.74	2.61	.250

NOTES: $NR^* = NR_L(1 + g) - NM$

Absolute t values are in parentheses

R^2 = coefficient of multiple determination

d = Durbin-Watson Statistic

U = Theil's inequality coefficient

S.E. = standard error of the estimate

Definitions of all the variables are given in Appendix A.

Sources and nature of data are discussed in Appendix C.

TABLE 10

PROJECTED VALUES OF SOME ENDOGENOUS VARIABLES UNDER THE 'STATUS QUO' SITUATION IN THE 'MODIFIED' MODEL

Years	LFO	LCO	LMO	QFO	QCO
1976.	21.3300	2.38300	3.48030	10404.5	459.340
1977.	22.2351	2.44117	3.52337	10698.9	450.075
1978.	22.2905	2.47558	3.56530	10727.6	454.352
1979.	22.4246	2.50709	3.62268	11016.9	459.659
1980.	22.9593	2.52216	3.66618	11341.9	474.726
1981.	23.6366	2.55325	3.72952	11676.9	477.835
1982.	24.0243	2.57754	3.77441	11911.[illegible]	479.321
1983.	24.2245	2.59753	3.82392	12069.2	480.493
1984.	24.3715	2.62109	3.85619	12478.1	497.236
1985.	24.6228	2.63369	3.91313	12354.7	516.298

Years	QMO	WAO	WMO	NMO
1976.	2464.10	.312000	.310030	.723000
1977.	2495.39	.311626	.312457	.73[illegible]
1978.	2544.16	.807327	.354954	.749952
1979.	2613.92	.815913	.377795	.759060
1980.	2577.98	.824377	.397947	.766068
1981.	2741.31	.823628	1.01966	.779076
1982.	2735.91	.825226	1.04750	.799934
1983.	2840.12	.833295	1.07353	.810030
1984.	2373.14	.835926	1.08754	.83[illegible]016
1985.	2947.06	.842430	1.11875	.840024

NOTES:

(a) LFO,LCO,LMO are the total amount of labour in million men in the food,cash and manufactured products respectively under the 'status quo' assumptions.

(b) QFO,QCO,QMO are the total amount of the putput in million taka in 1959/60 prices of the food,cash and manufactured products respectively under the 'status quo' assumptions.

(c) WAO,WMO are the indices of the rural and urban wages relative to the food price with 1959/60 as the base year, under the 'status quo' assumptions.

TABLE 11

SIMULATION RESULTS IN THE 'MODIFIED' MODEL : Percentage changes in some Endogenous Variables under various Policies

Years	PCLF1	PCLF2	PCLF3
1976.	4.64718	1.39261	3.22518
1977.	2.44315	.505377	1.22435
1978.	3.34650	1.49009	3.11684
1979.	4.40216	2.64246	4.05022
1980.	3.94999	1.52511	3.94589
1981.	2.94735	2.44200	2.34745
1982.	2.32216	1.60580	3.78104
1983.	4.56983	2.61509	4.64027
1984.	4.23680	3.57567	5.02446
1985.	6.27404	4.59743	5.27404

Years	PCLC1	PCLC2	PCLC3
1976.	9.04626	7.44959	9.55420
1977.	4.26750	2.99504	3.97408
1978.	3.79924	3.13119	3.29704
1979.	3.43258	2.09797	2.85107
1980.	.519320	.761572	.619320
1981.	1.43849	.896524	1.13016
1982.	1.97793	1.06924	1.57922
1983.	3.90735	1.44143	2.22357
1984.	3.03713	.630493	2.58121
1985.	1.96975	-.256562	.632934

Years	PCLM1	PCLM2	PCLM3
1976.	1.53106	.799822	1.42060
1977.	1.49693	.327011	.842525
1978.	1.72633	.395033	.972379
1979.	1.24110	.942451	.993620
1980.	2.34356	.934679	1.55344
1981.	1.09213	.979632	1.25121
1982.	1.72156	.639723	1.23974
1983.	1.99371	.524653	1.27307
1984.	1.31697	.534565	1.21955
1985.	2.54552	.530825	2.09924

NOTES: (a) PCLF1, PCLC1, PCLM1 are the percentage changes from the original situation ('status quo') in labour in the food, cash and manufactured products respectively under policy I.

(b) Similarly PCLF2, PCLC2, PCLM2 denote the percentage changes in labour in the production of the food, cash and manufactured products respectively under policy II, and so on.

(c) The symbol E-01 after any value means that the decimal point should be taken one place to the left while reading the particular value.

TABLE 11 (continued)

Years	PCQF1	PCQF2	PCQF3
1976.	4.64101	2.42098	3.31099
1977.	3.87146	.477480	1.37217
1978.	4.85067	1.64985	2.24153
1979.	3.72536	.265639	1.24873
1980.	2.10171	1.00038	1.19352
1981.	1.07020	.535583	1.15931
1982.	1.29010	.376576	1.14528
1983.	1.04407	.432000	1.04407
1984.	2.09397	.794759	1.09328
1985.	1.53281	.494693	1.06536

	PCQC1	PCQC2	PCQC3
1976.	.691916	.661910	2.00220
1977.	1.74938	1.03031	2.12836
1978.	2.78917	1.01942	3.06591
1979.	3.60061	2.45656	3.03347
1980.	3.53437	1.53960	2.01543
1981.	3.75263	.687177	2.02132
1982.	3.95171	2.37973	3.03254
1983.	3.39392	.574429	2.69747
1984.	2.72906	-.107533	1.94367
1985.	2.08628	-2.60336	-.796913

	PCQM1	PCQM2	PCQM3
1976.	5.36274	.820999	3.17195
1977.	4.39602	.393518	2.19369
1978.	4.84641	.205298	1.12577
1979.	3.93545	.651051	.879913
1980.	3.42834	.197069	.519245
1981.	3.31392	.715014	1.04773
1982.	4.93687	.146764	1.03161
1983.	2.62709	.233610	1.39933
1984.	3.63552	.675439	1.35392
1985.	1.78042	.274791	1.07779

NOTE: PCQF1,PCQC1,PCQM1 are the percentage changes from the original situation ('status quo') in the output of the food and cash crops and the manufactured product respectively under policy I, and so on.

TABLE 11(continued)

Years	PCWA1	PCWA2	PCWA3
1976.	2.09506	-.245914	2.47938
1977.	2.04283	1.52534	3.09272
1978.	3.09329	1.36703	3.83649
1979.	2.51093	.991160	3.25243
1980.	2.45310	1.90007	2.49934
1981.	2.79769	2.23310	2.79162
1982.	3.34114	2.75949	2.54128
1983.	2.75374	1.33130	2.51890
1984.	3.98124	2.93066	3.05429
1985.	4.64150	3.32394	2.71546

Years	PCWM1	PCWM2	PCWM3
1976.	2.10929	5.14256	1.30110
1977.	3.24651	5.36900	2.08700
1978.	1.13744	1.63840	1.15670
1979.	1.80457	2.09684	1.61639
1980.	1.96490	2.43050	1.49931
1981.	1.95605	2.67787	1.77560
1982.	3.26522	3.41756	2.53928
1983.	1.12461	1.12461	1.21031
1984.	1.64031	1.93639	1.51341
1985.	1.80612	1.97059	1.39494

Years	PCNM1	PCNM2	PCNM3
1976.	-2.78900	-2.20000	-2.00000
1977.	-2.75175	-2.59519	-2.65038
1978.	-2.65937	-2.07373	-2.18894
1979.	-2.62435	-2.55803	-2.72014
1980.	-2.89947	-2.65569	-2.68947
1981.	-3.49011	-2.39163	-2.93163
1982.	-2.73423	-2.29575	-2.52461
1983.	-3.72667	-2.41778	-2.13333
1984.	-3.61728	-2.75250	-3.71270
1985.	-3.57418	-2.47707	-2.93134

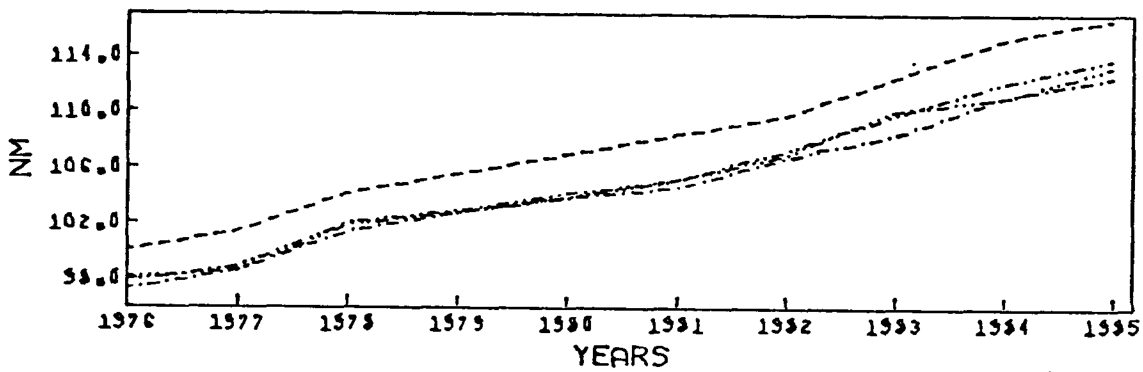
NOTE:

(a) PCWA1,PCWM1 are the percentage changes from the 'status quo' situation of the rural and urban wages respectively under policy I, and so on.

(b) PCNM1 and PCNM2 are the percentage changes in the number of people migrating (from the 'status quo' situation) from the rural areas to the urban areas under policies I and II respectively, and so on.

FIGURE 6

GRAPHICAL REPRESENTATION OF RURAL-URBAN MIGRATION UNDER THE 'STATUS QUO' SITUATION AND 3 POLICY STRATEGIES



NOTE: (a) NM on the vertical axis represents the index of the number of people migrating from the rural to the urban areas with index base of the number of people migrating in 1976 under the 'status quo' situation.

(b) ----- represents situation under the 'status quo' situation

-.-.-. represent situation under policy I

-..-..-.. represent situation under policy II

-...-...-... represent situation under policy III

CHAPTER VII

SUMMARY AND CONCLUSIONS

In this study, a phenomenon common to most of the developing countries; the existence of an urban-'modern' sector, along with a poorly integrated rural-'traditional' sector has been examined within a multi-equation quantitative framework incorporating the interactions between the 'modern' and 'traditional' sectors through the output and labour markets. The purpose of such study was to examine policy alternatives in order to assess the means by which the real income, output and employment of Bangladesh could be increased.

Another common feature attributed to the existence of 'modern' and 'traditional' sectors is the large flows of people from the rural sector to the urban sector whose capacity to absorb the new influx of people is severely limited. Therefore, the impact of various policies on the rural and urban sectors was examined in order to formulate broad policy strategies to reduce the rate of migration of prople from the rural sector.

Theoretical analysis was necessary to obtain insights into the complex interactions among the different variables and to help in the specification of the different equations. Quantification of the model was necessary to catch not only the directions of changes in the variables but also the magnitude of such changes. This quantitative exercise is useful for policy makers who are confronted with the allocation of scarce resources among alternative uses.

The present study has accomplished two main purposes. First, an econometric model relating the rural and urban sectors of the economy of Bangladesh was formulated. This type of simultaneous equation model was constructed for the first time for the Bangladesh economy. Then, econometric estimation (the Two-Stage Least-Squares Method) was applied to estimate the parameters of the model. The estimation of the model necessitated the collection and organization of the data for different variables for a considerably long period (29 years). No other study on Bangladesh has used the data for such a long period. Second, the model was used for policy analysis; both multiplier as well as policy simulation approaches were undertaken.

The simulation approach is an important method by which various government policies can be evaluated. Usually, policy simulation is carried out with a pure 'mathematical' (mechanical) model with the help of the computer simulation programmes, or, sometimes an 'economic' model is used, parameters of which are either assumed or derived from other independent studies. In this study, policy simulation was undertaken within the framework of an econometric model and the parameters were estimated by econometric method, employing data for a particular economy, Bangladesh. Thus, the approach of first estimating the parameters of an econometric model and then doing simulation exercises is a novel feature of the present study.

The empirical implementation of both the 'basic' and the 'modified' models provides us with structural information on the Bangladesh economy. The empirical models were also useful for policy simulation analysis.

For the policies emphasizing the agricultural development, the impact on the output and employment in both sectors was higher than with the policy emphasizing industrial development (using either the 'basic' or the 'modified' model). Thus, considering the fact that among all three policies which cost the same amount of money, the net benefit from the policies with higher investment in agriculture seems to be higher than the industrial development policy. Multiplier analysis of the 'basic' model reproduces the same results. This result is primarily due to the high capital-intensity in the urban sector. Thus, the implications of the analysis run counter to the "growth centre" policies which emphasize large-scale industrial development and its 'spread effects' on various other sectors of the economy. In a predominantly agrarian economy like Bangladesh, this trickling down of the effects of industrial development has not been successful in the past and our simulation results show that it is not likely to be successful in the future, either.

To examine the effects of the various government policies on migration, the 'modified' model with its adjustment mechanism via rural-urban migration was devised. When the process of rural-urban migration was considered, it was found that the reduction in the gap between the rural and urban wage following from an emphasis on agricultural development reduces migration to the urban areas. These results are important in the formulation of the government development policy. Thus, to avoid the high social cost of continuous rural-to-urban migration, an effective method is to make the rural sector more attractive by increasing economic opportunities in the rural sector through overall rural development.

The study has presented a two-sector general equilibrium analysis of rural-urban interactions in the process of economic development. In considering two major crops in the rural sector of Bangladesh, namely the food and cash crops, the competitive nature of these crops with respect to the allocation of scarce land has been highlighted. The increase in the production of food crop is essential to reduce the food deficit and at the same time, jute (the cash crop) being the major foreign exchange earner, its production cannot be neglected either. It is realized that since the future development of the two crops is inextricably linked, it is important that the production and price policies of the two crops be formulated simultaneously and be linked with overall rural development policy of the government.

Does the agricultural development precede modern industrial growth, or does it occur simultaneously? We have argued that given the scarce capital resources, the emphasis should be on the rural development. The study has been able to show that the agriculture sector can potentially be a labour absorbing sector. For example, in the 'modified' model, in 1985, strategy I (emphasizing agricultural development) increases employment in the production of food, the cash crop and the manufactured good from the 'status quo' situation by 6.27%, 1.97% and 2.54%, respectively. On the other hand, strategy II (emphasizing industrial development) increases employment in the production of food crop, and the manufactured good by 4.7% and 0.59%, respectively. But strategy II reduces employment in the production of cash crop from the 'status quo' situation by 0.26%. There should be a symbiotic relationship between the rural and urban sectors and as such growth and development should occur in both the rural and urban sectors simultaneously.

It should be pointed out that the analysis of the present study cannot be directly translated into policy. The degree of aggregation, the character of data and simplifying assumptions embodied in the study would require further exercises before drawing any action program from the results presented in this thesis. Although the model allows for the full play of the interactions between the two major sectors of the Bangladesh economy, one would like to carry out detailed sectoral analysis, probably with alternative specifications of the model. In actual planning, solutions will be required on a much more detailed basis.

The process of planning consists of two broad decisions which are essentially linked. It should begin with the identification of the broad pattern of social comparative advantage from which will emerge the pattern of sectoral priority in investment allocation. The next step is to identify the products and/or industries for formulating detailed investment programms. The present study primarily dealt with the first element, while detailed plan for allocation of resources require some kind of inter-industry study revealing, among other things, the capital requirements for each type of product or industry. The detailed calculation of the social costs of labour, capital and foreign exchange for each product is needed for investment allocation stretagy. Thus, a good deal of additional information will have to be combined with the results of an aggregate model presented in this study.

The period for which the model was estimated in this study is a considerably long one. In order to check whether the structure of the economy has substantially changed or not, the model could be estimated for a relatively short period of time taking the data on a recent period such as 1971 to 1977. However, in view of the large number of variables in the model, reducing the time period to a great extent may reduce the degrees of freedom in the empirical estimation of the parameters.

It should be recognized that the impact of various policies may depend on the sensitivity of the system to changes in the parameter values and sometimes on the specification of the model. For further insights into the policy implications, sensitivity analysis with varying parameter values, new sets of assumptions, alternative specifications and with alternative policy options can be undertaken.

Scope for Further Research

The aspects of economic development studies here are only an important subset of other interesting problems. The present study could be extended by introducing a foreign trade sector, an urban service sector, institutional changes and more detailed specifications of the demand functions.

The introduction of an external trade sector may be useful in the context of Bangladesh. A strategy which complements the basic rural development policy in Bangladesh may be the stimulation of the traditional export sector of jute, jute goods, hides and skins and matches. Rural based labour-intensive non-traditional exports such as handicrafts could be further developed. The model presented in this study could be utilized to assess the effects of these kinds of development.

The urban service sector is becoming an important source of employment in Bangladesh. There are many analytical problems in introducing the service sector but some simplifying assumptions could be made. For instance, it may be assumed that the output of the service sector is utilized as a component of final demand; if instead it enters as an input into some production activities, the production function may be modified to include it. The model could thus be extended to include the service sector.

The availability of data may allow functional re-specifications of the demand functions in that the separate demand functions for both food and the manufactured good could be specified for both the rural and urban sectors. This will permit an analysis of the changes in the inter-sectoral composition of demand due to changes in the income, output, employment and other variables. Such analysis would represent a significant improvement.

In the present study, the effects of the institutional changes on different variables were not examined in detail. After the emergence of Bangladesh in 1971, the government nationalized all the commercial banks and many industrial units. Other institutional changes were also made. The effects of land reform, changes in the mode of payment for the rural hired labour and other institutional changes in the rural and urban sectors could be explored within the broad framework provided in the present study.

This study was set out to assess several development strategies within a framework of the rural-urban interactions for the economy of Bangladesh. The study can be extended in the directions indicated, in order to derive further insights into the process of economic development of Bangladesh. Economists agree that there is no 'general theory' of development. However, in order to better analyze the process of development in a country like Bangladesh, a relatively simple and analytically tractable model was used in this study. This model has been fully capable to analyze the structure and the process of development of the economy of Bangladesh. The analytical framework of this study can be applied to study growth and development of other developing economies - especially those with a large agrarian sector and high population density.

APPENDIX A

LIST OF NOTATIONS

The symbols and their descriptions which appear throughout Chapter III and other chapters are presented below:

Q_f = household production of the food crop (rice)

Q_c = household production of the cash crop (jute)

L_f = demand for labour for household production of the food crop

L_c = demand for labour for household production of the cash crop

R_f = land allocation in household production of the food crop

R_c = land allocation in household production of the cash crop

K_f = capital used for household production of the food crop

K_c = capital used for household production of the cash crop

M = income for each household

z = leisure consumed by each member of a household

L_h = supply of labour by all members of a household for its agricultural production

L_o = total hired labour in household agricultural production

T = maximum amount of time within a given period which can be utilized by each member of the household in labour and/or leisure.

L = total amount of labour for the household's agricultural production

R = total amount of land for a household's agricultural production

L_A^S = total supply of labour by a household

N_A = number of people in a household

N_R = total number of people in the rural sector

W_a = money wage rate in the agricultural sector

P_f = price of the food crop ('numeraire')

P_c = price of the cash crop

Q_{fR}^D = demand for the food crop by a member of a household

Q_{mR}^D = demand for the manufactured good by a member of a household

$\bar{Q}_f^D$ = aggregate demand for the food crop

$\bar{Q}_c^D$ = aggregate demand for the cash crop[1]

Y_F = weighted average index of the total real national income of major jute importing countries

P_s = price of jute substitutes in the world market

F = total amount of fertilizers used in total food production in the rural sector

A_f, A_c = technological coefficients for the production functions for food and the cash crop, respectively.

$\alpha_f, \beta_f, \gamma_f$ = parameters of the production function for the food crop

$\alpha_c, \beta_c, \gamma_c$ = parameters of the production function for the cash crop

P_c^* = price of the cash crop relative to the 'numeraire'

P_m^* = price of the manufactured good relative to the 'numeraire'

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[1] Similarly a bar on Q_f, Q_c, L_f, L_c, R_f, R_c, K_f, K_c, R, L_A^S, denotes the aggregates of the respective variables.

W_a^* = rural money wage rate relative to the 'numeraire'

W_m^* = urban money wage rate relative to the 'numeraire'

P_{CL}^* = lagged relative price of the cash crop

$\bar{Q}_{CL}^D$ = lagged aggregate demand for the cash crop

$\bar{Q}_m$ = aggregate production of the manufactured good

$\bar{L}_m$ = aggregate demand for labour in the manufacturing sector

$\bar{Q}_m^D$ = aggregate demand for the manufactured good

$\bar{L}_m^S$ = aggregate supply of labour in the manufacturing sector

$\bar{K}_m$ = aggregate amount of capital used in the manufacturing sector

P_m = price of the manufactured good

W_m = money wage in the urban sector

N_U = total number of people in the urban sector

TT = time trend

D = dummy variable to capture the effects of war in 1971

D_m = dummy variable for the price in the urban labour demand and output supply functions

X_A = household agricultural production of food and the cash crop

L_A = total agricultural labour used to produce food and the cash crop by the household

R_A = total land used for household production of food and the cash crop

K_A = total capital used for household production of food and the cash crop

P_A = composite price of agricultural crops

g = annual rate of growth of population in the economy

NM = number of people migrating from the rural sector to the urban sector

$N_R^* = N_{RL}(1 + g) - NM$

APPENDIX B

'REPRESENTATIVE HOUSEHOLD' EQUILIBRIUM IN THE RURAL SECTOR AND DERIVATION OF HOUSEHOLD RELATIONS

In this appendix, a formal model of the peasant household of the rural sector of Bangladesh is derived from which an empirically implementable aggregate model for Bangladesh is developed in Chapter III.

B.1. Household Equilibrium in the Rural Sector

Assume that the 'representative household' farm attempts to maximize the utility function as follows:[1]

$$U_h = N_A\ U(z,\ Q^D_{fR},\ Q^D_{mR}) \qquad (B.1)$$

where z stands for the quantity of leisure enjoyed by a member in the household during a given period of time; Q^D_{fR} and Q^D_{mR} are the amounts of food and manufactured goods, respectively, consumed by each member in the household; and N_A is the number of people in each household in a given time period. All three arguments inside the brackets are assumed to have positive marginal utilities.

The household produces two products, a food crop (rice) and a cash crop (Jute), the prices of these goods (P_f and P_c) are treated as

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[1] The notion of 'subjective equilibrium' of the peasant household on which the present discussion is based has been analyzed in detail by Nakajima (1969) and Jorgenson and Lau (1969).

parameters by the farmer. The technology of the household farm is represented by the following two production functions, the first for food and the second for the cash crop.[2]

$$Q_f = A_f K_f^{\alpha_f} L_f^{\beta_f} R_f^{\gamma_f} \tag{B.2}$$

$$Q_c = A_c K_c^{\alpha_c} L_c^{\beta_c} R_c^{\gamma_c} \tag{B.3}$$

Q_f, Q_c are the quantities of food and cash crops and K, L, R are the quantities of capital, labour and land in the respective crops. Since capital is exogenous to the farm, the equations (B.2) and (B.3) can be written as:

$$Q_f = V_f L_f^{\beta_f} R_f^{\gamma_f} \quad \text{where} \quad V_f = A_f K_f^{\alpha_f} \tag{B.4}$$

$$Q_c = V_c L_c^{\beta_c} R_c^{\gamma_c} \quad \text{where} \quad V_c = A_c K_c^{\alpha_c} \tag{B.5}$$

We assume that the marginal productivities of all factors are non-negative. The problem of the household farm is to maximize its utility subject to its constraints on income, land, labour and leisure.[3] The household's objective

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[2] Hayami and Ruttan [(1971), Ch. 5] give theoretical justification as well as empirical evidence in favour of using Cobb-Douglas production function for the rural sector. The data on the Bangladesh agricultural sector also suggest that the shares of inputs in total output are constant, over time, implying a Cobb-Douglas function.

[3] Note that this formulation does not explicitly consider the risk-behaviour of the farm. Many economists have argued that farmers in the less developed countries are risk-averse (Behrman, 1968). The uncertainty of farm income can be introduced by introducing random variables in the agricultural production functions. For example, assume that production function for food, given by $Q_f = f(L_f, K_f, R_f)U$ is concave and let U be a continuous random variable reflecting the effects of weather, prices, on output, such that $U \geq 0$, $E(U) = \mu$ and $V(U) = \sigma_1^2$, a finite quantity (see Kurian, 1977). By this method, uncertainty in the production side can be introduced in the model.

function and its constraints can be represented as

$$U_h = N_A\ U(z,\ Q^D_{fR},\ Q^D_{mR}) \tag{B.6}$$

$$M = P_f V_f L_f^{\beta_f} R_f^{\gamma_f} + P_c V_c L_c^{\beta_c} R_c^{\gamma_c} - W_a L_o \tag{B.7}$$

$$M = P_f N_A Q^D_{fR} + P_m N_A Q^D_{mR} \tag{B.8}$$

$$R = R_c + R_f \tag{B.9}$$

$$L_h = N_A T - N_A z \tag{B.10}$$

$$L_f + L_c = N_A T - N_A z + L_o = L \tag{B.11}$$

$$\left.\begin{array}{ll} Z \geq 0 & L_o \gtrless 0 \\ Q^D_{fR} \geq 0 & R_c \geq 0 \\ Q^D_{mR} \geq 0 & R_f \geq 0 \\ L_f \geq 0 & \\ & L_h \geq 0 \\ L_c \geq 0 & \end{array}\right\} \text{variables to the farm} \tag{B.12}$$

$$\left.\begin{array}{l} R \geq 0,\ P_f > 0,\ P_m > 0,\ P_c > 0 \\ W_a > 0,\ N_A \geq 1,\ T > 0 \end{array}\right\} \text{parameters to the farm} \tag{B.13}$$

The constraint (B.7) describes the income of the household farm. Depending on the nature of the household, it may be a net purchaser or a net supplier of labour. Thus, in the optimal allocation of the variable input labour, only the wage cost is considered. Capital is taken as exogenous and thus its cost does not affect the optimal allocation of labour. Note that there is no provision in the model for an allocation decision involving capital use in the production of food and the cash crop. Since capital in the production of food and the cash crop is taken as exogenous, there is no practical justification for incorporating a decision mechanism dealing with the allocation of capital among the different crops in the household farm.[4] The constraint (B.7) also implies that the quantity of land is fixed to the household. This assumption is necessitated by the extreme difficulty of obtaining rental rate data because of the complex tenure system in Bangladesh.

The constraint (B.8) gives the expenditure side of the farm which equals the net income. The constraint (B.11) gives the amount of labour which the farm utilizes in its production.

The constrained maximization problem of the household which owns land can be presented in terms of the Lagrangian function:

$$y = N_A U(z, Q^D_{fR}, Q^D_{mR}) + \lambda_1 [P_f N_A Q^D_{fR} + P_m N_A Q^D_{mR} - P_f V_f L_f^{\beta_f} R_f^{\gamma_f} - P_c V_c L_c^{\beta_c} R_c^{\gamma_c} + W_a L_o]$$
$$+ \lambda_2 [N_A z + L_h - N_A T] + \lambda_3 [L_h + L_o - L_f - L_c] + \lambda_4 [R - R_f - R_c] \quad \text{(B.14)}$$

The set of first order conditions for an interior solution to the maximization of (B.14) is:

$$\frac{\partial y}{\partial z} = N_A(U_z + \lambda_2) = 0 \quad \text{(B.15)}$$

$$\frac{\partial y}{\partial Q^D_{fR}} = N_A(U_f + \lambda_1 P_f) = 0 \quad \text{(B.16)}$$

$$\frac{\partial y}{\partial Q^D_{mR}} = N_A(U_m + \lambda_1 P_m) = 0 \quad \text{(B.17)}$$

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[4] Capital may not be easily shifted from one crop to another.

$$\frac{\partial y}{\partial L_f} = -\lambda_1 P_f V_f R_f^{\gamma_f} \beta_f L_f^{\beta_f - 1} - \lambda_3 = 0 \qquad \text{(B.18)}$$

$$\frac{\partial y}{\partial L_c} = -\lambda_1 P_c V_c R_c^{\gamma_c} \beta_c L_c^{\beta_c - 1} - \lambda_3 = 0 \qquad \text{(B.19)}$$

$$\frac{\partial y}{\partial L_h} = \lambda_2 + \lambda_3 = 0 \qquad \text{(B.20)}$$

$$\frac{\partial y}{\partial L_o} = \lambda_1 W_a + \lambda_3 = 0 \qquad \text{(B.21)}$$

$$\frac{\partial y}{\partial R_f} = -\lambda_1 P_f V_f L_f^{\beta_f} \gamma_f R_f^{\gamma_f - 1} - \lambda_4 = 0 \qquad \text{(B.22)}$$

$$\frac{\partial y}{\partial R_c} = -\lambda_1 P_c V_c L_c^{\beta_c} \gamma_c R_c^{\gamma_c - 1} - \lambda_4 = 0 \qquad \text{(B.23)}$$

plus the constraints included in (B.14).

B.2. A Digression

The household farm which does not own any land, satisfies the conditions $R_f = 0$ and $R_c = 0$ in (B.12). The income of that household is derived solely from the labour it supplies to other households, that is, for that particular case, $L_o = -L_h$. Thus, constraints (B.7) and (B.8) together can be written as

$$M = W_a L_h = P_f N_A Q^D_{fR} + P_m N_A Q^D_{mR} \qquad \text{(B.24)}$$

In the case where the household owns land, that is, when $R_f > 0$, $R_c > 0$, two situations may be analyzed. Depending on the size of the family, and tastes of the members with respect to leisure, a household can be a net purchaser or supplier of labour, that is, $L_o \gtrless 0$.[5] A dia-

[5] The situation may also arise when $L_o = 0$ where the farm neither purchases labour from outside nor does it rent out any labour.

grammetic exposition will be given to analyze this case. For simplification, we assume that X_A is the total production function of the household consisting of both food and cash crops, P_A is the composite price of the agricultural product X_A; and L_A, K_A, R_A, the amount of labour, capital and land used to produce X_A. K_A and R_A are assumed to be fixed for this demonstration.

The Lagrangian in (B.14) can be rewritten as:

$$y = N_A U(T - \frac{L_h}{N_A}, \frac{M}{N_A}) + \lambda_1 [M - P_A X_A(L_A, R_A, K_A) + W_a L_o] + \lambda_3 [L_h + L_o - L_A] \qquad (B.25)$$

A set of first order conditions from (B.25) are

$$\frac{\partial y}{\partial L_h} = - \frac{\partial U}{\partial z} \frac{\partial z}{\partial (L_h/N_A)} + \lambda_3 = 0 \qquad (B.26)$$

$$\frac{\partial y}{\partial M} = \frac{\partial U}{\partial (M/N_A)} + \lambda_1 = 0 \qquad (B.27)$$

$$\frac{\partial y}{\partial L_o} = \lambda_1 W_a + \lambda_3 = 0 \qquad (B.28)$$

$$\frac{\partial y}{\partial L_A} = -\lambda_1 P_A \frac{\partial X_A}{\partial L_A} - \lambda_3 = 0 \qquad (B.29)$$

From (B.26) - (B.29) together with the condition $z = T - \frac{L_h}{N_A}$, we derive the following two conditions of 'subjective equilibrium' of the household

$$- \frac{U_{L_h}}{U_M} = W_a \qquad (B.30)$$

$$P_A \frac{\partial X_A}{\partial L_A} = W_a \qquad (B.31)$$

Using the first order conditions in (B.30) and (B.31), the household equilibrium can be shown by diagrams as follows:

Figure 1

Household Labour Supplied Out

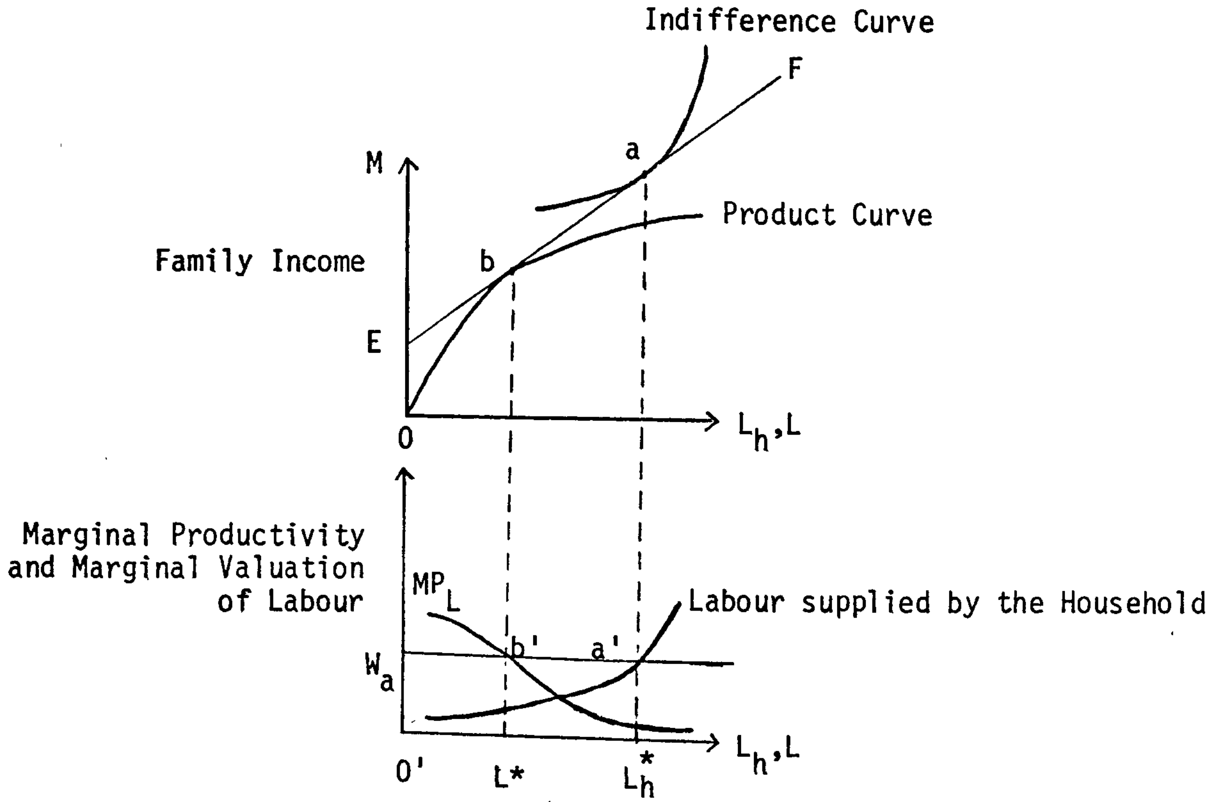

Figure 1. The slope of the line EF represents W_a, the wage rate and OE is household return to fixed inputs. At equilibrium point (a) first order condition (B.30) is satisfied and at (b) condition (B.31) is satisfied. In the lower figure, OW_a is the wage rate which is equated with household labour's marginal valuation of labour, when the labour is supplied out, at point a'. OL* is the total family labour used for household production of food and cash crops and $L^*L_h^*$ is the amount of family labour hired out to other farms. This case happens when the ratio of the size of the family to that of the farm is relatively high.

Figure 2

Labour Hired in by Household

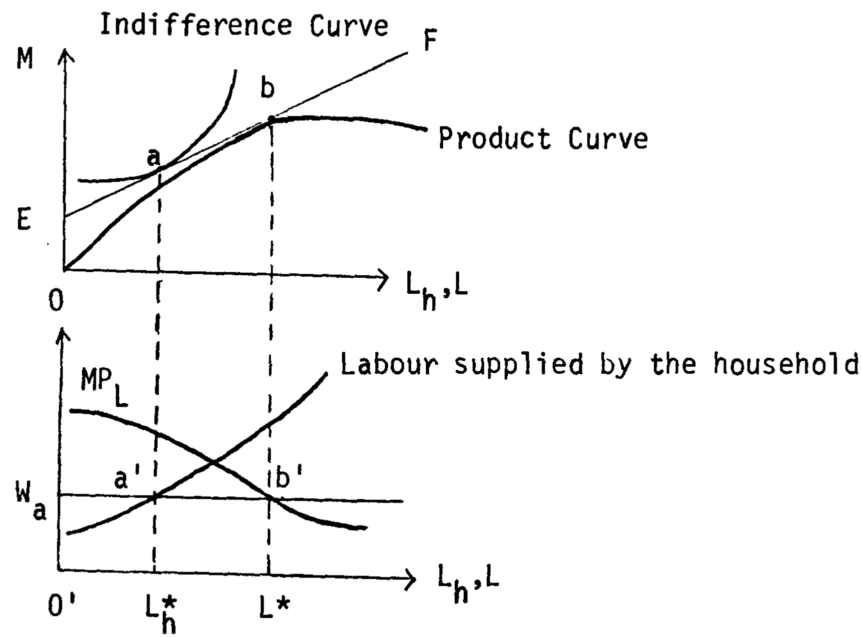

Figure 2. We get the opposite situation in this case. OL* is the total labour used for household production of food and cash crops of which $L^*_h L^*$ is the amount of labour hired in from other households, and OL^*_h is the amount of household labour. This happens when the ratio of the size of the family to that of the farm is relatively low.

B.3. Household Relations

From the set of first order conditions in (B.15) - (B.23) the output supply and input demand functions can be derived. We work out the following example.

From the first order conditions we get

$$P_f V_f R_f^{\gamma_f} \beta_f L_f^{\beta_f - 1} = W_a \tag{B.32}$$

$$P_c V_c R_c^{\gamma_c} \beta_c L_c^{\beta_c - 1} = W_a \tag{B.33}$$

which mean that the marginal revenue products of labour in food and cash crops equal the nominal wage rate.

From (B.22) and (B.23) we get

$$P_f V_f L_f^{\beta_f} \gamma_f R_f^{\gamma_f - 1} = P_c V_c L_c^{\beta_c} \gamma_c R_c^{\gamma_c - 1} \tag{B.34}$$

From the conditions (B.32) - (B.34) and the constraint (B.9), which is $R = R_c + R_f$, the solutions for labour demand in the food and cash crops, the allocation of land between the food and cash crops in terms of the variables which are exogenous to the household farm can be obtained as follows:

$$L_f = f_1(P_c^*, W_a^*, K_f, K_c, R, \text{production function parameters}) \tag{B.35}$$

$$L_c = f_2(P_c^*, W_a^*, K_f, K_c, R, \text{production function parameters}) \tag{B.36}$$

$$R_f = f_3(P_c^*, W_a^*, K_f, K_c, R, \text{production function parameters}) \tag{B.37}$$

$$R_c = f_4(P_c^*, W_a^*, K_f, K_c, R, \text{production function parameters}) \tag{B.38}$$

where

$$P_c^* = \frac{P_c}{P_f} \qquad \text{and} \qquad W_a^* = \frac{W_a}{P_f}$$

Note that the relative price of the agricultural goods and the wage rate are relative to the price of food, P_f. Thus, P_f is the 'numeraire' in the general equilibrium model presented in Chapter III.

For the convenience in the estimation of the parameters of the model, the relations are expressed in a log linear form as follows:

$$\log L_f = \text{constant} + a_{11}^* \log P_c^* + a_{12}^* \log W_a^* + a_{13}^* \log K_f + a_{14}^* \log K_c + a_{15}^* \log R \quad (B.39)$$

$$\log L_c = \text{constant} + a_{21}^* \log P_c^* + a_{22}^* \log W_a^* + a_{23}^* \log K_f + a_{24}^* \log K_c + a_{25}^* \log R \quad (B.40)$$

$$\log R_f = \text{constant} + a_{31}^* \log P_c^* + a_{32}^* \log W_a^* + a_{33}^* \log K_f + a_{34}^* \log K_c + a_{35}^* \log R \quad (B.41)$$

$$\log R_c = \text{constant} + a_{41}^* \log P_c^* + a_{42}^* \log W_a^* + a_{43}^* \log K_f + a_{44}^* \log K_c + a_{45}^* \log R \quad (B.42)$$

Substituting (B.39) - (B.42) into respective production functions in (B.2) and (B.3), the output supply functions of the food and cash crops are respectively as follows:

$$\log Q_f = \text{constant} + a_{51}^* \log K_f + a_{52}^* \log K_c + a_{53}^* \log W_a^* + a_{54}^* \log P_c^* + a_{55}^* \log R \quad (B.43)$$

$$\log Q_c = \text{constant} + a_{61}^* \log K_f + a_{62}^* \log K_c + a_{63}^* \log W_a^* + a_{64}^* \log P_c^* + a_{65}^* \log R \quad (B.44)$$

B.4. Household labour supply function

From the first order conditions (B.15) - (B.23), the following relations can be derived

$$\frac{U_z}{U_f} = \frac{W_a}{P_f} ; \quad \frac{U_z}{U_m} = \frac{W_a}{P_m} ; \quad \frac{U_f}{U_m} = \frac{P_f}{P_m} \tag{B.45}$$

which state that the ratios of marginal utilities of the two goods should be equal to their price ratios for any member in the peasant household. This set of relations, along with (B.30) and (B.31), yield the household demand for leisure or alternatively the supply of labour.

Without a specific type of utility function, an explicit relation for labour supply cannot be found; however, the household labour supply function can be written in general form as

$$L_A^S = L_A^S(W_a^*, P_m^*, P_c^*, K_f, K_c, R, N_A, \text{Production function parameters}) \tag{B.46}$$

where

$$P_m^* = \frac{P_m}{P_f}$$

and P_f is the 'numeraire'.

W_a^*, P_c^*, K_f, K_c, R are the variables which explain the household's income. Family size (N_A) along with the tastes of the individuals explain whether a household will be a net purchaser or supplier of labour as discussed in section B.2.

B.5 Comparative-static Aspects of the Model

The signs of the coefficients of the theoretical model in Chapters III and V and in the preceeding section are all presented as positive. To obtain 'a priori' sign predictions which can be compared to the signs of the estimated parameters, a comparative-static analysis needs to be undertaken.

$$U_z dN_A + N_A U_{zz} dz + N_A U_{zf} dQ_f + N_A U_{zm} dQ_m + N_A d\lambda_2 + \lambda_2 dN_a = 0 \qquad (B.47)$$

$$U_f dN_A + N_A U_{fz} dz + N_A U_{ff} dQ_f + N_A U_{fm} dQ_m + N_A P_f d\lambda_1 + N_A \lambda_1 dP_f + \lambda_1 P_f dN_A = 0 \qquad (B.48)$$

$$U_m dN_A + N_A U_{mz} dz + N_A U_{mf} dQ_f + N_A U_{mm} dQ_m + N_A P_m d\lambda_1 + N_A \lambda_1 dP_m + \lambda_1 P_m dN_A = 0 \qquad (B.49)$$

$$-\lambda_1 P_f (Q^f_{LL} dL_f + Q^f_{LR} dR_f + +Q^f_{LV} dV_f) - \lambda_1 Q^f_L dP_f - P_f Q^f_L d\lambda_1 - d\lambda_3 = 0 \qquad (B.50)$$

$$-\lambda_1 P_c (Q^c_{LL} dL_c + Q^c_{LR} dR_c + Q^c_{LV} dV_c) - \lambda_1 Q^c_L dP_c - P_c Q^c_L d\lambda_1 - d\lambda_3 = 0 \qquad (B.51)$$

$$d\lambda_2 + d\lambda_3 = 0 \qquad (B.52)$$

$$\lambda_1 dW_a + W_a d\lambda_1 + d\lambda_3 = 0 \qquad (B.53)$$

$$-\lambda_1 P_f (Q^f_{RL} dL_f + Q^f_{RR} dR_f + Q^f_{RV} dV_f) - \lambda_1 Q^f_R dP_f - P_f Q^f_R d\lambda_1 - d\lambda_4 = 0 \qquad (B.54)$$

$$-\lambda_1 P_c (Q^c_{RL} dL_c + Q^c_{RR} dR_c + Q^c_{RV} dV_c) - \lambda_1 Q^c_R dP_c - P_c Q^c_R d\lambda_1 - d\lambda_4 = 0 \qquad (B.55)$$

$$dR - dR_f - dR_c = 0 \qquad (B.56)$$

$$dL_h + dL_o - dL_f - dL_c = 0 \qquad (B.57)$$

$$N_A dz + z dN_A + dL_h - dN_A (T) + N_A (dT) = 0 \qquad (B.58)$$

$$W_a dL_o + L_o dW_a - P_c (Q^c_V dV_c + Q^c_L dL_c + Q^c_R dR_c) - Q^c dP_c - P_f (Q^f_V dV_f + Q^f_L dL_f + Q^f_R dR_f)$$
$$- Q^f dP_f + P_m N_A dQ_m + P_m Q_m dN_A + Q_m N_A dP_m + P_f N_A dQ_f + P_f Q_f dN_A + Q_f N_A dP_f = 0 \qquad (B.59)$$

The variables exogenous and endogenous to the peasant household are listed as below:

Exogenous to the household: N_A, P_f, P_m, V_f, V_c, P_c, W_a, R, T

Endogenous to the household: z, Q_f, Q_m, λ_2, λ_1, L_f, R_f, λ_3, L_c, R_c, λ_4, L_o, L_h

Rearranging the terms the problem can be set up in martix form as follows:

Let

H_1 = matrix of the endogenous variable

H_2 = matrix of the exogenous variable

This will facilitate in writing and evaluating the comparative-static results.[6] For example, by Cramer's rule we can derive $\frac{dL_f}{dW_a}$, $\frac{dQ_f}{dP_f}$, and so on.

Both the matrices H_1 and H_2 can be expressed in terms of quadratic form and vice versa. If the determinant $|H_1| > 0$ and also its other principal minors are positive, then the quadratic form of H_1 is 'positive definite'. Again, if the determinant $|H_1| < 0$, and all the odd-numbered principal minors are negative and all even-numbered ones are positive, then the quadratic form is said to be 'negative definite'. These conditions for positive or negative definiteness can again be stated in terms of sign restrictions on the coefficients forming the principal minors.

Thus, the 'a priori' signs for the coefficients of many variables may be known for our model by above method. But without additional informations about the relative strength of the negative force and the positive force, actual sign determination may be difficult.

The following comparative-static results have been obtained from the matrices H_1 and H_2. These results may be compared to the signs of the estimated parameters in Chapters IV and VI. Of the 'a priori' signs presented below the signs marked with * are the same as in the estimated parameters of the 'modified' model.

$$\frac{dz}{dP_f} > 0 \qquad \frac{dQ_f}{dP_f} > 0 \qquad \frac{dQ_m}{dP_m} < 0^*$$

[6] On pages 139 and 140, these matrices are given. The whole system can be written as $H_1J_1 = H_2J_2$.

$\frac{dz}{dV_f} > 0$ $\frac{dQ_f}{dP_c} > 0$ $\frac{dQ_f}{dV_c} > 0*$

$\frac{dL_f}{dW_a} < 0*$ $\frac{dR_f}{dP_f} > 0$ $\frac{dR_f}{dV_f} > 0*$

$\frac{dL_c}{dP_c} > 0*$ $\frac{dL_c}{dV_c} > 0*$ $\frac{dR_c}{dR} > 0*$

$\frac{dR_f}{dR} > 0*$ $\frac{dL_h}{dT} > 0$ $\frac{dL_h}{dN_A} < 0$

$\frac{dL_c}{dW_a} < 0*$ $\frac{dR_f}{dW_a} < 0*$ $\frac{dR_c}{dW_a} < 0*$

Vector J_1

$$
\begin{bmatrix}
0 & 0 & 0 & 0 & 0 & P_fN_A & P_mN_A & -P_fQ^f_L & -P_fQ^f_R & -P_cQ^c_L & -P_cQ^c_R & 0 & W_a \\
0 & N_A & 0 & 0 & N_AU_{zz} & N_AU_{zf} & N_AU_{zm} & 0 & 0 & 0 & 0 & 0 & 0 \\
N_AP_f & 0 & 0 & 0 & N_AU_{fz} & N_AU_{ff} & N_AU_{fm} & 0 & 0 & 0 & 0 & 0 & 0 \\
N_AP_m & 0 & 0 & 0 & N_AU_{mz} & N_AU_{mf} & N_AU_{mm} & 0 & 0 & 0 & 0 & 0 & 0 \\
-P_fQ^f_L & 0 & -1 & 0 & 0 & 0 & 0 & -\lambda_1P_fQ^f_{LL} & -\lambda_1P_fQ^f_{LR} & 0 & 0 & 0 & 0 \\
-P_cQ^c_L & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & -\lambda_1P_cQ^c_{LL} & -\lambda P_cQ^c_{LR} & 0 & 0 \\
0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
W_a & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-P_fQ^f_R & 0 & 0 & 1 & 0 & 0 & 0 & -\lambda_1P_fQ^f_{RL} & -\lambda_1P_fQ^f_{RR} & 0 & 0 & 0 & 0 \\
-P_cQ^c_R & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & -\lambda_1P_cQ^c_{RC} & -\lambda_1P_cQ^c_{RR} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & -1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & -1 & 0 & 1 & 1 \\
0 & 0 & 0 & 0 & N_A & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
d\lambda_1 \\ d\lambda_2 \\ d\lambda_3 \\ d\lambda_4 \\ dz \\ dQ_f \\ dQ_m \\ dL_f \\ dR_f \\ dL_c \\ dR_c \\ dL_o \\ dL_h
\end{bmatrix}
$$

Vector J_2

$$
\begin{bmatrix}
0 & 0 & (P_fQ_f+P_mQ_m) & (Q_fN_A-Q^f) & Q_mN_A & -Q^c & L_o & -P_fQ_V^f & -P_cQ_V^c \\
0 & 0 & \lambda_2 + U_z & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \lambda_1 P_f + U_f & N_A\lambda_1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \lambda_1 P_m + U_m & 0 & N_A\lambda_1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & -\lambda_1 Q_L^f & 0 & 0 & 0 & -\lambda_1 P_f Q_{LV} & 0 \\
0 & 0 & 0 & 0 & 0 & -\lambda_1 Q_L^c & 0 & 0 & -\lambda_1 P_c Q_{LV}^c \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & \lambda_1 & 0 & 0 \\
0 & 0 & 0 & -\lambda_1 Q_R^f & 0 & 0 & 0 & -\lambda_1 P_f Q_{RV}^f & 0 \\
0 & 0 & 0 & 0 & 0 & -\lambda_1 Q_R^c & 0 & 0 & -\lambda_1 P_c Q_{RV}^c \\
0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-N_A & 0 & T-z & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\begin{bmatrix}
dT \\ dR \\ dN_A \\ dP_f \\ dP_m \\ dP_c \\ dW_a \\ dV_f \\ dV_c
\end{bmatrix}
$$

APPENDIX C

THE SOURCES AND NATURE OF THE DATA

C.1. Introduction

In this study, both published and unpublished data provide the base for the empirical implementation of the models. In a number of cases, information from more than one source was combined and data available from various sources were examined for consistency. Sometimes, interpolation and extrapolation were necessary to complete the time series on some variables.

In Pakistan, the major source of data has been the Central Statistical Office (C.S.O., established in 1950). Formal planning began in Pakistan in 1955 with the First Five Year Plan (1955-1960) and planning prompted attempts to improve both the methodology and the coverage of data collection by various government and non-government institutions. An examination of the sources and nature of data may give some ideas about their coverage and reliability as well as their usefulness for the purpose of this study.

The specific sources of the data on different variables and the nature of these data will be discussed in section C.2. The data are provided in sections C.3.-C.6.

C.2. Specific Sources and the Nature of the Data

(a) Labour and population

The main sources of population and labour force data are

[26, 28, 30, 39, 42, 43]. More than one estimate was available for population and labour force variables due to the difference in the assumptions on the fertility and mortality rate. However, the discrepancies between various estimates were not pronounced. In order to check the consistency between the various estimates, data from [35, 40] were collected and checked against those from the above sources. The data taken from some independent studies on population such as the Population Projections for Bangladesh 1973-2003, Harvard University Center for Population Studies (1973, mimeo), World Bank Study [87] are basically consistent with the government data.

In this study, the units of population and labour force variables are in million men/years.

(b) Land in the agricultural sector

The acreage of land in the production of the food and cash crops are taken mainly from [40, 44] which give data during the Pakistan period. After the emergence of Bangladesh, the data on land were taken from [25, 26]. In order to check the reliability of data, the production figures and input used from other sources (discussed below) were examined and the data are reliable. Figures quoted in FAO [85], and OECD [61] publications were used to check the reliability for the whole series. The sources quoted above report some data from the agricultural census.

It was necessary to check the consistency between the acreage, yield and output data. Ideally, the total acreage multiplied by the yield per acre should be equal to output data provided by different sources. The data on yield, acreage and output are reported in the OECD [61], FAO [85] and other sources. It was found that the figures derived from acreage and yield were basically consistent with output figures for the food and cash crops. Thus, the acreage and yield data were found to be reliable.

The acreage of land is expressed in terms of physical units of thousand acres/years.

(c) Output of the food and cash crops

The major sources of output data are [33, 40, 44] for the period up to 1970. Data from 1971 to 1975 were taken from [25, 26].

A detailed study carried out by Alamgir and Berlage [4] on the various components of national income and expenditures in Bangladesh provides an excellent source to check whether data on production are reliable or not. The study provides detailed information about the production and consumption levels of different items. It has been found that the amount of domestic food production plus the amount imported from abroad equals total domestic consumption of food. The multipurpose sample survey of the CSO [38] also provides information, especially for the rural households to check the consistency in data from both the product and expenditure approach of national income accounting.

Similarly, the domestic production of jute has been found equal to the domestic use plus the amount exported abroad.[1]

The nominal data on output levels are all deflated by the appropriate price indices to convert them into 1959 prices (the sources of the price indices of the food and cash crops will be discussed below).

---

[1] The data on production, consumption, export, import and usage of jute all are taken from sources noted above.

The variables are expressed in million Takas in 1959 prices.

(d) Output of the manufactured good

The sources up to 1970 are [35, 37, 40]. After 1970, the sources are [25, 28, 29]. For some years, output data are estimated on the basis of the growth rates of the manufacturing sector, provided by [87]. The data were checked for consistency and reliability from the sources cited above in section (c).

The nominal data were deflated by the price index of the manufactured good to convert it into million Takas in 1959 prices.

(e) Prices of the food crop, the cash crop and the manufactured good

The main sources of the price data for the agricultural crop are [15, 31, 34, 40] for the years up to 1970. Rest of data were taken from [25, 26]. The price indices given by these sources were converted into 1959 base year price indices.

The composite price of the manufactured good was gathered in index form from [31, 34, 40] up to 1970. Data after 1970 were mainly taken from [25, 26]. Data for the period 1951-1959 were checked taking information provided by a study of Nurul Islam [54] and was found consistent and reliable. For other periods, price data were checked carefully with the study by Alamgir and Berlage [4] who calculated various components of national income and expenditure taking 1959 as the base year. The weights for different price indices were determined by the sources noted above. Some of these weights have been discussed by Alamgir and Berlage [4] and Islam [54].[2] In the present study, the price variables P_c^*, P_m^*, P_{CL}^* are used in index forms relative to the price index

[2] The weights are usually derived on the basis of the share of production of a commodity in a particular group.

of the food crop, with base year 1959.

(f) Price of jute substitutes

An average price index for the substitutes for jute in the international markets is constructed from data provided mainly by [15, 68]. In this study, the variable $(\frac{P_c}{P_s})$ has been used in index form with 1959 as the base year.

(g) Fertilizers in the agricultural crop

The main source is [86]. Some projections on the level of fertilizers used were made by OECD, especially for 1968-1974 and are quoted in [61]. Data published by the Bangladesh Agricultural Development Corporation have been used to complete the data series and to check the consistency in it. The amount of fertilizers is expressed in physical units of thousand tons of plant nutrient consisting of Nitrogen, Phosphate and Potash calculated from different kinds of fertilizers, such as Urea, TSP and AS.

(h) Capital in the agricultural sector

The measurement of capital is an extremely complex task which depends upon a set of definitions and a methodological framework. The amount of investment and the capital stock are related in the sense that investment implies addition to capital stock. There are problems in separating consumption from investment expenditure in a developing country like Bangladesh. However, we have taken expenditures on the following items as components of gross investment in agriculture:

(1) irrigation works such as canals, tubewells, and tanks; (2) expenditures on land improvement and reclamation; (3) purchase of cattle, and agricultural implements such as sickles, spades, ploughs, ladders, yokes, etc.; (4) expenditures on storage facilities for food grain and jute; (5) expenditures on pesticides, and seeds and development of improved seeds for rice and jute production.

The main sources of these data are [29, 34, 44, 46]. Some calculations of investment were done from data provided by [87]. A special study carried out by FAO [85], on the various components of the costs of production in the food and cash crop provided some information about the investment expenditures in rice and jute crop. Once the gross investment figure was calculated, the capital stock was calculated by a computer program given a depreciation rate and a benchmark capital stock. The benckmark capital stocks for both the agricultural and the manufacturing sectors have been calculated on the basis of the data provided by Alamgir and Berlage [4], Alamgir and Rahman [5], and The World Bank Study [87]. The figures found by this method were examined carefully in view of the information provided by Alamgir and Berlage [4] and Alamgir and Rahman [5]. Data generated by our computer program were found to be consistent with the calculations of saving, investment, and consumption by Alamgir et al. The nominal figures were deflated by price index of the agricultural product to express these , in million Takas in 1959 prices.

(i) Capital in the manufacturing sector

The components of capital in this sector consist of plant, machineries and other assets as vehicles, warehouses. From the gross investment data derived from [26, 28, 35, 37] the capital stock was calculated by the computer program as mentioned above, given a benchmark capital stock and a depreciation rate. The nominal series was deflated by the price index of the manufactured good to express it in million Takas in 1959 prices.

(j) Rural and urban wages

The multipurpose sampling surveys by CSO [38] gathered data on income, consumption of rural households. Bose [11] extended the data period and further improvements were made. Varous publications of CSO [35, 36] also provided data on the rural daily and urban daily wages. For the period after 1971, sources [26, 31, 32] provided useful information. The wage rates of the urban sector were usually collected from the major cities and industrial centres, some of which are reported in [28, 37].

In this study, W_a^*, W_m^* are expressed in index forms relative to the price of food crop with 1959 as the base year.

(k) National income of the jute importing countries

This index was constructed by taking the national income of the U.K., U.S.A., Japan, Eurpoean Economic Community (EEC) countries, and the rest of the world (ROW) from the sources [83, 84]. The index with 1959 as the base year is, in fact, a weighted average, the weights being determined by the share of imports of each country mentioned above. The weights changed in each period with the change in the volume of imports for these countries. Income of the countries were considered because jute is imported for industries (as raw materials, as packing material) and for making handicrafts and carpet backing for the consumers in these countries.

(1) Migration

The number of people migrating from the rural to the urban areas are expressed in million men/years and calculated mainly from population data by Vital Statistics Method (VS) described in Chapter V. Census data were used extensively. To check consistency, the studies by Choudhury and Curlin [13], Stoeckel *et al.* [78], and Z.S. Haq [48] were used.

APPENDIX C

C.3. Data Used in the Present Study

YEARS	$\bar{L}_f$	$\bar{L}_c$	$\bar{L}_m$	$\bar{R}_f$	$\bar{R}_c$
1947	11.5700	1.29000	.660000	19091.0	2260.00
1948	11.8100	1.31000	.700000	19519.0	2076.00
1949	12.0400	1.34000	.730000	19628.0	1763.00
1950	12.1500	1.50000	.760000	20101.0	1914.00
1951	12.5300	1.39000	.800000	20396.0	1984.00
1952	12.7800	1.42000	.820000	20876.0	2111.00
1953	13.0400	1.45000	.840000	22108.0	1171.00
1954	13.3000	1.48000	.860000	21750.0	2446.00
1955	13.5700	1.51000	.880000	19853.0	2831.00
1956	13.8400	1.54000	.920000	20431.0	2344.00
1957	14.1200	1.57000	.960000	20542.0	2571.00
1958	14.4000	1.60000	1.00000	19948.0	2703.00
1959	14.4900	1.62000	1.01000	21493.0	2616.00
1960	14.4700	1.80000	1.02000	22271.0	2715.00
1961	14.7800	2.02000	1.06000	21355.0	3309.00
1962	15.6500	1.74000	1.30000	21897.0	2971.00
1963	16.1600	1.80000	1.45000	22601.0	2902.00
1964	16.8700	1.87000	1.63000	23125.0	2831.00
1965	16.8300	2.30000	1.78000	23465.0	3308.00
1966	17.2500	1.71000	1.88000	22805.0	3435.00
1967	17.5700	1.95000	2.06000	24851.0	3562.00
1968	18.1000	2.01000	2.25000	24363.0	2435.00
1969	18.6400	2.07000	2.44000	25782.0	2685.00
1970	19.0000	2.12000	2.56000	24805.0	2477.00
1971	19.1700	2.37000	2.68000	23300.0	1800.00
1972	19.7700	2.20000	2.81000	24200.0	2270.00
1973	20.1700	2.24000	2.99000	24800.0	2245.00
1974	19.9600	2.90000	3.19000	24500.0	1520.00
1975	20.9900	2.33000	3.40000	25000.0	1500.00

YEARS	$\bar{L}_A^s$	$\bar{Q}_f$	$\bar{Q}_c$	W_a^*	W_m^*
1947	12.8600	4896.56	695.894	.903734	.993487
1948	13.1200	5574.90	556.961	.707364	.797166
1949	13.3800	5363.11	436.224	.983768	.999783
1950	13.6500	5336.28	611.044	1.28705	1.29139
1951	13.9200	5114.54	702.194	1.22900	1.24370
1952	14.2000	5333.04	693.672	1.20777	1.25800
1953	14.4900	5992.69	367.458	1.00571	1.71834
1954	14.7800	5577.71	473.796	1.67489	2.37173
1955	15.0800	4689.10	660.588	1.05616	1.28684
1956	15.3800	5986.23	560.929	.77892	.836848
1957	15.6900	5557.88	615.580	1.03093	1.06736
1958	16.0000	5072.54	610.473	1.07411	1.07588
1959	16.1100	6198.40	564.360	1.00000	1.00000
1960	16.2700	6965.26	453.310	1.00295	1.13898
1961	16.8000	6933.56	708.400	1.00677	1.10126
1962	17.3900	6402.30	640.669	1.07099	1.24078
1963	17.9600	7638.80	619.621	1.02264	1.35150
1964	18.7400	7554.07	551.805	.43551	1.36373
1965	19.1300	7557.77	727.811	.82348	.913242
1966	18.9600	6934.82	703.885	.646367	.732646
1967	19.5200	8058.12	696.480	.601854	.752965
1968	20.1100	8158.28	598.505	.542613	.691085
1969	20.7100	8638.23	757.394	.551226	.819758
1970	21.1200	8027.65	691.328	.697041	.876873
1971	21.5400	7311.90	439.642	.681045	.656451
1972	21.9700	7424.05	673.118	.586463	.604980
1973	22.4100	8709.83	620.164	.481354	.732898
1974	22.8600	8272.06	413.440	.525056	.842698
1975	23.3200	8334.46	461.273	.749921	.875265

Note: Definitions of the variables are given in Appendix A. Data units are discussed in Section 2 of Appendix C.

(continued)

YEARS	F	D_m	TT	D	NM
1947	.100000	0.	0.	0.	.187400E-01
1948	.200000	0.	1.00000	0.	.189300E-01
1949	.500000	0.	2.00000	0.	.231720E-01
1950	.800000	0.	3.00000	0.	-.591000E-01
1951	1.00000	0.	4.00000	0.	.100550
1952	1.70000	0.	5.00000	0.	.162600
1953	1.80000	0.	6.00000	0.	.830000E-01
1954	2.00000	0.	7.00000	0.	.847600E-01
1955	2.30000	0.	8.00000	0.	.112658
1956	5.70000	0.	9.00000	0.	.155295
1957	7.50000	0.	10.0000	0.	.170848
1958	8.40000	0.	11.0000	0.	.174952
1959	11.2000	0.	12.0000	0.	.183885
1960	22.5000	0.	13.0000	0.	.214785
1961	22.5000	0.	14.0000	0.	.220418
1962	27.0000	0.	15.0000	0.	.249792
1963	49.0000	0.	16.0000	0.	.279999
1964	45.0000	0.	17.0000	0.	.344825
1965	54.2000	0.	18.0000	0.	.353795
1966	75.8000	0.	19.0000	0.	.379100
1967	96.0000	0.	20.0000	0.	.393921
1968	108.000	0.	21.0000	0.	.408520
1969	129.700	0.	22.0000	0.	.431064
1970	143.200	0.	23.0000	0.	.183930
1971	114.200	0.	24.0000	.400000	-.304752
1972	182.110	1.00000	25.0000	.400000	.474792
1973	182.010	1.00000	26.0000	.200000	.500250
1974	129.110	1.00000	27.0000	0.	.668752
1975	140.000	1.00000	28.0000	0.	.712980

YEARS	P_m^*	P_f	N_u	Y_F	P_c/P_s
1947	.874269	90.5900	1.55655	52.0000	.948938
1948	.722586	112.900	1.57676	57.7500	1.43742
1949	.904260	92.0200	1.60930	49.7200	.958973
1950	1.16609	72.7900	1.64662	55.6600	.681065
1951	1.12386	83.0800	1.57834	62.2400	.996922
1952	1.19904	78.8800	1.70136	66.5400	.453150
1953	1.68041	57.7300	2.18912	71.9800	.705149
1954	2.09463	41.3200	2.24225	72.2700	.681619
1955	1.09574	77.7100	2.28797	78.9200	.819851
1956	.773494	118.540	2.34360	86.1800	1.09656
1957	.960830	99.3100	2.38013	89.7000	.597445
1958	.995709	95.5500	2.95040	93.7200	.568794
1959	1.00000	100.000	3.02383	100.000	1.00000
1960	1.17490	91.3100	3.20246	110.700	2.32522
1961	1.09918	95.8900	3.28938	119.210	1.22055
1962	1.03860	98.9700	3.33735	128.320	1.36581
1963	1.15035	88.7900	4.00537	141.000	1.66625
1964	1.13968	93.8600	4.64918	158.560	2.82498
1965	.958738	120.450	6.08431	174.570	2.64165
1966	.718180	161.060	6.23948	190.090	3.47498
1967	.726988	159.370	6.38315	204.620	3.02154
1968	.703294	173.640	6.52770	243.470	3.82518
1969	.719974	171.270	6.78079	269.310	3.34077
1970	.773435	170.150	6.77726	299.860	3.30000
1971	.939862	214.840	7.10362	340.000	2.85001
1972	.935996	336.540	6.48157	403.440	2.47895
1973	.668823	590.440	6.65873	517.060	1.99875
1974	.768316	626.500	6.72824	563.230	1.64587
1975	.890714	491.280	6.91420	570.000	1.14257

(continued)

YEARS	P_c^*	$\bar{Q}_m$	$\bar{K}_f$	$\bar{K}_c$	$\bar{K}_m$
1947	1.13445	1044.23	2486.78	276.309	1251.25
1948	1.28069	1080.68	2473.48	271.780	1352.73
1949	1.03890	1129.44	2512.94	279.215	1476.03
1950	1.24770	1180.30	2602.67	321.678	1652.89
1951	1.48146	1143.79	2548.43	283.159	1671.16
1952	.621070	1203.69	2828.99	314.332	1937.50
1953	1.28339	1250.99	2993.81	332.646	2142.22
1954	1.80929	1494.73	3389.26	376.584	2521.93
1955	1.16073	1625.66	2720.97	302.330	2072.45
1956	.971402	1615.78	2396.04	266.227	1878.12
1957	.965562	1660.90	2593.86	288.207	2092.40
1958	.800419	1782.39	2687.44	298.605	2252.90
1959	1.00000	1814.48	2591.24	287.916	2278.75
1960	2.50958	1789.45	2541.78	314.152	2382.24
1961	1.24028	1927.00	2492.85	339.934	2454.71
1962	1.06012	2090.53	2615.69	290.632	2641.86
1963	1.21230	2225.87	2762.44	306.938	2898.98
1964	1.60271	2228.18	2596.71	288.523	2859.08
1965	1.08692	2470.29	2370.20	323.209	2798.57
1966	1.06929	2813.42	2169.39	214.555	2616.34
1967	.827195	3021.29	2387.00	265.222	3089.58
1968	.936247	3342.24	2259.66	251.073	3038.35
1969	.831144	2842.42	2229.04	247.671	3173.47
1970	.987482	2580.85	2245.16	249.462	3384.44
1971	.863247	2298.52	1673.32	206.815	2700.82
1972	.728205	2420.24	1360.80	202.515	2333.51
1973	.503624	2020.45	973.723	180.475	1801.32
1974	.642490	1895.57	941.299	172.459	1852.30
1975	1.02697	1789.50	1260.00	155.457	2496.84

YEARS	g	N_R^*
1947	.01075	37.4800
1948	.01074	37.8600
1949	.01854	38.6200
1950	.02275	39.4000
1951	.02490	40.2200
1952	.01271	40.6500
1953	.02295	41.5000
1954	.02386	42.3800
1955	.02599	43.3300
1956	.02789	44.3700
1957	.01715	44.9600
1958	.02802	46.0400
1959	.02851	47.1500
1960	.06394	49.9500
1961	.03115	51.2600
1962	.02060	52.0400
1963	.02178	52.8300
1964	.01069	53.0500
1965	.03299	54.4300
1966	.03132	55.7500
1967	.03120	57.0900
1968	.02961	58.3600
1969	.02895	59.8700
1970	.01914	61.3100
1971	.04312	63.4900
1972	.03210	65.0400
1973	.03557	66.7000
1974	.03352	68.2400
1975	.02433	69.9000

APPENDIX C

C.4. Values of the exogenous variables under the 'status quo' situation

YEARS	$\bar{K}_f$	$\bar{K}_c$	$\bar{R}$	N_R^*	N_U
1976	1339.43	149.900	26791.5	71.9300	7.11000
1977	1373.34	151.410	27086.2	73.9400	7.31000
1978	1387.14	147.670	27384.2	76.0100	7.51000
1979	1480.30	183.090	27685.4	78.2900	7.74000
1980	1719.86	185.860	27989.9	80.6400	7.97000
1981	1745.85	186.790	28269.8	82.9800	8.20000
1982	1754.61	188.670	28552.5	85.2200	8.42000
1983	1900.74	200.340	28838.0	87.4700	8.65000
1984	2164.62	232.760	29126.4	89.9600	8.86000
1985	2527.53	292.750	29417.7	91.9000	9.08000

YEARS	D_m	TT	g	Y_F	P_c/P_s
1976	1.00000	29.0000	.290000E-01	592.800	1.02800
1977	1.00000	30.0000	.280000E-01	616.510	1.02500
1978	1.00000	31.0000	.280000E-01	641.170	1.02200
1979	1.00000	32.0000	.300000E-01	666.820	1.02400
1980	1.00000	33.0000	.300000E-01	693.490	1.16300
1981	1.00000	34.0000	.290000E-01	721.230	1.16100
1982	1.00000	35.0000	.270000E-01	750.080	1.23400
1983	1.00000	36.0000	.265000E-01	780.080	1.24600
1984	1.00000	37.0000	.250000E-01	811.280	1.19700
1985	1.00000	38.0000	.250000E-01	843.740	1.22100

YEARS	$\bar{K}_m$	F	D
1976	2527.53	144.200	0.
1977	2550.39	148.530	0.
1978	2609.72	152.980	0.
1979	2697.28	157.570	0.
1980	2765.56	162.300	0.
1981	2829.91	167.170	0.
1982	2921.93	172.180	0.
1983	3010.93	177.350	0.
1984	3677.54	182.670	0.
1985	4230.18	188.150	0.

APPENDIX C

C.5. Allocation of additional capital under various policies

YEARS	KF1	KC1	KM1
1976	1920.00	384.000	1536.00
1977	1655.00	331.000	1324.00
1978	1600.00	320.000	1280.00
1979	1500.00	300.000	1200.00
1980	1450.00	290.000	1160.00
1981	1400.00	280.000	1120.00
1982	1300.00	260.000	1040.00
1983	1100.00	220.000	880.000
1984	1000.00	200.000	800.000
1985	900.000	180.000	720.000

	KF2	KC2	KM2
1976	768.000	192.000	2880.00
1977	662.000	165.500	2482.50
1978	640.000	160.000	2400.00
1979	600.000	150.000	2250.00
1980	580.000	145.000	2175.00
1981	560.000	140.000	2100.00
1982	520.000	130.000	1950.00
1983	440.000	110.000	1650.00
1984	400.000	100.000	1500.00
1985	360.000	90.0000	1350.00

NOTES:

(a) KF1, KC1 and KM1 are the amount of additional capital in the production of food, the cash crop and the manufactured good respectively under policy I.

(b) KF2, KC2 and KM2 are the amount of additional capital under policy II.

APPENDIX C

C.6. Values of the policy(exogenous) variables under various policies

Policy I

YEARS	$\bar{K}_f$	$\bar{K}_c$	$\bar{K}_m$
1976	3259.43	533.900	4063.53
1977	3028.34	482.410	3874.39
1978	2987.14	467.670	3889.72
1979	2980.30	483.090	3897.28
1980	3169.86	475.860	3925.56
1981	3145.85	466.790	3949.91
1982	3054.61	448.670	3961.93
1983	3000.74	420.340	3890.93
1984	3164.62	432.760	4477.54
1985	3427.53	472.750	4950.18

Policy II

	$\bar{K}_f$	$\bar{K}_c$	$\bar{K}_m$
1976	2107.43	341.900	5407.53
1977	2035.34	316.910	5032.89
1978	2027.14	307.670	5009.72
1979	2080.30	333.090	4947.28
1980	2299.86	330.860	4940.56
1981	2305.85	326.790	4929.91
1982	2274.61	318.670	4871.93
1983	2340.74	310.340	4660.93
1984	2564.62	332.760	5177.54
1985	2887.53	382.750	5580.18

Policy III

	$\bar{R}$	F
1976	27236.24	168.28
1977	27535.84	173.33
1978	27838.73	178.53
1979	28144.96	183.88
1980	28454.55	189.40
1981	28739.10	195.09
1982	29026.49	200.93
1983	29316.75	206.97
1984	29609.92	213.17
1985	29906.02	219.57

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