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AGRICULTURAL PRICE POLICY IN BANGLADESH: GENERAL EQUILIBRIUM EFFECTS ON GROWTH AND SECTORAL INCOME DISTRIBUTION

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Declaration

Except where otherwise noted, this thesis is my own work.

Umme Salma

Umme Salma

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Glossary

Amon rice	A variety of monsoon rice
Aus rice	A variety of summer rice
Boro rice	A variety of winter rice
Upazila	The lowest administrative unit
Taka	Currency in Bangladesh, the exchange rate being US$1=Taka 29.89 in 1985-86 (Bangladesh, Ministry of Finance 1987)
Saree	The dress worn by women in Bangladesh
Lungi	A dress for males which substitutes for trousers
Gur	A local substitute of sugar

Abbreviations

BBS	Bangladesh Bureau of Statistics
CES	Constant elasticities of substitution
CET	Constant elasticities of transformation
CGE	Computable general equilibrium
c.i.f.	Cost, insurance and freight
CRESH	Constant elasticities of substitution, homothetic
CRETH	Constant elasticities of transformation, homothetic
EC	European Community
FAO	Food and Agriculture Organization of the United Nations
f.o.b.	Free on board
GDP	Gross domestic product
HYV	High yielding variety
IFDC	International Fertilizer Development Corporation
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary least squares
SAM	Social accounting matrix

ABSTRACT

Bangladesh grew very slowly when it was a part of Pakistan and its growth scarcely accelerated after independence in 1971. Poor overall performance reflects poor agricultural productivity, for agriculture is still the dominant economic sector, providing livelihood for some 80 per cent of the population.

This study is concerned with the reasons for the low growth of agriculture and the economy more generally. Since farmers in Bangladesh, like farmers in most countries, are responsive to the prices that face their production and consumption decisions, the study evaluates the effects of indirect (macro and trade) and direct (sectoral) prices on agricultural development and economic development more generally. The evaluation is carried out in a general equilibrium context.

A 25-sector and 35-commodity computable general equilibrium model, with a single representative private consumer, is used to analyse the impact of price policies. Aggregate disposable income accruing to the representative household is divided into two components: farm income and non-farm income. The model is essentially neo-classical with some adaptations to represent the structural and institutional features of the Bangladesh economy. Particular care has been taken to model production technology in agriculture. An econometric study using a system approach was carried out to determine the technology structure in agriculture and estimate the output supply and input demand elasticities of farmers.

The experiments which simulate technological growth in agriculture also emphasise the role of agriculture in the overall economic development

of Bangladesh. Increased investment in rural infrastructure, especially water control and transportation, brings about marked improvement in the choice of crops and production techniques, and hence in the agricultural sector as well as the economy as a whole. The constraining effect of inappropriate indirect (macro and trade) policies currently prevents the transfer of resources into agriculture. When trade reforms are simulated so that scarcity premia and tariffs are removed/reduced, agricultural performance improves as production costs fall. If the currency is depreciated agricultural and other export profitability rises, also attracting increased investment into these sectors.

Not unexpectedly, short-run simulations of policy reforms show less impressive growth than long-run simulations. In both the short and the long run, in accordance with the results of other studies of the agricultural sector in many developing countries, indirect policies appear to have a greater impact on agricultural productivity and output than direct policies. Direct policies do not offset the bias against agriculture created by indirect policies, but their removal would exacerbate the problems faced by agriculture if indirect policies were not reformed. In the short run, public investment in agricultural infrastructural facilities would be needed if the indirect and direct reforms were to be fully utilized. The budgetary expenditure at present expended on agricultural subsidies could be used for such public investment. In the long run, rising agricultural profitability would then be likely to attract private capital to the sector.

CHAPTER 1

INTRODUCTION

An overview

This study is concerned with the agricultural sector of Bangladesh and with its growth. Agriculture is dominant in Bangladesh in terms of its share of gross domestic product (GDP), employment, and exports. In 1984/85 it accounted for 47 per cent of GDP, 58 per cent of employment, and 32 per cent of exports (Bangladesh, Bureau of Statistics 1986c, 1990). Given that agricultural and overall economic growth are positively related[1], it is not surprising that Bangladesh only achieved an annual GDP growth rate of 2.6 per cent during the period 1980 to 1989 against a population growth rate of 2.6 per cent, when its agricultural production grew at an annual rate of 2.1 per cent (World Bank 1991a).

An investigation into the causes of negative *per capita* growth in agriculture leads to the analysis of economic policies, because `poverty in rural areas does not originate in the sector, but is the result of distorted signals throughout the economy' (Hughes 1988:27). Most of these signals are transmitted through prices, and in so far as farmers are responsive to price signals, agricultural price policy influences the agricultural growth rate. It is generally agreed that farmers in Bangladesh, like `farmers the world over, in dealing with costs, returns, and risks, are calculating economic agents' (Schultz 1978:4). Agricultural price policy, broadly

[1] For a general discussion on the relation between agriculture and economic development see Johnston and Kilby (1975), Johnston and Mellor (1961), Mellor (1966), Ishikawa (1967), Enke (1962), Hayami and Ruttan (1985), Ghatak and Ingersent (1984), and Eicher and Staatz (1984). For discussions of experiences of developed countries see Nicholls (1964), Habakkuk (1965), and Ohkawa and Rosovsky (1964). Rangarajan (1982), Gibb (1974), Bell, Hovell and Slade (1982), Bautista (1986), and Hwa (1988) stress the complementary relationship between agriculturalal and industrial growth in developing countries.

defined to include all policy interventions that influence relative price structures between agriculture and non-agriculture, between a particular crop and another, and between outputs and inputs, affects the net returns to agricultural producers. This in turn affects the allocation of resources within agriculture, between agriculture and non-agriculture, and between domestic production and imports.

Agricultural price policy so defined has two components: direct or sector-specific policies and indirect or more general economic policies. The first set of policies are aimed to affect directly the relative price structure within agriculture, and include agricultural input and output pricing policies such as fertilizer subsidy policy, irrigation equipment distribution policy and output support price policy for a particular crop. The second set of policies are labelled indirect because they are policies which are adopted for reasons not directly and primarily associated with agriculture, but which create significant spillover effects on net farm returns. Trade, exchange rate, monetary and fiscal policies constitute this set of policies. Protection for manufacturing raises the cost of agricultural inputs and a rise in the prices of domestically produced import substitutes makes the net returns to manufacturing more lucrative. Expansionary monetary and fiscal policies often lead to higher inflation at home than abroad, and if the exchange rate is not allowed to adjust, the currency becomes overvalued, necessitating import controls and rationing. The bias against agriculture becomes stronger, not only because an overvalued exchange rate reduces the competitiveness of exports (which are usually mostly agricultural in developing countries such as Bangladesh), but also because import controls increase the degree of protection conferred to import substituting manufacturing by adding scarcity premia to imports.

Import-substituting industrialization has been the chosen strategy in Bangladesh since the beginning of the 1950s when the country started its political partnership with the then Pakistan after the departure of the British. Import substitution shaped economic policies until the end of the 1980s. Then finally the Fourth Five-Year Plan claimed that

> `Prior to 1985/86, Bangladesh had an import policy characterized by extensive quota restrictions and bans.... a new two-year import policy has been announced from 1989/90. ....major reform measures in the import regime include simplification of import procedure, gradual expansion of imports through the secondary exchange market (SEM), relaxation of quantitative restrictions, rationalization of tariffs etc.' (Bangladesh, Ministry of Planning 1990:iv-6).

At the same time, drives to achieve self-sufficiency in foodgrains and stabilization of agricultural prices have led to the adoption of various policies which directly target agriculture, resulting in a complex system of commodity taxes, input subsidies, state trading monopolies, and price-setting arrangements for agricultural commodities.

In recent years there has been a trend away from government control towards privatization in agricultural marketing and distribution. Input subsidies have either been completely withdrawn or reduced drastically. Food procurement emphasizes an incentive price to farmers, although a public food distribution system with an urban bias is also in operation. Concerns are being voiced from different quarters about the possible negative outcome of withdrawing agricultural input subsidies and privatizing the distribution and ownership of capital inputs (Osmani and Quasem 1985). However, in the absence of complementary changes in macroeconomic policy, the removal of assistance to agriculture through input subsidies may expose agriculture to further discrimination.

Research to assess the effects of government intervention on agricultural profitability is timely. It is essential to find out whether the concerns of price sceptics, about reduced assistance to agriculture following from withdrawal of input subsidies, are genuine before any further cost is imposed on agriculture. It is also necessary to identify policy switches required to bring about a reasonable growth rate in agriculture.

The rationale and consequences of a discriminatory agricultural price policy: a general discussion

A negative bias against agriculture is common in developing countries. The extent of taxation of agriculture in some countries is indicated by comparing the ratio of protection to value added in agriculture with protection to value added in industry (Table 1.1). All the countries listed except the Republic of Korea have imposed a heavy penalty on agriculture.

Table 1.1 **Protection of agriculture compared with manufacturing in selected developing countries**

Country	Year	Relative protection rates[a]
Philippines	1974	0.76
Argentina	1969	0.46
Chile	1961	0.40
Colombia	1978	0.49
Brazil[b]	1980	0.65
Mexico	1980	0.88
Nigeria	1980	0.35
Egypt	1981	0.57
Peru[b]	1981	0.68
Turkey	1981	0.77
Republic of Korea[b]	1982	1.36
Ecuador	1983	0.65

Source: World Bank, 1986, *World Development Report 1986*, World Bank, Washington DC:62.

[a] Values less than one indicate that manufacturing receives more protection than agriculture.

[b] Refers to primary sector.

The cause of the bias against agriculture lies in policy planners' perception of economic development and agriculture's role therein. Although the role of agriculture as a supplier of food, capital, labour, foreign exchange, and market for domestic manufactures was acknowledged, development ideology in the 1950s failed to determine whether the contributions of agriculture should be interpreted in a "voluntary or a compulsory sense" (Myint 1975:353). Agriculture may voluntarily contribute to domestic food supply and save foreign exchange for manufacturing if a rise in agricultural productivity takes place; it may increase the size of the domestic market for manufactures if farmers voluntarily prefer domestic manufactures to imports, and it may release resources if savings outflow is induced by a higher return in manufacturing than in agriculture. On the other hand, agriculture may be forced to supply cheap food to urban consumers by price and procurement policies, to increase the size of the market for domestic manufactures by facing import restrictions, and to release capital by taxation and manipulation of the terms of trade against it.

A voluntary contribution from agriculture to economic development requires an initial productivity growth in agriculture. Engel's law operates as demand for foodgrains does not rise in proportion to increases in income (Schultz 1953), and an income elasticity greater than one for services raises the prices of non-traded goods relative to traded goods (Anderson 1987). In response to relative price changes, resources move out of agriculture to other sectors where returns are greater. This pattern has been observed in most developed countries. But the economic history of the majority of the developing countries is different. Development economics in the 1950s was largely influenced by Lewis's (1954) dual economy model with unlimited supply of labour in the traditional sector, Prebisch's (1959) pessimism about agricultural and primary exports and Hirschman's advocacy for manufacturing on the ground of its `crushing' (1958:109-110) superiority over agriculture in terms of linkage effects. The need to invest in agriculture and its growth was downplayed in favour of arguments for the rapid transfer of resources out of agriculture into industry which was seen as the appropriate strategy for economic development. In many developing countries, the approach of governments to the developmental challenge has been coloured by these theories, and in their rush to achieve industrialization they have often treated agriculture as a "black box from which people, and food to feed them, and perhaps capital could be released" (Little 1982:105). The policy environment that evolved as a consequence was an import-substituting industrialization policy with heavy protection to manufacturing.

The net effect of indirect policies is a reduced profitability of agriculture. Studies of trade and exchange rate policies for several countries have shown that protection of the manufacturing sector by these policies has adversely affected prices of agricultural products compared with the prices of manufacturing products and prices of non-tradeables. Examples of some of these studies are Bautista (1987) for the Philippines, Tshibaka (1986) for Zaire, Mundlak, Cavallo and Domenech (1990) for Argentina, Oyejide (1986) for Nigeria and Dorosh and Valdes (1990) for Pakistan.

Direct policies, like indirect ones, were adopted to facilitate the performance of agriculture in its expected role of providing cheap food and earning foreign exchange. In low-income developing countries, food takes a dominant share of the consumers' budget. Fluctuations in food prices are therefore a major source of fluctuations in consumers' real income. They have been a matter of political concern for many governments committed to provide cheap food to urban areas. The perceived need for managing food production and prices has led governments to adopt various policies affecting relative agricultural input and output prices. Attempts have been made to keep the domestic source of fluctuation under control by providing stable government supply of inputs in combination with food procurement policies. Having created a bias against agriculture by industry and macro economic policies, many developing countries have sought to improve food security and the domestic supply of foodgrains through input and output price subsidies. In addition, state control of foodgrains trading is widely practised to insulate the domestic market from world food price fluctuations.

In many developing countries a common phenomenon is the control of pricing, marketing and trading of cash crops, to make agriculture perform its other role of earning foreign exchange. At the same time, export taxes are imposed on its exports to facilitate resource transfer out of agriculture.

The severity of the consequences of discrimination against agriculture is demonstrated in a World Bank study of 18 developing countries (Krueger, Schiff and Valdes 1988) showing that indirect policies discriminated against agriculture in all 18 countries; in some instances direct policies added to the discrimination although in others they mitigated it, albeit with limited success (Table 1.2).

Table 1.2 **Direct, indirect and total protection rates[a] for selected commodities, 1980-84 (in percentages)**

Country	Effects on exportables				Effects on importables			
	Product	Direct	Indirect	Total	Product	Direct	Indirect	Total
Argentina	Wheat	-13	-37	-50	None	-	-	-
Brazil	Soybean	-19	-14	-40	Wheat	-7	-14	-21
Chile	Grapes	0	-7	-7	Wheat	9	-7	2
Colombia	Coffee	-5	-34	-39	Wheat	9	-34	-25
Egypt	Cotton	-22	-14	-36	Wheat	-21	-14	-35
Ghana	Cocoa	34	-89	-55	Rice	118	-89	29
Ivory Coast	Cocoa	-26	-28	-54	Rice	16	-26	-10
Korea	None	-	-	-	Rice	86	-12	74
Malaysia	Rubber	-18	-10	-29	Rice	68	-10	58
Morocco	None	-	-	-	Wheat	0	-8	-8
Pakistan	Cotton	-7	-35	-42	Wheat	-21	-35	-56
Philippines	Copra	-26	-28	-54	Corn	26	-28	-2
Portugal	Tomatoes	17	-13	4	Wheat	26	-13	13
Sri Lanka	Rubber	-31	-31	-62	Rice	11	-31	-20
Thailand	Rice	-15	-19	-34	None	-	-	-
Turkey	Tobacco	-28	-35	-63	Wheat	-3	-35	-38
Zambia	Tobacco	7	-57	-50	Corn	-9	-57	-66

Source: Krueger, A., M. Schiff and A. Valdes, 1988. `Agricultural incentives in developing countries: measuring the effect of sectoral and economywide policies', *The World Bank Economic Review*, 2(3):255-71.

[a] A negative protection rate implies a bias against the crop.

Objectives of the study and framework of the analysis

Objectives

This study is concerned with an evaluation of the agricultural price policy that existed until 1985 in Bangladesh in terms of its impact on agricultural and national growth, efficiency and equity. The basic theme underlying the study is that agriculture in Bangladesh has not undergone a natural process of development whereby productivity growth in agriculture automatically releases resources for use in other sectors. Instead of being a `resource reservoir' (Reynolds 1975:14) in this dynamic sense, it was subject to a `ruthless primitive capital accumulation' (Khan 1972:94) to finance import-substituting industrialization in the decades of the 1950s and 1960s[2], and there have not been any significant changes in policies in later decades to reverse or counter the earlier policies. Because of the large size of the agricultural sector, its lack of growth has affected the entire economy.

The study aims to test the following hypotheses:

- agricultural growth in Bangladesh contributes to growth in the rest of the economy;
- agriculture is taxed by the current control structure in the economy;
- a dismantling of the current control structure with a move towards general trade liberalization and a free float of the exchange rate in a single exchange rate system would perform better in terms of both overall efficiency and equity than partial micro reforms; and
- considerable scope exists for boosting agricultural and overall growth by investing in agricultural infrastructure and productivity.

Framework of the analysis

Although agricultural price policy is traditionally analyzed in a partial equilibrium framework (see Barker and Hayami 1976, and Tolly, Thomas and Wong 1982 for some examples), this study is undertaken in a general equilibrium framework[3]. The preference for a general equilibrium approach is derived from the following weaknesses of a partial approach.

The first problem with a partial approach is that it fails to take account of the complex linkages between agriculture and the rest of the economy. It evaluates the welfare implications of a price policy by taking only the first-

[2] Two studies quantify the extent of intersectoral resource transfer during the Pakistan regime. Griffin and Khan (1972:29) cite an estimate of resource transfer out of agriculture of Rupees 31,120 million during the two decades leading to 1968/69. Taking an annual average, the resources that were transferred accounted for about 10 per cent of GDP at current prices of the median year. Constructing a balance of payments for agriculture for 1964/65, another study found that the resource transfer from agriculture reached 15 per cent of the value of its gross output (Griffin 1965). The concealed taxation approximated 70 per cent of manufacturing value added of that year and hence it would not be an exaggeration to assert that the early industrialization in Pakistan was "financed" in a most direct sense by the agricultural sector (Lewis 1970:66).

[3] Some examples of general equilibrium analysis of agricultural price policy are: Anderson and Warr (1987) and Adelman and Robinson (1978) for The Republic of Korea, de Janvry and Subbarao (1986) and Narayana, Parikh and Srinivasan (1987) for India, Dethier (1985) for Egypt, de Melo (1979) for Sri Lanka, McCarthy and Taylor (1980) for Pakistan, and Burniaux and Martin (1989) for OECD countries).

round effects of a price change on consumers' and producers' surpluses, and therefore misses the effects derived from the linkages between changes in factor income and household demand. This explains why some of the general equilibrium analyses of agricultural policies produce results which are apparently counter-intuitive. For example, analysing the effects of the EC's Common Agricultural Policy on an economywide basis Stoeckel (1985) found that rather than saving jobs, the policy had actually contributed to unemployment. Higgs's (1989) and Martin et al's (1988) studies of Australia show that agriculture performs better if agricultural supports are withdrawn, but with a simultaneous removal of supports in the industry sector.

A partial analysis also suffers from `lack of economic structure' (Hertel 1990a:22). The reduced-form demand and supply elasticities in partial equilibrium analysis do not give information about the assumptions about preferences, technology and factor markets. This makes it difficult to interpret the results of these analyses. For example, it is not explicit whether supply elasticities are optimal quantity responses with exogenous prices, or whether some factors are held constant in the relevant time horizon. If the latter holds, the cross-elasticities imply that the supply response is a movement along a fixed transformation curve and the commodities appear to be substitutes rather than complements. However, if the fixed factors are made variable, it is likely that the expansion effects dominate and the commodities are gross complements. Both theoretical (Hertel 1987) and empirical studies (Ball 1988) provide testimony to this statement. If commodities are gross complements rather than substitutes, the consequences of trade liberalization are greater. Since technology and factor market assumptions are typically not explicitly stated, a partial equilibrium analysis does not indicate whether the estimates of the impact of a policy change is truly accounted for. In contrast, general equlibrium analysis, by explicitly spelling out the assumptions about the nature of the variables, gives an accurate picture of the structure that is assumed to exist behind the policy simulations.

A general equilibrium analysis, however, is not free from weaknesses. Although most of the times theoretically sophisticated, the empirical implementation of a general equilibrium model requires enough conceptual simplifications. The models are often highly stylized and preferences, technology and endowments are simplified for the sake of transparency and tractability. The extent of required simplifications and abstractions may seriously undermine the reliability of model predictions. In addition, the requirement of finding a large data of parameter values is likely to encourage using values of dubious reliability, without a 'feel for the range of likely error' (Gardner 1988).

The term agricultural price policy does not include monetary policy in the general economic policy set in this study. The reason is that the model deals only with the real sector; it does not have a monetary sector, and an assessment of monetary policy, therefore, is not possible.

The database

The study uses 1984-85 as the reference period, the choice of the year being governed by the availability of a suitable input-output flow matrix and the relevant parameter values. Thus the general equilibrium model is built on the control structure prevalent in 1984-85 and the simulation results are interpreted as an outcome of reforms in the policies which have created the structure. Although the phasing out of agricultural input and food subsidies started long before 1985 and a complete deregulation of the marketing of fertilizer took place in 1984, subsidies were not completely withdrawn and the government budget for 1984-85 incurred subsidy expenditures on food, fertilizer and irrigation. Fertilizer subsidies have now been withdrawn but the other two subsidies are still in operation. The general economic policy environment demonstrates a pattern typical of a regime dominated by import control and exchange rationing. A multiple exchange rate system with periodic adjustment in the rates has been the practice of the government with regard to exchange rate policy. The industrialization strategy was essentially an `export oriented-cum-selective import substitution strategy' (Bangladesh, Ministry of Planning 1990:iv-6) although periodic microeconomic reforms such as cuts in the tariff rates were attempted.

Organization of the study

A computable general equilibrium (CGE) model is developed to describe the economy and the processes which operate therein. Particular care is taken in modelling the production structure of the agricultural sector. An econometric study is carried out to validate the technology assumed in the model for agriculture and to estimate the output supply and input demand elasticities of the farmers.

The following hypothetical policy experiments are examined using the model to test the hypotheses described above:

- an across-the-board reduction in manufacturing tariffs,
- a removal of the import licensing system,
- floating of the exchange rates,
- unification of the exchange rates,
- withdrawal of fertilizer subsidies,

- withdrawal of irrigation subsidies,
- withdrawal of food subsidies,
- 10 per cent increase of capital stock in agriculture,
- technological change generating 10 per cent growth in agricultural production.

The first four experiments together will allow an assessment of indirect policy reforms. The current control structure created through exchange control and import licensing, will be completely overturned and the industrial protection granted through tariffs will be uniformly reduced. The second three experiments deal with sectoral policy reforms. The next experiment allows an exploration of the prospects of growth through increased investment in agriculture. The last experiment, to justify the importance of this study, answers the fundamental question of whether agricultural growth matters in the overall growth of the Bangladesh economy.

The organisation of the study is as follows:

Chapter 2 describes the state and characteristics of the economy of Bangladesh in the 1980s and argues that the current state is a result of long-term policy stance spread over four decades beginning from the 1950s.

Chapter 3 analyses the evolution of sector-specific and macro economic policies that have contributed to a negative bias towards agriculture. The chapter also provides an analytical framework that illuminates the mechanisms through which indirect policies operate to create the bias.

Chapter 4 concentrates on outlining the production structure of the agricultural sector of Bangladesh and econometrically estimating a set of input demand and output supply elasticities of the farmers. Some of these elasticity values are later used in the CGE model to simulate the general equilibrium effects of agricultural pricing policies.

The general equilibrium model is developed in Chapter 5. Before the actual model is outlined in detail, issues concerning general equilibrium modelling of agricultural price policies are discussed briefly.

Chapter 6 describes the data and model solution procedures. Simulation results of different experiments are reported in Chapter 7. Chapter 8 concludes the study with the presentation of policy recommendations.

Appendix A contains the time-series price and quantity data for variables relevant for econometric estimation of farmers' output supply and input demand functions. Appendix A1 provides the full set of model equations. Appendix A2 describes the model variables. Appendix A3 describes the parameters with their data source and spells out the formulas that compute the share coefficients. Appendix A4 provides the choice of model closures identifying the endogenous and exogenous variables. Appendix A5 contains the derivation of the percentage change forms of some of the equations in level forms. Appendix B lists sectors and commodities identified in the model. Appendix C contains a number of tables from the input-output database.

CHAPTER 2

THE ECONOMY OF BANGLADESH : 1950-1985

Bangladesh became an independent nation in December, 1971 following a war of liberation against what was then West Pakistan. Before that, after the British left in 1947, the area of Bangladesh was joined with the western side of the Indian Subcontinent to form the state of Pakistan. Although the independent entity of Bangladesh only dates from 1971, the present structure and character of the Bangladesh economy is in many ways also a result of the policies that were followed during the 24 years of political partnership with Pakistan. Hence this study goes back beyond 1971, as far as data permits. The period before 1971 is referred to as pre-independence and the period after 1971 as the post-independence years.

The population of Bangladesh is predominantly rural with a very low level of *per capita* income. The low standard of living is characterized by poor social indicators of development such as literacy, life expectancy, and persons per physicians (Table 2.1).

Agriculture

Crop production is the prime agricultural activity, contributing more than two-thirds of the agricultural value added. Livestock production accounts for 15 per cent and the remaining portion originates in forestry and fisheries. Fish is an important source of protein, contributing more than half of the animal protein intake. In 1990 this sector accounted for 9 per cent of merchandise export earnings and employed nearly 7 per cent of the agricultural labour force (Bangladesh, Bureau of Statistics 1990).

Table 2.1 **Socio-economic profile of Bangladesh, 1985**

Population (million)	100
Urbanization rate (per cent)	18
Cropped land *per capita* (acre)	0.22
Literacy rate (per cent)	33
Life expectancy (years at birth)	51
Daily *per capita* calorie supply (calories)	1922
Daily *per capita* protein supply (grams)	41
Per capita energy consumption (Kg coal equiv)	57
Persons per physician (number)	6723
Rural population with access to safe water (per cent)	43
Per capita GNP (US $)	150
Sectoral share of labour force	
Agriculture (per cent)	72
Non-agriculture (per cent)	28
Sectoral share of GDP	
Agriculture (per cent)	50
Manufacturing (per cent)	8
Services (per cent)	42

Source : Asian Development Bank, 1990. *Key Indicators of Developing Asian and Pacific Countries*, Economics and Development Resource Centre, Asian Development Bank, Manila.

Crops

Rice is the single most important crop grown, accounting for four-fifths of the total cropped area and 90 per cent of the total value of crop production in recent years. Three main varieties of rice are grown: *aus*, *amon*, and *boro*. *Amon* is a variety of monsoon rice, whereas *aus* and *boro* are varieties of summer and winter rice respectively. Jute is the second most important crop, being grown on about 5 per cent of the total cropped area. In raw and manufactured form it earns around 75 per cent of export income, and is the principal cash crop which meets most of the non-subsistence consumption needs of the farmers. Unlike rice, jute is grown mostly for sale and relative prices of rice and jute play an important role in the relative acreage allocation to jute and *aus* variety of rice. Wheat production was negligible before the early 70s, but with the spread of modern technology, wheat production has grown dramatically and today it is the third most important crop. Other principal crops include sugarcane, potatoes, oilseed, pulses and tea. Tea is a foreign exchange earner contributing around 6 per cent of national export earnings.

Analysis of the cropping pattern during the last four decades shows a gradual expansion of cereal crops at the cost of non-cereal crops, especially jute and pulses (Table 2.2). Pulses are an important source of protein for the poor, while some of the non-cereal cash crops like jute, tobacco and sugarcane, are inputs into industrial processing. The rise in cereal production has resulted in an increase in non-cereal agricultural food imports (Khan and Hossain 1989, Abdullah 1990).

Table 2.2 **Share of crops in agricultural output, 1949-52 to 1982-84**

Crops	1949-52	1969-71	1982-84
Aus rice	12.7	16.8	15.7
Amon rice	56.6	48.0	45.8
Boro rice	3.3	14.7	19.5
Wheat	0.2	0.6	4.8
Cereals	**72.9**	**80.0**	**85.8**
Pulses	5.6	2.8	1.9
Oilseeds	3.0	3.1	2.1
Potato	0.5	1.6	1.7
Chilli	1.4	1.0	0.7
Other food	**10.5**	**8.6**	**6.4**
Jute	10.8	6.0	3.5
Sugar-cane	4.4	0.8	3.6
Tobacco	1.4	0.6	0.6
Cash crops	**16.6**	**11.4**	**7.8**
All crops	**100.0**	**100.0**	**100.0**

Source: Hossain, M., 'Agricultural development in Bangladesh: A historical perspective', paper presented at a seminar jointly conducted by Bangladesh Economic Association and International Food Policy Research Institute, Dhaka, 1985b:4.

A modest rate of growth in overall crop production was achieved in both the pre- and the post-independence periods. Foodgrain production increased by 3.17 per cent per annum during 1957/58 to 1970/71 and by 2.9 per cent per annum during 1970/71 to 1983/84 (Hossain 1984b). Production of jute, on the other hand, shows a declining trend. During 1969-85 an average annual decline of 1.4 per cent was observed (Khan and Hossain 1989)

The nature of crop growth has been quite different in pre- and post-independence periods (Osmani and Quasem 1985, Khan and Hossain 1989). During the sixties the source of growth was increased cropping intensity due to an extra *aus* crop per year, while in the seventies it was the result of acreage reallocation in favour of foodgrains and greater yields per acre. The allocation of land to cereal crops was the outcome of the spread of seed-water-fertilizer technology in food production. It has been estimated that the increased use of these three inputs has contributed to two-thirds of the increase in crop production between 1975 and 1984 (Hossain 1984b).

High yielding varieties (HYV)

The use of HYV seeds with modern irrigation started in 1966/67 and the use of chemical fertilizer began to gain momentum at the turn of the sixties. The area under HYV seeds expanded from 2.5 per cent of total acreage under cereals in 1969/70 to 31.5 per cent in 1984/85 (Table 2.3).

Table 2.3 **Expansion of high yielding varieties in Bangladesh, 1969/70 to 1984/85**

Year	HYV as % of acreage under *aus*	*amon*	*boro*	wheat	HYV as % of gross cropped area	HYV as % of total cereal production
1969/70	0.6	0.2	26.5	-	2.5	8.0
1975/76	10.3	9.7	55.9	58.8	15.7	30.3
1976/77	11.3	7.3	57.5	72.7	13.9	26.6
1977/78	12.6	8.6	58.6	83.3	16.0	29.3
1978/79	12.8	11.8	55.9	89.1	18.7	32.6
1979/80	13.3	14.6	63.0	94.9	22.7	39.0
1980/81	15.7	15.9	64.4	96.7	25.4	41.4
1981/82	15.0	15.9	68.9	96.7	25.8	42.2
1982/83	15.1	17.9	75.4	95.9	27.4	46.4
1983/84	15.9	17.7	76.1	96.0	28.5	45.0
1984/85	15.9	18.9	72.0	97.1	31.5	48.8

Source: Bangladesh, Bureau of Statistics, 1986c. *Statistical Yearbook of Bangladesh 1986*, Government of Bangladesh, Dhaka.

In 1984/85, almost all of the wheat area and about three-fourths of the *boro* area were under HYV, while only a sixth of the land under *aus* and *amon* was allocated to HYV. Although the shift to HYV has been quite rapid, it will be argued in the following section that the full potential for the spread of modern seed varieties has not yet been exploited. As seen from Table 2.4, only about one-third of the suitable land was under HYV in 1983/84, the shortfall being the highest for *aus*, and the least for *boro* and wheat.

Table 2.4 **Potential and actual acreage under HYV**

Crop	Area Suitable for HYV (000 acres)	Area Under HYV in 1983/84 (000 acres)	HYV area in 1983/84 as % of Suitable Area
Aus	6845	1235	18
Amon	7608	2628	35
Boro and Wheat	9734	3934	40

Source: Osmani, S.R. and M.A. Quasem, 1985. Pricing and Subsidy Policies for Bangladesh Agriculture, (mimeo.), Bangladesh Institute of Development Studies, Dhaka, 1985.

Irrigation

The climate of Bangladesh is generally sub-tropical monsoon with predominance of summer and monsoon seasons. The rainy season lasts from June until October, with 80 per cent of the rainfall occurring during this period. The remaining months are mostly dry and agriculture during this season depends markedly on artificial irrigation. Till the early 1960s irrigation was mostly carried out by traditional methods. Mechanical irrigation was almost non-existent, but in 1969/70 35 per cent of total irrigation was mechanized. By 1984/85, 82 per cent of irrigation was mechanical. Currently, however, total acreage under traditional and modern methods of irrigation is only 20 per cent of the cultivable land (Bangladesh, Bureau of Statistics 1990).

Rahman (1981, 1983) argued that supply side constraints are more responsible for the low adoption of modern seed varieties than forces that operate on the demand side. Access to irrigation plays a crucial role in HYV adoption. The regional variation in the diffusion of modern varieties of cereals is closely related to variation in the area irrigated by modern methods. Also, 75 per cent of regional variation in fertilizer consumption is explained by the variation in irrigated area (Boyce 1986). Hossain (1986) found an even stronger degree of complementarity between fertilizer use, irrigation and HYV adoption. The observed complementarity of HYV seeds, irrigation and fertilizer implies the necessity of a simultaneous spread in their use, although irrigation `constitutes the key technological constraint to agricultural growth in Bangladesh' (Boyce 1986:29).

The potential for the expansion of irrigation is large. With the existing vast volume of water available, nearly 40 per cent of the cultivated land could be irrigated, through water conservation measures and by withdrawing streamflows from the rivers (Bangladesh, Ministry of Irrigation and Flood Control 1986). The groundwater resource potential is estimated to be able to irrigate another 45 per cent of the cultivated land. However, specific attention is needed to utilize the existing irrigation opportunities in the dry winter months, as the options are rather limited in the wet months when irrigation requires additional investment of huge amount for flood control and river drainage.

Fertilizer

The use of fertilizer started to increase during the 1960s and this trend gained momentum with the rapid adoption of modern seed varieties in the 1970s (Table 2.5). The entire area under modern varieties is treated with fertilizer and its rate of application is six to ten times higher (depending on the season) in modern varieties than on traditional types of crops (International Fertilizer Development Corporation 1984).

Table 2.5 **Fertilizer consumption and rate of application, 1963/64 to 1983/84**

Year	Consumption (000 ton, nutrient)	Application (nutrient lbs/acre)
1963/64	49.7	4
1970/71	144.6	10
1977/78	339.2	23
1980/81	420.0	28
1983/84	543.5	36

Source: Bangladesh Agricultural Development Corporation, as presented in p. 20 of Osmani, S.R. and M.A. Quasem, Pricing and Subsidy Policies for Bangladesh Agriculture, Bangladesh Institute of Development Studies, (mimeo.), Dhaka, 1985.

Pattern of land ownership and tenancy

The agrarian structure of the economy is an institutional reason for the low HYV adoption rate, along with lack of irrigation. Bangladesh has a very small land base with a *per capita* holding of 0.22 acre in 1985. The small farm, defined as a holding under 2.5 acre, is the dominant production unit. From the distribution of land ownership given in Table 2.6 it appears that approximately 80 per cent of the farmers own small holdings and occupy 29 per cent of total agricultural land, while the remaining 20 per cent of farmers occupy 71 per cent of the land.

Table 2.6 **Distribution of rural land ownership 1983/84**

Size groups	Share of households (per cent)	Share of area (per cent)
Less than 1.0	58.3	7.8
1.0-2.5	21.6	21.2
2.50-5.0	11.6	27.5
5.0-7.5	4.7	17.6
7.5 or more	3.8	25.9
All farms	100.0	100.0

Source: Bangladesh, Bureau of Statistics, 1986b. *The Bangladesh Census of Agriculture and Livestock: 1983-84*, Vol 1, Government of Bangladesh, Dhaka.

Not all lands are cultivated by owners and tenancy arrangements are an important aspect of Bangladesh agriculture. Around 20 to 25 per cent of land is leased out by big to small farmers, and almost all of this (93 per cent) is in the form of share tenancies where landlords receive half or more of the produce, usually without sharing any input cost (Jannuzi 1977).

Ownership concentration and share tenancy are inversely related to the adoption of HYV technology in Bangladesh (Hossain 1988). The reason for tenants not adopting HYV arises from the terms of leases which place the entire burden of input cost on them. The low adoption rate by large farmers is explained by the same factor which is also responsible for the inverse relation between farm size and productivity observed in many studies for Bangladesh (see for examples, Hossain 1974, 1977). The general explanation for higher productivity in small farms is the low opportunity cost of labour. The small farms, possessing a pool of underemployed family members, find it more profitable to cultivate labour-intensive HYVs employing labour as long as its marginal productivity is positive. The larger farms, employing more hired labour, only employ labour till its marginal productivity equals the going wage rate.

Another important negative impact of the concentration of land ownership and the current tenancy pattern is that they discourage investment in agriculture. By analysing the investment behaviour of different landownership groups, Hossain (1988) found that the income elasticity of investment was inversely related to the size of land ownership, and the marginal rate of productive investment was the lowest for the large landowning groups. In addition to arriving at a similar conclusion, Rahman (1980) observed that sharecropping arrangements dampened incentives for productive investment by both landlords and tenants.

Manufacturing

Compared with agriculture, the manufacturing sector is very small. In the mid 1980s, it accounted for only 10 per cent of GDP and employed less than 3 per cent of the labour force (Asian Development Bank 1990). Among the industries, jute and cotton textiles, paper and newsprint, sugar, cement, chemicals, fertilizers and leather are important.

Manufacturing does not have homogeneous production units in terms of plant size and capital intensity. Large and medium scale production units contribute between 50 to 60 per cent of manufacturing value added: small, cottage and handloom industries account for the rest. Of total manufacturing employment, 14 per cent is absorbed in large and medium industries, another 14 per cent in small industries, and cottage and handloom industries provide employment to the remaining 72 per cent (Khan and Hossain 1989).

Large and medium industries can be labelled as the modern manufacturing sector, borrowing from organised credit institutions and hiring in a relatively organised labour market. Cottage industries, on the other hand, obtain 70 per cent of their labour requirements from family labour (Khan and Hossain 1989). Their capital equipment is mostly locally produced and technology is traditional. Small industries are closer to large industries in terms of technology, but they, together with cottage and handloom industries, receive very few benefits from the various incentive policies of the government and have little access to institutional credit. Government incentive policies that favour larger manufacturing units have disadvantaged other manufacturing enterprises. A recent study of handloom production shows that the effective rates of protection for coarse and medium quality *lungi* and *saree* (common clothing for a majority of the people) produced by the handloom sector are within the range of 12 to 65 per cent, while mills enjoy 33 to 180 per cent effective rate of protection on these items (Ahmad and Islam 1989).

The large and medium manufacturing enterprises were almost all nationalized (92 per cent of the fixed assets of the modern manufacturing sector) immediately after independence in 1971. There was gradual denationalization after 1975, and by 1985 the public sector held only 40 per cent of the fixed assets in the manufacturing sector, mostly in public utilities.

A comparison of relative performance in terms of profitability shows that the small, cottage and handloom sector has performed better than the modern sector (Khan and Hossain 1989). Analysing survey and census data for 1981/82, Khan and Hossain found that the rate of return on capital was more than 70 per cent for small and cottage industries, 35 per cent for handlooms, and only 11 per cent for large and medium industries.

Exports

The export sector is mainly dependent on a few agro-based commodities. During the 1950s and 1960s jute accounted for nearly 90 per cent of export earnings. In recent years its contribution has not been less than 60 per cent. Two new exports, shrimps and clothings, have increased dramatically since independence, rising from a negligible contribution of 1.5 per cent in the early 70s, to 30 per cent of exports in 1985/86 (Table 2.7).

Table 2.7. **Composition of exports (per cent), 1972-75 to 1980-85**

	1972-75	1975-80	1980-85
Raw jute	32	24	16
Jute products	54	49	46
Leather	5	10	9
Shrimps	2	5	9
Tea	4	7	7
Clothing	-	-	4
Newsprint	1	1	1
Others	1	5	8

Source : Compiled from data given in *Economic Survey of Bangladesh 1986/87*, Government of Bangladesh, Dhaka.

Dependence on one export meant an unstable export base. Primary products usually face wide fluctuation in prices; the export value of raw jute, both in terms of quantity and price, varied considerably during the 1970s and 1980s.

Imports

The structure of imports has undergone some changes during the 1970s and the 1980s (Table 2.8). A decline in the share of consumer items has been more or less compensated by an increased share of intermediate items. The share of capital goods has not changed significantly. Among consumer goods, foodgrains have remained the single most important item. Though self-sufficiency in foodgrains has been the proclaimed objective of the government since the very beginning of its planning effort as an independent nation, the translation of this aspiration into reality has not eventuated. The food import bill has increased every year, from $272 million in 1976 to $484 million in 1985, an annual increase of about 6 per cent. Most of these food imports are financed by concessional food aid, although to maintain a target level of supply, the government has to commit a large amount of cash for imports if a crop is bad or if aid is below expectations.

Unemployment and underemployment

On the basis of the 1983/84 agricultural census, 46 per cent of the households were landless (defining households owning less than 0.5 acres as effectively landless), and needed to be employed as wage labourers. An analysis of labour force data exhibits no upward trend in absolute numbers in agricultural employment between 1974 and 1983/84. Instead a small decline is observed (Table 2.9). As discussed earlier, the small growth in overall crop production achieved during this period was largely because of increased foodgrains production at the expense of decline in jute acreage. Jute employs 93 per cent more labour than HYV *aus* rice, and 16 per cent more labour for traditional *aus* rice (Alauddin and Mujeri 1985). A replacement of jute by HYV *aus* might not have displaced a significant amount of labour. But only 16 per cent of *aus* rice uses HYV seed (Table 2.3). Replacing the traditional variety by HYV in the remaining 84 per cent is constrained by a lack of water control. This is because *aus* grows in low-lying land prone to flood. To grow HYV varieties large-scale flood control schemes are required.

Table 2.8 **Labour force and employment, 1974 and 1983/84**

Census 1974	Labour Force Survey	1983/84
Labour force (million)	22	29
Employment in		
Agriculture	17	16
Non-agriculture	5	12
Unemployment rate (per cent)	2	2
Agricultural employment as per cent of total employment	79	59

Source:Bangladesh, Bureau of Statistics, 1986c. *Statistical Yearbook of Bangladesh 1986*, Government of Bangladesh, Dhaka.

Published unemployment data is misleading, as the concept of open unemployment is not applicable to Bangladesh. The open unemployment estimates of the Bangladesh Bureau of Statistics are between less than one to a little over two per cent of the rural labour force. This conspicuously low rate reflects the inappropriateness of the concept in a country where the `organisation of the economy is such and sharing of work is so widely used a practice that open unemployment is not likely to be an important category' (Islam and Muqtada 1986:2).

A more appropriate concept for Bangladesh is, therefore, that of underemployment. Among the various indicators of underemployment such as time, income or productivity, most of the available studies have used time as the chief indicator. Islam (1986), on the basis of several government surveys conducted on labour force and employment during 1979 to 1984 (Bangladesh, Bureau of Statistics 1980, 1982, 1986a), found rural male underemployment rates to be 31 per cent in 1979, 21 per cent in 1980, and 22 per cent in 1983/84. Khan (1985) defined 288 days as the full-employment level, and using the normative concept of unemployment (Krishna 1976), found the unemployment rate to be approximately 31 per cent and constant between 1973/74 and 1982/83. Other estimates of the unemployment rate are 48 per cent (Masum 1979) and 42.5 per cent (Ahmed, I. 1981) in 1975/76.

An important dimension of rural underemployment is its seasonality. This is due to the nature of monsoon agriculture, where crop production is usually confined to particular seasons, and also to the nature of the production process itself. Crop production has various stages and demand for labour varies substantially from one stage to another, causing peak and slack seasons. Although underemployment diminishes significantly during the peak season, it never disappears altogether. The 1980 Manpower Survey (Bangladesh, Bureau of Statistics 1980) provided an estimate of seasonality in underemployment. According to this survey, nearly 6 per cent of the male agricultural workforce worked less than 40 hours a week during the peak season. While 39 per cent worked less than 40 hours a week during the slack season, a further 28 per cent of male workers could only obtain employment for less than 20 hours per week during the slack season.

The concept of open unemployment is not applicable to the urban sector either. With acute mass poverty, people cannot afford not to work. Official surveys report the same strikingly low unemployment rate for the urban sector as they do for rural areas. The concept of underemployment is again more relevant in urban areas. The 1983-84 Labour Force Survey (Bangladesh, Bureau of Statistics 1986a) indicates that about 23 per cent of the urban employed labour force works 40 hours or less per week. Applying income measures of unemployment which defines employment as the labour time necessary to earn minimum subsistence income minus non-labour income (Dandekar and Rath 1971), a recent study found that, at a very modest urban poverty threshold income, three-fourths of the urban employed labour force were underemployed (Amin 1986).

Some macro aggregates

Government consumption expenditure doubled from 1972 to 1985 but government investment expenditure remained unchanged (Table 2.9). Exports stagnated with a 300 per cent rise in imports. The only two macro aggregates that show improvement are private consumption and private investment. While private consumption decreased as a proportion of total resources (GDP+imports), private investment increased. However, increasing income inequality and the upsurge in the consumption of the urban rich (termed as the `technological transformation in consumption' by Abdullah and Rahman 1987:4), suggest that the burden of the relative fall in aggregate private consumption may have been borne by the poorer people.

Table 2.9 **Structure of demand, 1972/73 to 1984/85**

Account	1972/73	1977/78	1984/85
Private consumption	82	80	77
Government consumption	3	5	7
Private investment	3	4	5
Government investment	5	6	5
Import	5	12	14
Export	5	5	5

Source: Bangladesh, Bureau of Statistics, 1986c. *Statistical Yearbook of Bangladesh 1986*, Government of Bangladesh, Dhaka.

The government's revenue raising measures have not been sufficient to finance its rising expenditure. Government revenues in recent years have been around 9 per cent of GDP. Compared with other low income countries, this is very low (World Bank 1987:Table 5.2). A recent international comparison of the tax effort, taking taxable capacity into account, ranks Bangladesh second lowest among 17 developing countries (Chowdhury and Hossain 1988).

Revenue earning is overwhelmingly dependent on indirect taxes (Table 2.10). In recent years they accounted for more than 80 per cent of current revenue. The most important indirect source is revenue from foreign trade. Customs duty and sales taxes together comprise the revenue from foreign trade, which has generated more than half of the total revenue since 1975/76. The other important sources of indirect tax revenue are taxes on domestic goods and services. In recent years this tax has consisted almost exclusively of excise taxes. The base of the excise is the entire domestic production sector, but the tax is confined to a few commodities including tobacco, petroleum and petroleum gas, and jute manufacturing, which account for 45, 24 and 4 per cent of the revenue share respectively.

Table 2.10: **Tax structure in Bangladesh: selected years 1974 to 1985 (per cent)**

Tax	1974	1980	1981	1982	1983	1984	1985
Direct	18	18	20	21	22	20	21
Income	9	13	14	15	14	13	14
Land Revenue	2	1	1	.92	1	1	2
Stamp	4	3	4	4	3	4	4
Regisrtration	2	1	1	1	1	1	1
Other	1		-	-	-	-	-
Indirect	82	82	80	79	80	80	79
Import	29	39	38	40	39	40	36
Export	-	2	1	0.5	0.5	0.6	0.5
Excise	28	21	23	23	25	24	28
Sales	12	19	16	14	15	15	14
Other	13	1	1	1	0.7	1	1

Source: Bangladesh, Ministry of Planning, 1987. *Fiscal Statistics, 1987*, Government of Bangladesh, Dhaka.

Direct taxes comprise taxes on income (taxes on agricultural and non-agricultural income, and corporation tax) and taxes on property (wealth tax, gift tax, estate duty, land revenue, capital gains tax, urban property tax, house rent tax and non-judicial stamps). Income and corporation taxes together account for less than 15 per cent of total revenue. This percentage has remained virtually unchanged during the last two decades. Nearly 75 per cent of the taxes on income come from corporate taxes. The contribution of personal income tax is meagre. Although it can be argued that a very narrow tax base arising from the very small earnings of the majority of the population is responsible for this, it cannot be denied that government policies have not been successful in transforming the high growth in income of the richer section of the population into either public investment through taxes or productive private investment through appropriate policy signals.

The poor performance of the government in mobilizing internal resources and the very low rate of private savings (around 5 per cent of national expenditure during the later half of 1980s, Bangladesh, Bureau of Statistics 1990) result in an aggregate domestic savings rate which is the lowest among neighbouring developing countries (Table 2.11).

Table 2.11 **Gross domestic savings as a percentage of GDP in selected developing countries during 1985 to 1988 (per cent of GDP)**

Country	1985	1986	1987	1988
Bangladesh	2	2	4	3
India	22	22	20	21
Nepal	14	12	12	11
Pakistan	6	11	14	12
Sri Lanka	12	12	13	12

Source: World Bank, 1991b. *World Tables 1991*, Washington DC.

Given the low domestic savings rate, the high investment rate of around 12 per cent during this period (World Bank 1991b:51) has been made possible by foreign financing, the two major sources of which are remittance earnings and foreign aid.

Remittances of workers, mainly from the petroleum-exporting countries of the Middle East and North Africa, became very important in the 1970s when the number of workers going abroad began to increase rapidly. In 1977/78, 14 per cent of trade deficits was met by remittance earnings, and in 1985/86, the contribution was 36 per cent (Bangladesh, Ministry of Finance 1987). To attract the remittances of the workers, the Bangladesh government introduced a Wage Earners' Scheme in 1975. Under this scheme, the remitters are allowed to sell the foreign exchange at the secondary market which attracts a premium. Because of the scarcity of foreign exchange at the officially fixed rate, these premiums are significant, although with gradual devaluations of the official rate, the premium has declined over the years (Table 2.12).

Table 2.12 **Official and secondary market exchange rate, 1977/78 to 1987/88 (Taka per US $)**

Year	Official rate of foreign exchange	Secondary rate of foreign exchange	Premium(%)
1977/78	15.12	19.87	31.40
1978/79	15.22	19.68	29.30
1979/80	15.47	19.22	24.22
1980/81	16.34	20.05	22.71
1981/82	20.05	22.97	14.56
1982/83	23.76	24.12	1.52
1983/84	24.95	27.16	8.86
1984/85	26.10	29.38	12.6
1985/86	29.91	32.74	9.46
1986/87	30.64	33.08	7.96
1987/88	31.25	34.48	10.34

Source: Bangladesh Bank, Statistical Department. *Economic Trends*, various issues.

Foreign capital inflows financed by net foreign loans and grants were equivalent to 8 per cent of GDP during 1980/81 to 1986/87. Up to June 1986 outstanding foreign assistance amounted to $14,011 million of which outright grants accounted for about 51 per cent (Bangladesh, Ministry of Finance 1986). The rest consisted of medium- and long-term loans at a very concessional rate of interest with a repayment period of 39 years and a grace period of nine years. In addition, Bangladesh has occasionally drawn short-term credits from the International Monetary Fund and from commercial sources. As a consequence, the debt burden has become severe; in 1985/86 debt services (amortization plus interest) amounted to 61 per cent of export earnings and 40 per cent of export earnings plus remittances.

Stagnation in *per capita* income

In so far as changes in GDP reflect real income trends, the last forty years have shown virtual stagnation in *per capita* income. According to World Bank estimates, *per capita* GDP during 1965-1984 grew at an annual rate of 0.6 per cent (World Bank 1986). Khan (1972) estimated *per capita* GDP growth rate to be 0.27 per cent between 1949/50 and 1969/70. However, given the built-in upward bias in the methodology used to estimate GDP[1], he argued that the real growth rate in this period was zero. Since the bias is still operative, it is doubtful whether the World Bank estimate of 0.6 per cent growth is significantly different from zero.

Khan and Hossain (1989) estimated the growth rate for the pre- and post-independence periods separately. They found that between 1949/50 and 1969/70 *per capita* GDP grew by 0.66 per cent *per annum*, while between 1972/73 and 1986/87 it grew by 1.64 per cent. They pointed out that the recent higher trend was mainly due to a very depressed base following the War of Independence.

While GDP grew very little in *per capita* terms, its structural composition changed somewhat. Table 2.13 shows that the contribution of manufacturing to GDP remained unchanged during the post-independence period, but there was a shift away from agriculture to sectors aggregated as `other'. It would be tempting to conclude that a dynamic diversification caused agriculture to decline in its share of production, but a further disaggregation of `other' into its components belies such a claim. Growth in public administration, defence and miscellaneous services mainly accounts for the shift. The share of these three sectors was about 8 per cent in the late 1960s, and they ranged between 11 and 12.5 per cent in the 1980s. However, the real contribution to production of these three sectors is not very clear.

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1 Value added in sectors such as fisheries, livestock production and housing and services is assumed to grow at a constant annual rate, usually at a rate equal to the population growth rate. Available evidence, however, suggests that these have been the lagging sectors.

Table 2.13 **Sectoral shares in GDP, 1949/50 to 1984/85 (per cent)**

Year	Agriculture	Large industry	Small industry	Other
1949/50	65.2	0.6	3.3	30.9
1954/55	63.0	1.4	3.3	32.3
1960/61	62.6	3.0	3.4	31.0
1963/64	59.4	3.4	3.1	34.1
1966/67	55.9	5.0	3.2	35.9
1969/70	55.3	6.0	2.9	35.8
1973/74	57.0	4.4	2.3	36.3
1977/78	53.2	5.8	4.5	36.5
1981/82	48.8	6.1	4.6	40.5
1984/85	46.9	5.6	4.4	43.1
1985/86	46.8	5.5	4.3	43.4

Source: Khan, A.R., 1972. *The economy of Bangladesh*, and Bangladesh, Bureau of Statistics, 1986c. *Statistical Yearbook of Bangladesh 1986*, Government of Bangladesh, Dhaka.

Similarly, data on labour force composition (Table 2.8) suggest a structural transformation from 1974 to 1983/84. Between the 1974 Census and 1983/84 Labour Force Survey, the agricultural labour force remained more or less unchanged in number, while the total labour force increased by nearly 33 per cent. The increased labour force was absorbed in non-agricultural employment, causing the share of agricultural employment to drop from 79 per cent in 1974 to 59 per cent in 1983/84. The urban manufacturing, with little growth, could only absorb a small share of the additional labour force. Rural off-farm employment provided jobs for 78 per cent of the new workers, trading and cottage industries being the largest source of employment.

Per capita income not only stagnated, but became less evenly distributed. Most available studies conclude that income distribution has become more unequal since the 1960s (Khan 1977, Ahmad and Hossain 1985, Osmani and Rahman 1986), and poverty has increased (Bangladesh, Ministry of Planning 1983, Osmani 1990). Land holdings, an important indicator of rural income distribution, exhibit a persistently high level of land concentration during 1960 and 1978.

Table 2.14 **Shares of land owned by fractile groups of households (grouped by land holding size)**

Fractile groups	1960	1968	1974	1977	1978
Bottom 60%	25	24	19	11	9
Middle 30%	39	40	43	40	39
Top 10%	36	36	38	50	52
Gini Ratio	-	-	0.59	0.63	0.66

Source: Osmani, S.R. and A. Rahman, 1986. Income Distribution in Bangladesh, *Research Report No. 53*, Bangladesh Institute of Development Studies, Dhaka:21.

Between 1977 and 1983/84, landlessness (owning less than 0.5 acres) increased by more than 13 per cent. With the cultivable land area virtually unchanged, the consequence is `open landlessness or its disguised version where operating a miniscule holding has to be supplemented by recourse to wage labour' (Khan and Lee 1984:10).

A corollary to increasing landlessness is the increasing importance of wage income in total earnings. In 1973/74, the lowest 37 per cent of the rural households, ranked according to household income, derived 31 per cent of their income from wages (including wages from farm work); in 1978/79, wages contributed 44 per cent of the income of the bottom 55 per cent of the rural households (Bangladesh, Bureau of Statistics 1978, 1984). Khan (1984) finds that in the 1960s, 25 per cent of those who reported cultivation as their main occupation were dependent on wages as a supplementary source of income, and by 1979, the number increased to 37 per cent.

Having to resort to wage income by itself is not a real problem if there are enough employment opportunities. Discussion in previous pages has demonstrated that this was not so. Unemployment exists in agriculture as well as in non-farm sectors. In Chapter 6 it is indicated that the wage rate in off-farm employment in rural areas is lower than the agricultural wage rate. Given the small proportion of non-farm employment in rural areas, the movements in real wages of agricultural workers are the principal determinants of real income for a fairly large proportion of the agricultural population. Table 2.15 shows the wage pattern of agricultural workers over nearly four decades. Real wages have declined markedly over the years despite periodic fluctuations. The estimated trend rate of decline is a statistically highly significant -1.7 per cent per annum (Khan and Hossain 1989).

Table 2.15 **Wage rate of male agricultural workers, 1949 to 1988 (Taka per day)**

Year	Nominal wages	Real wages[a]	Year	Nominal wages	Real wages[b]
1949	1.92	11.29	1971/72	3.38	7.43
1950	1.62	10.17	1972/73	4.72	6.71
1951	1.56	9.55	1973/74	6.69	6.69
1952	1.52	9.42	1974/75	9.05	5.33
1953	1.38	8.19	1975/76	8.82	7.09
1955	1.32	9.21	1976/77	8.93	7.32
1957	1.70	9.52	1977/78	9.44	6.41
1958	1.85	9.21	1978/79	10.88	6.43
1959	1.85	9.27	1979/80	12.46	6.19
1960	1.95	9.83	1980/81	13.97	6.54
1961	2.18	10.88	1981/82	15.48	5.92
1962	2.25	10.55	1982/83	17.05	6.13
1963	2.41	11.28	1983/84	19.58	6.28
1964	2.65	12.72	1984/85	24.54	6.95
1965	2.34	10.62	1985/86	29.83	8.09
1966	2.40	9.10	1986/87	32.56	7.70
1967	2.60	9.19	1987/88	32.30	7.08
1968	2.75	9.78			
1969/70	2.96	9.40			
1970/71	3.13	9.42			

[a] Money wages deflated by the index of cost of living of agricultural workers with 1972/73 as the base.

[b] Money wages deflated by the index of cost of living of agricultural workers with 1973/74 as the base.

Source: Khan, A.R. and M. Hossain, 1989, *The Strategy of Development in Bangladesh*, Macmillan, London:157.

The real wage situation in manufacturing is not much different from agriculture. Table 2.16 presents real wage indices in manufacturing as a whole and in the jute textile industry, the largest of the manufacturing industries. Real wages dropped by more than 33 per cent immediately after independence. Since then real wages have been rising very slowly but are still below pre-independence levels.

Table 2.16 **Real wage indices in manufacturing sector**

Year	Manufacturing	Jute textiles	Construction
1969/70	100	100	100
1973/74	66	66	-
1974/75	46	48	-
1975/76	58	59	85
1976/77	63	59	89
1977/78	75	79	80
1978/79	81	84	90
1979/80	82	87	94
1980/81	85	90	96
1981/82	77	78	94
1982/83	83	75	99
1983/84	81	76	99
1984/85	-	69	91
1985/86	-	86	-

Source: Bangladesh, Bureau of Statistics, 1990. *Statistical Yearbook of Bangladesh 1990*, Government of Bangladesh, Dhaka.

Causes of stagnation

Several explanations have been given for the lack of growth in Bangladesh. Some studies have identified the lack of stable government as the prime cause (Khan and Hossain 1989, Abdullah and Rahman 1987). This study puts much of the onus on the quasi-autarkic industrialization strategy pursued by the government of Pakistan at the expense of the agriculture. Unfortunately this policy has been continued by Bangladeshi policy makers.

At the time of political independence in 1947, Pakistan had almost no industrial base. Agriculture dominated production, employment and exports.

> 'The movement for Pakistan was led by an elite of Muslim landlords, traders and businessmen of India. This elite saw the opportunity for industrialising and modernising the nation through private enterprise, and this was attractive to them because it would ensure their leadership of the economy.The elite had no difficulty in getting their ideas accepted by a government which had come to rule in a country that was created on the basis of religious nationalism.' (Griffin and Khan 1972:124)

Economic policy from the very start focused on the promotion of industrialization through private ownership. Though some authors argued that import-substituting industrialization was a choice 'arrived at by default' (Bruton 1970:126) for many developing countries, this was not so for Pakistan. The emerging capitalists argued that Pakistan was not strong enough to withstand international competition. Its capital base was small and entrepreneurs lacked experience. It was thus thought that there was a need to extract surplus from other sectors in the economy and agriculture was considered to be the area capable of generating a surplus. The instrument applied was control over trade. The allocation of foreign exchange at the overvalued official rate to importers paid an implicit subsidy to industrial entrepreneurs. The high premium at which imported goods were sold in the market created the profits needed to build capital. However, the overvalued currency was a tax on exporters who were mostly the farmers.

The protectionism that followed did not lack ingenuity and it worked, albeit at great cost to agriculture, for 24 years. The situation did not change greatly after independence in 1971. Power was in the hands of a party which

> `was a pro-Western party without a commitment to any fundamental social change. Beginning in the middle of the 1960s, its program became staunchly nationalistic, typical of parties which combined populism with support for the interests of the emerging capitalist and middle classes against non-indigenous capitalists' (and against their own poor) (Khan and Hossain 1989:85).

Although private enterprise was succeeded by nationalization at independence, nationalization was precipitated by the exodus of Pakistani capitalists for 85 per cent of the industrial assets of Bangladesh were owned by people who became foreigners in December, 1971. In 1975, however, when a series of coups established a military government, a return to privatization began.

Liberalization has continued during the past decade. The exchange rate has been brought closer to a price that would result in a more manageable balance of payments, by reducing industrial protection rates, by reducing foreign exchange control, by raising official interest rates, and by reducing subsidies on agricultural inputs. Steps have also been taken to give subsidies to non-traditional exports.

The institutional framework has not, however, changed greatly. Many of the policy changes have contributed little to allocative efficiency, because, instead of uniform reductions in distortions, the government has acted selectively so that the new measures have often created new distortions. `Policy distortions have in reality become fungible....subsidies on fertilizer have been removed while those on irrigation equipment have been retained' (Khan and Hossain 1989:179). The food subsidy has been reduced for civilians, but it has remained unaltered for defence personnel. A strong bias continues to be exercised against agriculture.

CHAPTER 3

AGRICULTURAL PRICE POLICY IN BANGLADESH

Policies that impact on agriculture are classified into two broad groups; trade and exchange rate policies and agricultural sector-specific policies. This chapter begins with a description of the history and development of government interventions that have shaped these policies. The distortions which result from the policies are then analyzed.

Trade and exchange rate policy

Following the end of the Korean war in 1952, Pakistan which at that time included Bangladesh, faced a severe foreign exchange shortage. Rather than devaluing, the government opted for foreign exchange rationing together with import licensing and quantitative controls. Referring to Pakistan, Hamid and Nabi concluded that

> `This paved the way for import-substituting industrialization and set the course of the relationship between industry and agriculture, the pattern of public investment and government intervention which, with some modifications, persists till today.' (1989:22)

The analysis applies equally to Bangladesh, whose macro-economic policy is largely a legacy of its past association with Pakistan.

Foreign trade policy

The dominant feature of the import policy in the decade of 1950s and 1960s was that all imports were subject to licensing. Allocation of import licenses was on the basis of `essentiality'. Consumer goods, especially luxury items, were given the lowest priority and raw materials, spare parts and machinery were given high priority. This escalated protection for consumer goods, particularly those that were the least essential. Although the protection stemmed mainly from the pattern of licensing, it was also supported by an evolving tariff system. In 1965/66 tariffs ranged from 34 per cent on machinery and equipment and 39 per cent on unprocessed raw materials to 180 per cent on consumer luxuries (Thomas 1966). The effective rates of protection were, of course, more divergent and generally greater in value than nominal rates, ranging from negative values for agro-processing industries to a positive value of 396 per cent for motor vehicles (Soligo and Stern 1965). The consequence was a distorted investment pattern which encouraged consumption by permitting an excessive expansion of consumption goods industries (Khan 1963, Power 1963). Griffin (1965) suggests that 63 to 70 per cent of the resource transfers from agriculture were dissipated in higher consumption in urban areas.

Independence from Pakistan in 1971 was followed by a policy of nationalization of all industries, banks and insurance companies. But only the ownership of property changed hands. The structure of incentives remained inward-looking and continued to favour capital intensity.

Although attempts have been made from time to time, especially in the 1980s, to liberalize and reduce tariffs more generally, there has been little fundamental change in industrial incentives. This can be seen from the levels of nominal and effective protection in the 1980s. In 1984 the nominal tariff rate was on average 33 per cent on consumer goods, 26 per cent on intermediate goods and 23 per cent on capital goods, while the average effective protection rate for import substituting manufacturing was about 92 per cent (Bangladesh, Trade and Industrial Policy Reform Programme 1986a).

The structure of incentives is not systematic. As well as providing protection to domestic industries, the tariff structure is also designed to curtail the consumption of luxury goods, to provide incentives to private investment in manufacturing, and to disperse private investment regionally. In order to direct investment into industries deemed desirable, *ad hoc* measures were often introduced, including `tailor made' tariffs, special exemptions from duties for imports destined for specific industries or regions, and exemptions from sales and excise taxes. Such objectives were often in conflict. They created a complex incentive pattern with many anomalies. Because of the anomalies, investors constantly applied for tariff adjustments, which are largely made at the discretion of the administration. Thus, instead of guiding investment decisions, the tariff system has tended to become a mechanism by which the *ex post* profitability of investments is ensured. This has lead the economist Sobhan to comment that "There is obviously little rationality in our policy interventions which appear to derive from ad hoc initiatives rather than a clearly thought out strategy of industrialization" (1990:130).

The industrial incentive structure often not only varies among industries but also between products of the same industry, between stages of production in manufacturing and among markets to which they cater. Table 3.1 provides an estimate of the effective rate of protection by commodity and by market. It demonstrates a very widely dispersed incentive structure with a surprisingly large number of industries actually losing foreign exchange or at least saving very little in relation to the domestic resources they use. Several other studies of trade and exchange rate policies in Bangladesh have similar conclusions (Farashuddin 1980, Sattar 1984).

Table 3.1: **Effective protection rates by industry and type of buyer (in per cent)**

Product	Sale in domestic market	Export
A. Industries that lose or save very little foreign exchange at high domestic resource cost		
Steel and Engineering:		
1.Cast iron	149	-
2.M.S. rod	288	-
3.Gi pipe	260	-
4.Copper wire	411	-
5.Television	290	-
6.M.S. billet	NVA[c]	
7.M.S. plate	NVA[c]	
8.C.G.I. Sheet	NVA[c]	
Chemical & Allied:		
1.Sulphuric acid	142	
2.Hydrochloric acid	366	-
3.Chromium sulphate	228	-
4.Starch	1590	-
5.Liquid glucose	482	-
6.BSIF products	435	-
7.Plastic pipes	88	-2
8.Footwear	160	-
9.Electrical accessories	86	-221
10.Caustic soda	NVA	-
11.DDT	NVA[c]	-
12.Alum	NVA[c]	-
13.Paper	NVA[c]	-
14.Pulp	NVA[c]	-
15.Paper tube	NVA[c]	-
16.Metal jacket	NVA[c]	-
17.Tyre & tube	NVA[c]	-
Agro-based Industries:		
1.Sugar	407	-
2.Pineapple juice	95	4
3.Edible oils	978	-
4.Vegetable ghee	435	-
5.Cow leather	251	-
Textile Sector:		
1.Cotton yarn	113 to 513	-
2.Nylon yarn	181	-
3.Rayon yarn	NVA[c]	-
4.Silk yarn	NVA[c]	-
5.Gray cotton shirting	115 to 127	-
6.Gray polyester shirting	150 to 180	-
7.Gray polyester suiting	213	-
8.Finished shirting	196	-
9.Men's shirts	311 to 318	-
10.Men's trousers	197	-

(coninued over next page)

(continued)

Table 3.1: **Effective protection rates by industry and type of buyer (in per cent)**

Product	Sale in domestic market	Export
<u>B. Industries with intermediate effective rate of protection</u>		
<u>Steel and Engineering</u>:		
1.Electric motor	33	-204 to 32
2.Diesel engine (25 % local content)	33	-127 to 56
3.Electronic component	31	-127 to 56
4.Transformer	7	-234 to -45
<u>Textile Sector</u>:		
1.Finished suiting	54	-
2.Ready made garments	-	23 to 26
<u>Chemicals and allied</u>:		
1.Paper (KPM)	47	-
<u>Agro-based Industries</u>:		
1.jelly	33	-2
2.Ketchup	33	2
<u>C. Industries with low or negative ERPs</u>:		
<u>Steel and Engineering</u>:		
1.Ship breaking	15	-
2.Pipes and tubes	-	-120 to 15
3.Electric bulb	-67	-
4.Bicycle	14	-
5.Powerloom	-35	-
6.Spinning frame	-4	-
7.Softener	-18	-
8.Cop winding machine	-17	-
9.Broadloom	-19	-
10.Reeling machine	-22	-
11.Lathe	-22	-
12.Diesel engine(73 % local)	-58	-
<u>Chemicals & Allied</u>:		
1.Newsprint	-20	35
2.Bleaching powder	-279	-
3.Dextrose monohydrate	-52	-
4.Packing material	-25	-145
5.Porcelain	7	-1
6.Earthenware	16	-
7.Plastic machinery parts	-	16
8.Rubber sandal	-12	-
9.Industrial enamel	-40	-
10.Auto finish	-9	-
11.Marine enamel	-39	-
12.Plastic emulsion	-9	-

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(continued)

Table 3.1: **Effective protection rates by industry and type of buyer (in per cent)**

Product	Sale in domestic market	Export
<u>**Agro-based Industries**</u>:		
1.Tea, loose	-	-12
2.Mushroom	-	-18
3.shrimp	-	1
4.Fish	-	-1
5.Cigarettes	-43	-
6.Cow wet blue	-	-69
7.Goat wet blue	-	-39
8.Goat leather(finished)	-	14
9.Footwear	-	-31
10.Jute goods	-	-3
<u>**Textile Sector**</u>:		
1.Silk fabric	-61	-89 to 16
2.Household linen	-	5 to 13
3.Finished shirting	-	-201
4.Finished suiting	-	-146
5.Nylon socks	-13	11
6.Cotton vest	-70	19

[a] NVA = negative value added at border prices

Source: Bangladesh, Trade and Industrial Policy Reform Programme, 1987. *Overview of Industrial Assistance Policy in Bangladesh and Recommendations for Reform*, Government of Bangladesh, Dhaka:4-7.

Foreign exchange regime

With the exception of a few years, the foreign exchange system has been characterized, since late 1950s by a multiple pricing system similar to that prevalent in many developed countries which have a repressed foreign exchange system. The official exchange rate is periodically adjusted to keep current account balances within a pre-determined limit. But tariffs, import licensing and exchange rationing maintain it at an overvalued level.

Exchange rationing is exercised by the requirement that all export earnings, including remittances, are surrendered to the government. The government then allocates a part of the foreign exchange received at the official exchange rate to licensed importers according to predetermined criteria. These include the `sanctioned capacity' of firms determined by the department of industry, allotment of imports per unit of capacity, and the percentage of the import entitlement eligible for cash licenses. While the sanctioned capacity is set individually for each firm, the other two criteria are set at the industry level. Since the variance in the ratio of output to sanctioned capacity among firms is greater than among industries (Bangladesh, Trade and Industrial Policy Reform Programme 1985), the benefits of import licenses to individual firms are not uniform. The allocation procedure is generally very complex, and it is so dependent on administrative discretion that its operation is difficult to understand (see Bangladesh, Trade and Industrial Policy Reform Programme 1986b, for a detailed description of the procedure). Given the complexities involved, it is not surprising that the sanctioning and initiation of credit disbursements took about three years for some enterprises (Bangladesh, Trade and Industrial Policy Reform Programme 1986b).

The foreign exchange remaining after the allocation at the official exchange rate is sold to importers at a different rate under the Wage Earners' Scheme. This scheme is essentially a floating secondary market exchange rate system. The concept of the secondary rate under the Wage Earners' Scheme evolved to encourage remittance inflows. The rate is determined in an auction, although the Bangladesh Bank (the central bank) intervenes from time to time to avoid sharp fluctuations in the rate.

Before independence, one source of foreign exchange in the secondary market was the amount of foreign exchange that exporters were allowed to retain according to the Export Bonus Scheme, introduced in 1959. Under this scheme, exporters could retain a certain portion of their export earnings in foreign currencies. They could sell their foreign currency in the open market at a premium or use it to import necessary raw materials. The premium was the difference between the official price and the secondary market price of foreign exchange.

After independence, the Export Bonus Scheme was initially abolished, but was reintroduced in 1977, the free market rate being replaced by the wage earners' rate. The system is called the Export Performance Licensing Scheme. In terms of objectives and operation, there is no fundamental difference between the Export Bonus and Export Performance Licensing Schemes. They were devised to compensate for the discrimination caused against exports accruing from heavy protection to goods for import substitution.

The scheme has not made up for the negative bias against exports for two reasons. First, compensation has been confined to manufacturing export. Agricultural exports, which account for the bulk of total exports, have almost always been rewarded at the official rate. Indeed, jute, tea and hides have been subject to an explicit export tax for most of the period. Second, the weighted average retention rate for manufacturing exports as a whole is less than 100 per cent, although the retention rate for individual commodities has been in some cases more than 100 per cent. The rates varied over time and ranged from 10 to 40 per cent between 1979 and 1981. In 1984-85, there were three rates, 60, 80 and 100 per cent. The local currency benefit per US$ of export depends on two factors: the percentage of retention allowed (r), and the premium on the foreign exchange (e^2-e^1), where e^1 is the official exchange rate and e^2 is the secondary market exchange rate. The local currency value of one dollar worth of export under this scheme is ($r.e^2 + (1 - r).e^1$), whereas local currency value of one dollar import is $r.e^2$. As the retention rate is usually less than 100 per cent, the local currency value of exports is less than the local currency value of equivalent imports. The value of exports is reduced further if the secondary rate diverges significantly from the free market rate which applies to the pricing of imports.

Agricultural sector-specific price policy

The government has repeatedly stated two important goals regarding agriculture. These are the achievement of food self-sufficiency along with increased agricultural exports and the reduction of poverty and income inequality (Bangladesh, Ministry of Planning 1983, 1985, 1990). An elaborately structured intervention system has evolved to this end. The current array of intervention instruments include subsidies on some inputs, state procurement of foodgrains, jute and sugarcane at guaranteed `support' prices, state monopoly in the foreign trade in food, public food distribution and the maintenance of a food buffer stock.

Subsidies on Inputs

Fertilizer

Chemical fertilizer was first introduced in 1958. As well as heavily subsidizing it to promote the use of a then unfamiliar input, the government wanted to ensure its regular and adequate supply. Consequently, the Bangladesh Agricultural Development Corporation was established to control the procurement and distribution of fertilizer. The Corporation distributed fertilizer to farmers through appointed dealers at primary distribution points and *upazilla* (the lowest administrative unit in Bangladesh) sales centres. Dealers were responsible for catering to farmers' needs in specified areas at prices fixed by the government in return for a commission. The prices were set considerably below world prices and remained virtually unchanged throughout the 1960s. It is estimated that the rate of subsidy on urea and phosphate was 58 per cent, and on potash, 67 per cent, in 1968/69 (Kahnert et al, 1970 cited in Osmani and Quasem 1985).

Fertilizer prices were raised periodically from the early 1970s. The increase in fertilizer prices was not merely the result of adjustment to rising costs; there was a conscious policy decision to reduce the subsidy element. The rise in the domestic price of fertilizer was 2.4 times the rise in its world price between 1973/74 and 1983/84. The fertilizer subsidy is still a major item in the government budget even though the subsidy rate fell from 43 per cent in 1977/78 to 25 per cent in 1983/84 (Table 3.2). The absolute subsidy cost has risen from Taka 944 million in 1977/78 to Taka 1426 million in 1983/84 because of a rapid increase in consumption (2.5 times since the mid 1970s).

Table 3.2 **Fertilizer subsidy in Bangladesh**

Year	Subsidy cost (million Taka)	Subsidy rate (per cent)	Subsidy cost as proportion of development expenditure in agriculture
1977/78	944	43	27.1
1978/79	1286	48	29.4
1979/80	1342	40	20.2
1980/81	1172	15	15.5
1981/82	1084	23	12.3
1982/83	850	12	8.9
1983/84	1426	25	13.6

Source: Ahmed, R., 1985. `Structure, dynamics and related policy issues of fertilizer subsidy in Bangladesh', in *Fertilizer Pricing Policy and Foodgrain Production Strategy in Bangladesh*, Vol 2: Technical Report: International Food Policy Research Institute, Washington DC and Bangladesh Institute of Development Studies, Dhaka:68.

At the same time as the subsidy was being reduced, distribution at the wholesale and retail levels was subject to a radical change. A new system of distribution requiring more private sector involvement replaced the old system throughout the country by April 1983. The responsibility of the Bangladesh Agricultural Development Corporation to supply fertilizer became restricted to 94 primary distribution points. The price at the primary distribution points was set by the government at a uniform level throughout the country. Private dealers could register and purchase from any such distribution point and charge whatever price the market would support.

The procurement policy has, however, remained unchanged. Each year the government makes an estimate of the likely demand and procures the difference between domestic production and demand through imports. Imports are financed mainly through aid, the balance being purchased by the government. For example in 1983/84, a typical year, 71 per cent of total imports were purchased with grants, 5 per cent with credit, 17 per cent under barter agreements and 7.5 per cent with cash foreign exchange resources (Osmani and Quasem 1985).

Irrigation

The irrigation policy of Bangladesh has evolved through several steps in terms of the choice of technique, management, distribution, and pricing. At first, surface water irrigation carried through low-lift pumps and the large-scale gravity schemes of the Bangladesh Water Development Board were emphasised. However, attention gradually shifted to simpler technologies such as shallow tube-wells and hand tube-wells. Ground-water irrigation using tube-wells became more commonplace (Table 3.3).

Table 3.3 **Acreage irrigated by different methods, 1969/70 to 1988/89 (thousand acres)**

Year	Area under mechanical irrigation			Area under traditional irrigation	Mechanical irrigation as % of total irrigation
	Tube wells	Low-lift pumps	Gravity scheme		
1969/70	81	742	82	1709	35
1970/71	119	1033	83	1649	43
1971/72	84	830	58	1616	38
1972/73	93	1165	64	1671	44
1973/74	131	1408	67	1596	50
1974/75	234	1442	67	1819	49
1975/76	263	1363	84	1747	50
1976/77	234	1232	92	1445	51
1977/78	314	1370	135	1770	51
1978/79	396	1434	157	1674	54
1979/80	446	1536	241	1649	54
1980/81	548	1645	303	1554	62
1981/82	670	1740	322	1533	64
1982/83	1018	1845	378	1326	71

Source: Bangladesh Bureau of Statistics, *Statistical Yearbook of Bangladesh*, Government of Bangladesh, Dhaka, various years.

The procurement of irrigation equipment from abroad is mainly financed from foreign aid grants and credits. Until 1979/80, the entire responsibility for procurement rested on the Bangladesh Agricultural Development Corporation and the Bangladesh Krishi (agricultural) Bank. Since 1979/80, direct procurement by the private sector has been allowed. At present, only shallow tube-wells are currently imported by the private sector.

The distribution of irrigation equipment has been mainly undertaken by the Bangladesh Agricultural Development Corporation except for shallow tube-wells which are distributed by the Bangladesh Krishi Bank and the Bangladesh Bank. All types of irrigation equipment are currently distributed either for rent or for sale. The ownership of deep tube-wells and low-lift pumps was retained by Bangladesh Agricultural Development Corporation until 1978/79. Other types of equipment were sold to co-operatives and private individuals from the very beginning. Since the late 1970s the emphasis has shifted to promoting privatisation of irrigation equipment at a high subsidy. The deep tube-wells were first put up for sale in 1979/80 and by August 1983, 43 per cent of the operating deep tube-wells and 48 per cent of the low-lift pumps were owned privately (Osmani 1985).

The private ownership of irrigation machinery falls into two categories; co-operatives and individuals. At the initial stage of privatisation, purchases by co-operatives were given preference over individual purchases by concessional payments arrangement. This was later discontinued. Concessional facilities are confined to the sales of deep tube-wells.

Heavy subsidies were involved in the sale and rental of irrigation facilities from the very beginning (Table 3.4).

Table 3.4 **Rates of subsidy on irrigation equipment (per cent)**

	Deep tube-wells		Low lift pumps	
Year	Rental	Sales	Rental	Sales
1980/81	96.8	73.8	82.8	27.6
1981/82	96.1	76.7	76.1	27.6
1982/83	92.5	73.3	58.1	28.7

Source: Osmani, S.R. and M.A. Quasem, 1985. ***Pricing and Subsidy Policies for Bangladesh Agriculture*****, Bangladesh Institute of Development Institute, (mimeo), Dhaka:93.**

Although, as with the fertilizer subsidy, the overall irrigation subsidy is gradually being reduced, a differential pricing system has been introduced recently to tilt the incentive structure in favour of private ownership of irrigation equipment. In the four years between 1980/81 and 1983/84, the rental charge for both types of machines rose 400 per cent while the sale price rose by only 16 per cent for low-lift pumps and 86 per cent for deep tube-wells (Osmani and Quasem 1985:92). Shallow tube-wells have always been sold at prices very close to the procurement price and therefore, involve little subsidy.

The above subsidy rate is not inclusive of the hidden subsidy granted through the liberal provision of credit for the purchase of machines. The opportunity cost of capital is very high so that the effective subsidy in the sales programme turns out to be higher than indicated in Table 3.4.

The highest rate of subsidy occurs in large scale irrigation projects where water is distributed free. After 1976, several attempts were made to recover at least operating expenses, but without success. A water rate of 3 per cent of the gross incremental benefit accruing to the recipients of the irrigation service was imposed but, mainly because of the complications involved in estimating the incremental benefits, little income was realised. Another ordinance issued in 1983 was more flexible, but it was again unsuccessful in raising revenues.

The above data on irrigation subsidies are only average estimates. In practice, the cost of irrigation is not uniform to all users. The cost varies widely with the source of irrigation and the type of ownership of irrigation equipment (Hossain 1988, Quasem 1985, Osmani and Quasem 1985). The study by Quasem (1985) indicates that for privately owned irrigation equipments, the excess of charges over cost (capital, operation and maintenance) varies from 10 per cent in case of shallow tube-wells to 84 per cent in case of low-lift pumps. For rented machines, the cost mark-up was found in the range of 43 to 48 per cent.

Credit

Financial markets are under strict government control in Bangladesh. The lending and borrowing rates are subject to ceilings, and credit is consequently rationed through quantity controls and preferential treatment. Although the number of rural branches of commercial banks has increased significantly over the years and special credit arrangements have been made for agriculture at a subsidized rate of interest, the amount available has been meagre compared with requirements. Hossain (1988), analyzing a survey conducted by the International Fertilizer Development corporation, found that in one crop season only 4.6 per cent of the farmers received credit from institutional sources. The majority of farmers, therefore, have to depend on the informal market for their credit supply. Rahman (1979) found interest rates in the informal market to be as high as 158 per cent.

Output price policy

The government intervenes directly in the output pricing of some crops by setting a minimum price for procurement purposes. The primary aim is to stabilize prices and income. Rice, wheat and jute prices fall into this category.

Since the mid 1970s the system has been geared to provide incentives for increased foodgrain production, but without much success. The growers' price of rice has often stayed below the procurement price, but the amount procured has remained a small percentage of total production. The paucity of purchase centres, the limited financial resources of the government, and collusion between officials and traders has limited the operation of procurement system (Osmani and Quasem 1985). The purchase and payment procedures discourage the majority of small farmers from selling their grains to the government, and procurement is made mainly from sellers who are large farmers-cum-traders.

The government intervenes in pricing and marketing of two important crops other than foodgrains. These are jute and sugarcane. Intervention in jute markets occurs directly and indirectly. A jute procurement price is fixed directly. Indirectly, rice price setting has an impact. The rice-jute price ratio is an important determinant of the acreage under jute cultivation. A comparison of the rice-jute price ratio in the world and domestic markets during 1964/65 and 1978/79 shows that while the rice price was consistently lower than the jute price in the world market except for two years, the domestic rice price has been higher except for one year (Ahmed R. 1981). Also, the price ratio in the domestic market has been rising.

Although the jute export business was nationalized at the time of independence in 1971, the marketing of jute now involves both the government and the private sector. The export price of jute is set by a Price Advisory Committee. A minimum export price is determined by world market conditions and export sales can go forward on individual initiatives at any price above this minimum.

The sugarcane procurement price is fixed by the government. Within a defined mill zone, sugarcane producers are compelled to sell all their output to the mills at this price to protect sugar manufacturing from the competition of *gur* (an indigenous substitute for sugar) makers.

Public foodgrain distribution system

The public food distribution system has been used for indirect intervention in food pricing. To maintain targeted *per capita* consumption, the government imports a sizeable amount of foodgrains every year. Food imports have averaged about 13 per cent of total available foodgrains during the last fifteen years. The importance of the public food distribution system in overall foodgrain balance is clear from Table 3.5.

Foodgrain distribution through rationing comprises 14 per cent of public food distribution. Among the ration recipients, the highest preference is given to defence staff who are in the essential priority group. Six major city dweller groups are in the statutory category, which is second in priority. Lowest preference is given to low-income people through a modified rationing system. This amount is residually determined after other priorities are met. Whereas the statutory and essential priority quotas are more or less fixed, the amount of foodgrains distributed under modified rationing varies widely. Other channels of the public food distribution system are open market sale to stabilize prices, and food for public works and other relief programmes. A `food for public works' programme is mainly carried out to provide employment in rural areas in lean seasons.

Table 3.5 Foodgrain balance in Bangladesh, selected years (million tons)

Year	1973/74	1979/80	1985/86
Gross production	12.07	13.62	16.08
Net domestic supply[a]	10.82	12.06	14.61
Domestic procurement	0.07	0.36	0.35
Import	1.70	2.76	1.20
Government distribution	1.76	2.45	1.54
Statutory rationing	0.50	0.49	0.16
Priority categories	0.40	0.91	0.47
Modified rationing	0.78	0.39	0.10
Other	0.05	0.61	0.81
Closing stock[b]	0.22	0.80	0.98
Per capita availability (ounce/day)	15.83	15.53	15.00
Government distribution as % of total availability	14.10	17.30	9.70

[a]: gross production minus 10% for seed, feed and waste.

[b]: government stocks net of storage losses.

Source: Bangladesh, Ministry of Planning, 1987. *Fiscal Statistics 1972/73 to 1987/88*, Government of Bangladesh, Dhaka; Rahman, A. and W. Mahmud, 1988. `Rice market interventions in Bangladesh', in *Evaluating Rice Market Intervention Policies: Some Asian Examples*, Asian Development Bank, Manila.

Food subsidies claim a large share of government expenditure, though the share is now decreasing every year following a government decision in mid 1970s to withdraw subsidies within a few years (Table 3.6).

Table 3.6 **Expenditure on food subsidies, selected years, 1975 to 1986**

Year	Food subsidies (million Taka)	Food subsidies as a % of government current expenditure
1975	916	17
1978	1056	12
1982	1820	11
1985	2300	8
1986	1590	4

Source: Bangladesh, Ministry of Planning, 1987. *Fiscal Statistics 1972/73 to 1987/88*. Government of Bangladesh, Dhaka.

Analysis of the effect of the policies

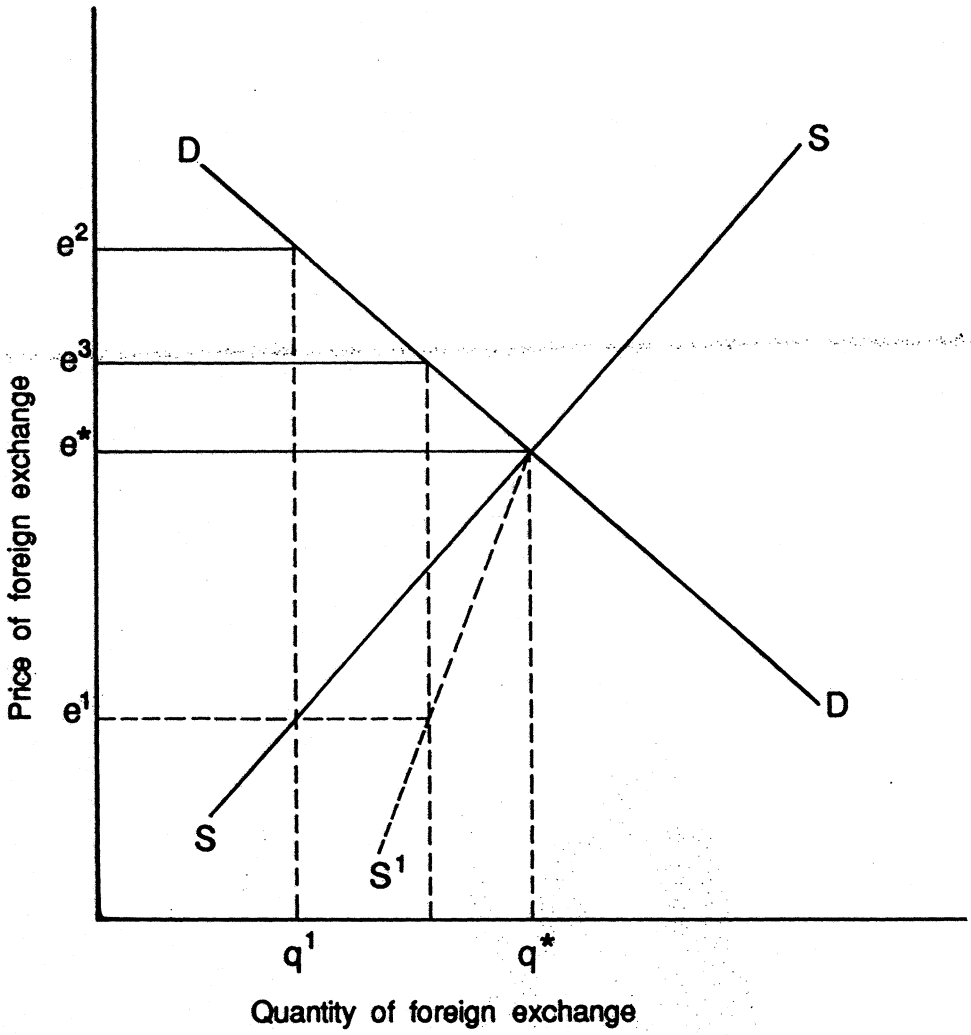
To understand the bias created by general economic policy against agriculture, it is helpful to use the concept of a disaggregated version of real exchange rate - the import real exchange rate and the export real exchange rate. While the former is a ratio of the domestic price of imports to the price of nontraded goods, the latter is a ratio of the price of exports in domestic currency to the price of nontraded goods[1]. The imposition of an import tariff implies an increase in the import real exchange rate while keeping the export exchange rate unaltered. As a consequence, exporting becomes less profitable, and so far as exports are dominated by agriculture, agriculture is expected to contract.

In the case of Bangladesh, the introduction of the export performance licensing scheme has created another wedge within the export real exchange rate. Because of the foreign exchange retention facilities under the scheme, agricultural and non-agricultural exports receive different values for export to the value of one dollar. To understand the net effect of these various real exchange rates on resource allocation and on real national income, a framework drawing on a recent study of China's foreign exchange system by Martin (1990) is used.

In Figure 3.1, SS is the supply curve of foreign exchange where the vertical axis represents the price of foreign exchange relative to the price of nontraded goods, and the horizontal axis represents quantity supplied. Similarly, DD represents the demand for foreign exchange. Given a production possibility frontier between exports and nontraded goods, SS is

[1] Nontraded goods contain imported components and the relative prices of nontraded also move as domestic price of imports move and hence changes the real exchange rate from what it would be if price of nontraded goods did not move. However, for the sake of simplicity, in this explanation it is assumed that nontraded goods do not contain any traded component.

Figure 3.1 **Short-side rationing model of the foreign exchange market**



derived from various combinations of exports and nontraded goods that would be produced at various relative prices. Similarly, DD represents substitution between imported and nontraded goods, given a particular level of absorption. The price of imports is tax-inclusive, so that any point on DD represents demand for foreign exchange for import purposes at a given level of tariff.

In the absence of exchange rate intervention, the equilibrium exchange rate, e^*, is reached at the intersection of DD and SS. When the exchange rate is over-valued and the official price is fixed at e^1, the domestic currency equivalent of export earnings is reduced, resulting in less incentives to export. Assuming that the country is small in the international market, or at least not sufficiently large for increased exports to reduce foreign exchange earnings, a reduced volume of exports reduces earnings, and the total supply of foreign exchange falls from q^* to q^1. This induced scarcity of foreign exchange pushes the domestic secondary market price of foreign exchange to e^2 creating a premium on the official rate, $e^1 - e^2$. The scarcity premium-inclusive price of foreign exchange is higher than the equilibrium rate, which could have been attained if the official rate were flexible. In the Bangladesh context, e^2 is represented by the secondary exchange rate, although in reality the secondary exchange rate differs from e^2 to the extent the rate is government managed.

A further consequence of the reduced supply of export earnings is a reduction in import capacity. Imports are also taxed in the sense that the higher domestic price of imports reduces demand.

To understand the implications of the exchange control systems for real national income, further exploration is needed. Using the single sector, product market model of de Melo and Robinson (1989), the following analogous picture is used to capture the effects.

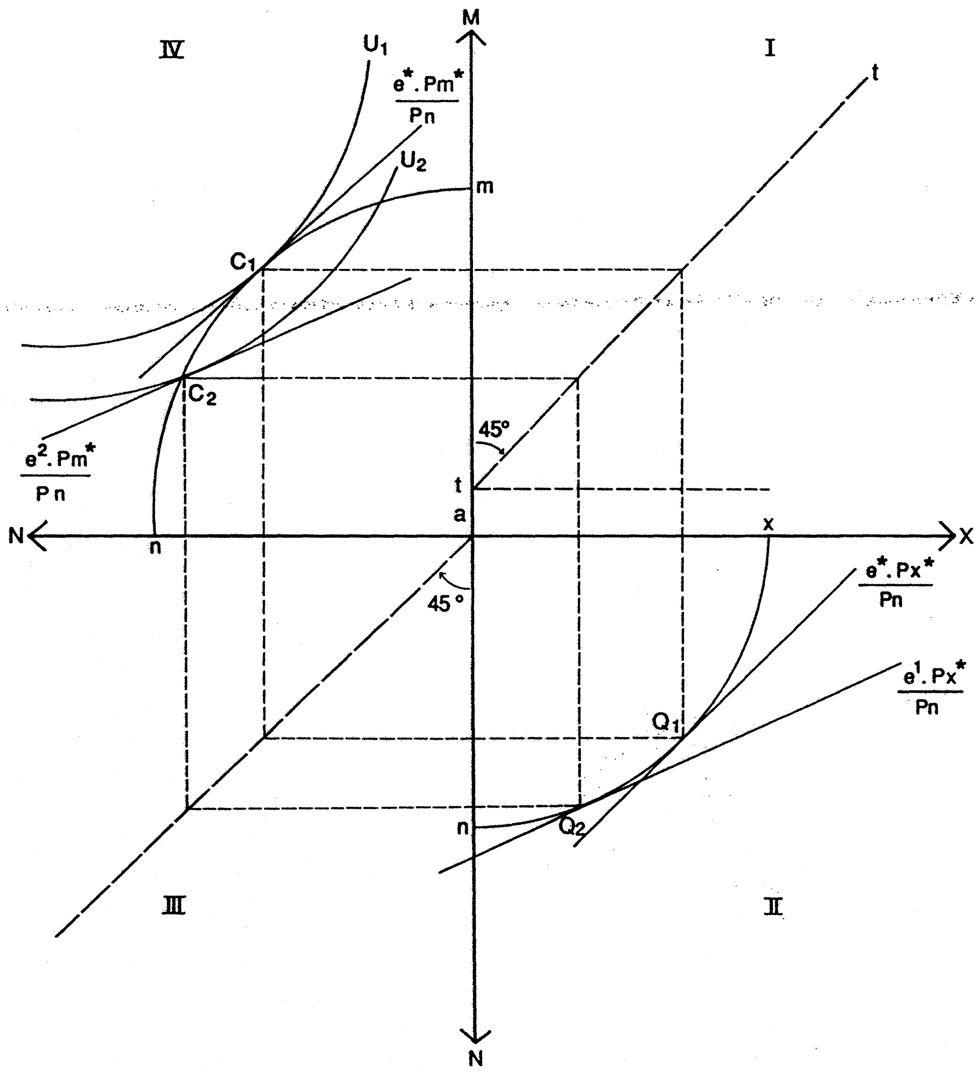
The production possibility frontier underlying SS in Figure 3.1 is XN in Figure 3.2. The export goods are sold in the world market to purchase imports at terms of trade given by the locus of tt in quadrant I of the figure. The tt locus is drawn with a 45^0 angle and an intercept which implies total import value equals total foreign exchange inflow of which exports are a part. In this model, all receipts other than exports are held constant and are represented by the intercept term.

In quadrant II, at a non-distorted price of foreign exchange, Q_1 is the production point achieved. The corresponding exports, together with given aid flow and remittances, purchase imports determine by tt. In quadrant IV, the production possibility frontier and the terms of trade locus together determine the location of the consumption possibility frontier, nm, in terms of imports and non-traded goods. The consumption point is reached at C_1, where U_1 is the community indifference curve tangent to nm, the consumption frontier, and the equilibrium price of foreign exchange relative to the price of non-traded goods.

Since the price of nontraded goods is modelled as the numeraire, the corresponding import and export prices are in effect the import real exchange rate, $e^2.p_m^*/p_n$, and the export real exchange rate, $e^1.p_x^*/p_n$, where p_m^* and p_x^* are the prices of imports and exports in foreign currency.

An intervention in the form of overvaluation of the currency shifts the nominal exchange rate from e^* to e^1 and causes real effects since the numeraire is held constant. Production shifts from Q^1 to Q^2 in quadrant IV. The reduction in exports reduces import availability. Consumption

Figure 3.2 **A simple general equilibrium characterization of exchange rate overvaluation**



therefore must move along the consumption possibility frontier from C^1 to C^2 in quadrant IV.

The reduced availability of imports caused by reduced export earnings raises the domestic price of imports relative to the price of nontraded goods. The depreciation of the import real exchange rate is given by the increase in slope of the community indifference curve U^2 at the new consumption point C^2 compared with its slope at the undistorted consumption point C^1. This depreciation of the real import exchange rate is indicated in Figure 3.2 as a move from e* to e^2. The loss in real national income is given by the lower level of utility represented in the indifference curve U^2.

The reduction in utility is aggravated if rent-seeking is introduced. With rent-seeking activities, resources are used for unproductive purposes implying a shrinkage in the production possibility frontier and a corresponding scaling down of the consumption possibility frontier. The final outcome is a consumption point representing a utility level lower than in U^2.

If some proportion of foreign exchange is allowed for retention, the export real exchange rate appreciation will be less pronounced. To understand the effects, Figure 3.1 is used again. A new supply curve is given by the dashed line SS' below the intersection of supply and demand curves for foreign exchange. At any point in this range, the supply of foreign exchange is enhanced as exporters increase their supply in response to the higher returns from exporting following a reduced degree of appreciation. Increased availability of foreign exchange lowers the scarcity premium on foreign exchange and the secondary market rate falls to e^3.

The fall in real national income will be less sharp than before. The final consumption point will be somewhere between C^1 and C^2 depending on the retention rate. The higher the rate, the closer it will be to C^1. The slope of the tangent to the indifference curve will increase less as the secondary market price of foreign exchange is less than it is in the absence of this scheme.

Figure 3.2 provides a qualitative estimate of the bias against exports created by trade and exchange rate policy. However, it does not distinguish between exports by sector of origin to show what happens to agricultural exports, particularly those not benefited under the export performance licensing scheme. The perceived benefits of the depreciation of the weighted average real exchange rate for overall exports following the depreciation of the real exchange rate for non-traditional exports under the retention scheme may not be realized if agricultural exports are seriously penalized by the discrimination. In practice, because of lower relative profitability in agricultural exports, agricultural exports may contract to such an extent that the expansion in non-traditional exports may not be enough to compensate for the decline. In that case the share-weighted export real exchange rate may appreciate in contrast to the scenario postulated by the diagram. The net result would be a contraction in overall exports and a reduced level of welfare.

The diagram presented above (Figure 3.2) traces the mechanism through which an adverse agricultural price policy may cause harm to agriculture as well as the overall economy. A number of studies have attempted to measure the extent of the bias. One of them is carried out by Stern, Mallon and Hutcheson (1987) who have estimated different real exchange rates for the period 1973/74 to 1984/85 (Table 3.7). It appears that although the import real exchange rate has fluctuated over the years, it has consistently been above the export real exchange rates. In 1984-85, it was higher by more than 30 per cent than the real exchange rate for agricultural exports and by nearly 16 per cent higher than the real exchange rate for non-agricultural exports.

Table 3.7 **Real effective trade-weighted exchange rate for traditional exports, non-traditional exports, imports, and official exchange rate**

Year	Official exchange rate	REER[a] for traditional exports	REER[a] for non-traditional exports	REER[a] for imports
1973/74	7.97	7.94	7.97	9.77
1974/75	8.88	7.45	7.45	8.69
1975/76	15.05	12.72	12.90	15.22
1976/77	15.43	13.68	14.07	18.23
1977/78	15.12	13.29	13.74	17.79
1978/79	15.22	13.19	13.68	18.07
1979/80	15.49	13.25	14.36	17.11
1980/81	16.26	13.17	14.08	17.35
1981/82	20.07	14.69	15.53	18.55
1982/83	23.80	15.61	15.85	19.88
1983/84	24.94	14.90	15.82	19.13
1984/85	25.96	12.59	13.73	16.42

a Real effective exchange rate.

Source: Stern, J.J., R.D. Mallon and T. Hutcheson, 1987, 'Foreign Exchange Regimes and Industrial Growth in Bangladesh', *World Development*, 16 (12) : 1419-1439.

A study by the Food and Agricultural Organization of the United Nations (FAO) (1987) has measured the bias against agriculture by reference to deviations from border prices. The bias in producer prices resulting from interventions in cereal markets was found to increase by 24 per cent or more between 1973 and 1983 relative to that prevailing between 1969 and 1971.

A study estimated the nominal rates of protection (defined as ratio of domestic to border prices) for wheat and rice in Bangladesh to be 0.76 and

0.69 respectively (Binswanger and Scandizzo 1983). Thus the extent of bias against rice was 0.24 and against wheat was 0.31.

The welfare loss arising from deviations of domestic rice prices (see Table 3.8) from world rice prices is estimated by Rahman and Mahmud (1988) in a partial equilibrium approach. The deadweight losses between the periods 1974/75 and 1985/86 were estimated to be 1.4 per cent of the periodic average of GDP.

Table 3.8 **Ratio of domestic to international rice and wheat prices, 1973/74 to 1984/85**

	Ratio of domestic to international prices of	
Year	Rice	Wheat
1973/74	1.11	1.19
1974/75	1.14	1.73
1975/76	0.67	0.64
1876/77	0.71	0.74
1977/78	0.84	1.21
1978/79	0.67	0.86
1979/80	0.95	0.84
1980/81	0.60	0.74
1981/82	0.62	0.74
1982/83	0.93	0.85
1983/84	0.98	0.87
1984/85	1.08	0.91

Source: Rahman, A. and W. Mahmud, 1988. "Rice market interventions in Bangladesh", in *Evaluating Rice Market Intervention Policies: Some Asian Examples*, Asian Development Bank, Manila:177, 216.

The magnitude of welfare loss of the price bias, however, depends on the degree of farmers' response to prices. Rahman and Mahmud assumed an elasticity value of 0.12 for domestic supply of rice and wheat. No estimate of aggregate supply response in Bangladesh agriculture is available. The aggregate supply response for developing countries generally varies between 0.1 to 0.3 for the short run and 0.2 to 0.5 for the long run (FAO 1987). These estimates are based on time series data, and

Hertel (1989) has shown that the supply response estimated from time series data suffers from a downward bias. Since many price movements are transitory (Peterson 1979) the magnitude of long-run price variability is overstated, producing an understated supply response. Also, if a time trend is used as a proxy for technological change (as with most of the studies on supply response), in so far as technological changes themselves are a function of relative prices (Hayami and Ruttan 1970), the time trend absorbs some of the supply response which should be credited to long-run price elasticity of supply. Hence, the true supply responses of the farmers are likely to be larger than the literature suggests. In fact, using cross-section data for a number of countries, Peterson (1979) found an aggregate supply response of 1.25 to 1.66 which is significantly higher than the time series estimates. However, even assuming a small value of 0.10 for aggregate supply elasticity for Bangladesh, the negative price bias on agricultural products relative to other products of say 20 per cent may cause a reduction in total agricultural production of the order of 2 per cent. Given the size of agriculture in the economy, the reduction in output can have a significant impact on employment, income and general poverty.

Other than incentive effects, the budgetary costs involved in providing input subsidies and maintaining food buffer stocks for price stabilization are quite sizable given the low revenue base of the country. The food and input subsidies together account for approximately 10 per cent of government expenditure during the first half of the 1980s. The administrative costs involved in implementing these policies is not included in this figure. The public food distribution system has income distribution implications (Chowdhury 1987). The bias towards the affluent in the rationing distribution system is obvious. Since the mid 1970s the government has stopped issuing new statutory cards to the city dwellers. Studies suggest that the village poor started to migrate to the city slums at an increasing rate at nearly the same time. Thus, a large section of the urban poor are not covered by the scheme. Modified rationing, which targets the rural poor, are residually determined after meeting the quota of other groups of ration receivers. As such the supply is often uncertain, and even when it is available, it often goes to people favoured by local authorities (Karim, Majid and Levinson 1980).

The potential cost of government interventions in agriculture could well be much larger than the estimates for a single crop presented above. This follows from the contradictions inherent in a price policy that is expected to serve conflicting objectives. Myint (1975) demonstrated how the objectives of supplying food and foreign exchange simultaneously can be incompatible if a country does not have a comparative advantage in food production and/or food and export crops compete for acreage allocation. Although domestic foodgrains prices were kept low in comparison to world prices, a policy of supporting rice prices tilted the domestic rice-jute price ratio in favour of rice. Starting from the early 1960s, the rice-jute price ratio has declined by more than 11 per cent in 1980 (Osmani and Quasem 1985). The potential loss due to price discrimination against jute exports in favour of import-substituting rice in Bangladesh was estimated by Ahmed (1981a). He showed that assuming infinite world demand elasticity for Bangladesh jute, a reallocation of one marginal acre of land to jute would yield foreign exchange which could buy 51 per cent more rice than was produced in that marginal acre at 1978/79 price ratios. The margin of gain, however, would reduce as the value of the elasticity drops. The policy of taxing jute exports to extract revenue has not been consistent with the objective of encouraging jute production. This is because the policy, based on a perceived monopoly power of the country in international trade, has been found to be misjudged (Repetto 1970, as cited in Khan 1972), and the cost has been a reduced share of world trade for Bangladesh (FAO various years).

Providing cheap food to consumers and incentives to producers is mutually inconsistent and has a heavy fiscal cost. To counter the negative effects of cheap food supply on production incentives, the government provided input subsidies and high procurement prices. Miller and Tolly (1989) have demonstrated that the extent of price intervention through these two policies is limited because of the trade off between benefits from the adoption of new technology and the resource misallocation effect of price distortions. Although temporary interventions may be justified, after a time gains will be reduced such that the intervention is no longer justifiable.

To understand and estimate the overall potential effects of the Bangladesh agricultural price policy which has a number of contradictory components, a full-blown economy-wide general equilibrium model, with a disaggregated treatment of agriculture, is required. The next three chapters are devoted to building the model and searching for a plausible set of elasticity and parameter values.

CHAPTER 4

PRODUCTION TECHNOLOGY AND ALLOCATION DECISIONS IN BANGLADESH AGRICULTURE

The impact of policy induced price changes at the farm level depends on the price responsiveness of the farmers. Hence, knowledge about the technology structure and allocation decisions of farmers is essential for an evaluation of the policies that affect the relative price structure.

Estimates of output supply responses in Bangladesh have usually been carried out in terms of a single crop or a few important crops (some examples are: Cummings 1974, Hussain 1964, Rabbani 1965, Rahman 1986). The input demand elasticities have mainly focussed on demand of a single input, fertilizer (International Fertilizer Development Corporation 1984, Hossain 1985a). None of the above studies tested the empirical validity of the assumptions implicit in their models. The implicit technological assumption behind studies based on a single composite output is separability between inputs and outputs[1]. Supply elasticities estimated for one or a few crops with separate production functions for each crop ignore the joint nature of production decisions.

Both observation and intuition seem to reject the hypotheses of non-jointness[2] and separability in agricultural production in Bangladesh. Many farms produce several commodities and production decisions about one commodity are likely to affect the rest. The nature of the Bangladesh crop sector is such that almost all of the arable land is suitable for almost any of the crops and a higher relative profitability of one in a year reduces

[1] Separability between inputs and outputs implies that input and output mixes are independent of each other, i.e. the quantity ratios of commodities in the output group do not depend on quantities of inputs.

[2] There are a few definitions of jointness. In this study, non-jointness implies non-jointness in input quantities; i.e., decisions about production of a commodity is made independently of decisions about other commodities.

cultivation of the others. The cropping pattern over the last twenty years, accompanied by government policies favouring some crops at the expense of the others, shows significant changes. The choice between rice and jute cultivation has been historically influenced by relative profitability (Rabbani 1965, Mujeri 1981) determined by both input and output prices. Therefore, it seems essential to model the production interrelationships in Bangladesh agriculture in a comprehensive way involving the entire crop sector and all the inputs used in the production process. The study by Abedin (1985) has estimated output supply and input demand elasticities taking the major outputs and inputs into account. However, by not including the minor crops in the estimation, he has made the implicit assumption that allocation decisions about major crops are independent of minor crop prices.

The intention in this exercise is to estimate the output supply and input demand elasticities involving the entire crop sector. The objectives of the study are to:

- test the structure of the technology to determine whether assumptions such as separability and non-jointness are valid assumptions in Bangladesh agriculture, and
- obtain precise knowledge about agricultural production technology by estimating a system of input demand and output supply functions in a multi-output, multi-input context in a short-run equilibrium where some factors of production (for example, land) are fixed and receive economic rent.

Once the technology structure is known and price responsiveness measured, this information is used to characterize the agricultural sector in the economywide model (developed in the following Chapter) to evaluate the effects of policy induced price changes.

One important point to note is that this excercise approaches modelling of agricultural production as a choice between different crops and input mixes within the agricultural sector alone, implying that agricultural production decisions are independent of non-agricultural production decisions and production and consumption decisions are independent of each other. As the previous chapter demonstrates, a majority of small farm households derive an important part of their income from non-agricultural sources. Thus agricultural production decisions may be preceded by a labour supply decision between agriculture and non-agriculture. Further, at the income levels prevailing for most of these farm households, production decisions and labour allocation decisions may well be determined to some extent by preferences and risk assessments of the household as a consuming unit. Thus instead of an isolated decision, a more appropriate approach would be to model agricultural production decisions as a part of broader household decision modelling which looks at the household as a mixed production and consumption unit and includes an allocation decision regarding the use of its labour endowment between agriculture and non-agriculture (see Singh, Squire and Strauss 1986 for an introduction to agricultural household models of this type). However, empirical estimation of agricultural production decisions applying this approach would require data on labour supply and consumption in the agricultural sector which is not available. Thus although admitting the superiority of the household production economics, the study is confined to estimate agricultural production decisions in isolation, which is nevertheless a standard approach in modelling production decisions in a number of countries (see for example, Shumway, Jegasothy Alexander 1987, McKay, Lawrence and Vlastuin 1983, and Coxhead 1988).

Theoretical framework

The characteristics of production technology can be indicated by estimating the boundary of the production possibilities set. A short-run production possibilities set may be represented by:

$$F(Y, X; Z) = 0 \tag{4.1}$$

where

$Y = Y_1,...,Y_m$ = vector of outputs,

$X = X_{m+1},...,X_n$ = vector of variable inputs, and

$Z = Z_{n+1},...,Z_p$ = vector of quasi-fixed (fixed in the short run only) factors.

Following Lau (1978a), the regularity conditions assumed are that F is a finite, non-negative, real-valued, twice differentiable, convex and bounded function.

Given the production possibilities set in (4.1), the short-run or variable profit, Π', defined as revenue minus variable costs, can be expressed as

$$\Pi' = p'F(Y, X ;Z) - r'X \tag{4.2}$$

$$= p'_s[PF(Y, X ;Z) - RX]$$

or $$\Pi'/p'_s = \Pi = PF(Y, X ;Z) - RX \tag{4.3}$$

where

p' = vector of nominal prices of outputs,

r' = vector of nominal prices of inputs

$P = p'/p'_s$, vector of normalized prices of outputs

$R = r'/p'_s$, vector of normalized prices of inputs

$\Pi = \Pi'/p'_s$, normalized profit and

p'_s = nominal price of the numeraire variable.

The first-order conditions obtained by maximizing the variable profit function (4.3) subject to (4.1) yield optimal levels of outputs Y(P,R,Z) and of inputs X(P,R,Z), where P and R are respectively vectors of normalized output and input prices. The ith element in P is p'_i/p'_s and the kth element in R is r'_k/p'_s. Substituting these expressions for Y and X into (4.3) produces the indirect profit function, Π^*, which has the same arguments as Y and X,

$$\Pi^* = \Pi^*(P,R,Z). \qquad (4.4)$$

where Π^* is a finite, positive, real-valued, twice differentiable, convex and bounded function. Some comparative static results that follow from these properties (Lau 1978a:147-148) are

(i) Π^* is monotonically increasing in output prices and decreasing in input prices;

(ii) cross-price effects are symmetric, i.e., $\Pi^*_{ij} = \Pi^*_{ji}$, where Π^*_{ij} is second-order partial derivative of Π^* with respect to first i and then j.

(iii) the matrix Π^*_{ij} is positive semidefinite; and

(iv) Π^* is homogeneous of degree one in normalized prices of outputs and variable inputs.

Since Π^* is derived subject to the constraint in (4.1), it can reveal information about production technology as (4.1). This dual relationship between the production function and profit function has been established in economic theory (for a proof see Gorman 1968, Mcfadden 1978, Diewert 1973 and 1974, Jorgenson and Lau 1974, and Lau 1978a). The theory has shown that if (4.1) and (4.4) possess the respective properties outlined above, a production function and a profit function can be used to describe production technology well.

It follows that empirical research to reveal the production technology can be undertaken in two ways. It can be undertaken directly, by solving a set of simultaneous functions derived as first-order conditions from the constrained maximization problem of maximizing (4.3) subject to (4.1) to obtain output supply and input demand functions, or indirectly, by applying Hotelling's (1932) lemma and differentiating (4.4) to give a set of output supply and input demand equations. Thus

$$\delta\Pi^*(P,R,Z)/\delta P_i = Y_i(P,R,Z) \qquad i = 1,...,m \qquad (4.5)$$

and

$$\delta\Pi^*(P,R,Z)/\delta R_j = - X_j(P,R,Z) \qquad j = m+1,...,n \qquad (4.6)$$

where Y_i and X_j are respectively output supply and input demand functions.

The first method is called a primal approach and the second one the dual approach. Knowledge about production technology can also be derived from exploiting the dual relation that holds between production functions and cost and revenue functions. By applying Shepherd's (1953) lemma, the input demand functions are given by the first-order partial derivatives of the cost function with respect to input prices, and output supply functions are given by the first-order partial derivatives of the revenue function with respect to output prices. However, these input demand and output supply functions are not quite the same as those derived from the profit function. The input demand functions obtained from a cost function are Hicksian or constant-output demand functions and the output supply functions derived from revenue functions are compensated or constant-input supply functions. The input demand and output supply functions derived from a profit function are, on the other hand, Marshallian functions with no input or output constraints (Lopez 1984, Wall and Fisher 1987).

The dual approach has certain distinct advantages over the primal approach (Wall and Fisher 1987:52-54). The derivation of the output supply and input demand functions in the primal approach is complex as it requires solving a set of simultaneous equations derived as first-order conditions from the maximization problem.

The second advantage follows from the nature of the arguments in the profit function at the optimal input-output level as stated in (4.4). Equation (4.4) is a reduced form equation dependent only on exogenous prices and fixed factor quantities. In the primal approach the production function depends on variable factor quantities which in reality are not exogenous to the producers. As a result, the error term will be correlated with the explanatory variables and Ordinary Least Squares (OLS) estimation will give biased and inconsistent estimates. However, use of instrumental variables can be of help in such a situation.

There is another statistical advantage in using the dual approach in that it reduces the possibility of multi-collinearity. Prices are usually less collinear than input quantities. Information on prices can also be more readily available than information on input quantities.

A final advantage of the dual approach is its flexibility. In single-equation production functions usually either or both of the two hypotheses of non-jointness and separability are maintained. The dual approach allows a test of non-jointness and separability without maintaining them.

Model specification

The empirical research conducted in this study exploits the dual relationship between production and profit functions to estimate the production technology in Bangladesh agriculture. For general equilibrium modelling purposes an estimate of price elasticities derived from a Marshallian demand function where both inputs and outputs are allowed to adjust to price changes is relevant. Examples of studies that have exploited duality theory to study production technology for some countries include McKay, Lawrence and Vlastuin (1980 and 1982), Doran and Williams (1982), and Lawrence and Zeitsch (1990) for Australia, Lopez (1984) for Canada, Weaver (1983) for U.S., Abedin (1985) for Bangladesh, Shumway, Jegasothy and Alexander (1987) for Sri Lanka, and Higgins (1986) for Ireland.

However, to hold the duality between profit and production functions, profit maximizing behaviour and competitive pricing are the usual maintained hypotheses. Junankar (1980) questions the validity of profit maximisation in the case of Indian agriculture. He finds that the neoclassical model works poorly at `explaining the behaviour of farmers in less developed countries as it ignores the sociopolitical matrix within which they act and react' and a `model allowing for the production of multiple outputs under uncertainty could be formulated which would perform better' (Junankar 1980:201).

The presence of uncertainty is important in farm allocation decisions in Bangladesh. Production is sensitive to weather conditions, partly because the sector lacks sufficient irrigation facilities. Uncertainty about rainfall forces many farmers who do not have access to irrigation to plant wheat even though HYV rice is more profitable. This is because wheat is more drought-resistant than rice. Risk-aversion may affect production decisions for some other crops as well. Shahabuddin and Butterfield (1986:31) find that a safety-first model incorporating risk elements performs somewhat better for Bangladesh agriculture than an expected profit maximization model with risk neutrality. However, the results appear to suffer from some weakness as the "test of `validation' is somewhat weak", and there is the additional problem of `misspecification of the expected profit maximization model.....'.

Although expected profit maximization and safety are not in conflict (Roumasset 1976), this study, by not incorporating the risk element into the model, does not trivialize the importance of the influence of risk preference in farmers' decision-making. Wall and Fisher (1987) indicated that there is not one typical attitude to risk but a range of attitudes depending on the profit level. Sandmo (1971) has shown that for the risk averse firm with uncertain prices, output is less than it is under certainty. The situation is reversed if the firm is risk loving. Since the model here deals with aggregate data, to incorporate the risk element an aggregate measure of farmers' risk preference is required. In the absence of such information the model sets aside the issue of attitude towards risk, and assumes that if the influence of risk in individual farmers' decision-making is not netted out in the aggregate, it will be at least not very important in influencing the estimated results significantly.

For the second hypothesis of competitive pricing behaviour to hold it is necessary that individual farmers in isolation cannot influence the prices, and variable factors are perfectly mobile. This is a more or less realistic presentation of commodity and labour markets in Bangladesh agriculture, where growing landlessness has created a large market for hired labour and product prices are mainly determined in the market.

Choice of a functional form

A wide range of functional forms is available to model production decisions. The most commonly used have been Cobb-Douglas or constant elasticity of substitution (CES) functions. While a Cobb-Douglas function restricts partial elasticities of substitution between all products to be equal to one, the CES form restricts them to be equal, but not necessarily to one. An extension of CES is the CRESH/CRETH function used by Vincent, Dixon and Powell (1980) to model Australian agriculture. The CRESH, constant ratio of elasticity of substitution homothetic, function originally suggested by Hanoch (1971) allows partial elasticities of substitution to vary between different pairs of inputs. However, it suffers from rigidities by assuming homotheticity and separability in inputs and outputs.

The translog, generalized Leontief, normalized quadratic, generalized McFadden, and Fourier flexible forms are examples of more flexible functional forms. These flexible functional forms commonly used for dual relationships are nonlinear and they are termed flexible because they are second order or Taylor series approximations to any underlying actual production functions. Hence, they do not impose as many restrictions on production technology as functional forms such as Cobb-Douglas, CES or CRESH/CRETH.

These flexible functional forms have been developed for a variety of applications of applied production theory, and there is not one particular function that can be expected to suit all purposes. Nevertheless, Fuss, McFadden and Mundlak (1978:224) have set out (i) parsimony in parameters, (ii) ease of interpretation, (iii) computational ease, and (iv) robustness, as the main criteria that should be used in selecting among these functional forms. The last criterion implies that an estimated profit function must possess properties such as convexity and monotonicity.

This study has chosen the normalized quadratic profit function as the functional form for profit function estimation. Although many of the flexible functional forms fulfil some of the selection criteria stated in the previous paragraph, none of the commonly used ones automatically satisfy global convexity. Global convexity can be imposed following procedures due to Wiley, Schmidt and Bramble (1973), Lau (1978b), and Jorgenson and Fraumeni (1981). However, Diewert and Wales (1985) have shown that when convexity is imposed on a translog function, it collapses to a Cobb-Douglas form and loses its flexibility. The normalized quadratic function developed by Lau (1976) and the normalized biquadratic restricted profit function (Diewert and Wales 1987) are the only functional forms on which global convexity can be imposed while retaining flexibility.

Lopez (1985) has shown that linear flexible functional forms, of which the normalized quadratic is an example, impose certain homotheticity and separability constraints on production technology, making the structure far less flexible than it was initially assumed to be. Morrison (1988) and Mahmud, Robb and Scarth (1986) have also shown that the normalised quadratic form suffers from an asymmetry problem. As the numeraire equation contains coefficients of the profit function, the choice of numeraire affects the results.

It is, therefore, a matter of judgement which criterion should be given more weight in making a decision about the choice of a particular functional form. Diewert and Wales (1985) have argued that functional forms for production functions used in general equilibrium modelling should satisfy curvature conditions globally. As already mentioned, since the empirical estimates of partial demand and supply elasticities obtained here are to be fed into a general equilibrium model developed in the following chapter, the normalized quadratic functional form is appropriate for the purpose. Examples of studies using a normalized quadratic profit function to estimate the input demand and output supply elasticities are Shumway, Saez and Gottret (1988), Moschini (1988), and Coxhead (1988).

The empirical model

The model identifies three different crop groups and two variable inputs. Rice and jute are two of the crops, accounting for about 90 per cent of the total crop production in the country. The commodity `other' is an aggregate of the remaining commodities. The important crops in this group are wheat, sugarcane, pulses, oilseeds, potatoes, and tobacco. Most of these are winter crops and they compete for land use with the *boro* variety of rice. As noted in Chapter 2, jute competes with *aus* and HYV *boro* varieties of rice.

The important inputs in the crop sector are labour, land, draught power, irrigation facilities, seeds, fuel, and fertiliser. Seeds are usually used in fixed proportion to output. Although the relative prices of different varieties of seeds are potentially capable of influencing farmers' decisions, access to irrigation facilities in Bangladesh is more crucial in determining the seed variety (Chapter 2). Because of this factor and also because of lack of data on use and prices of seeds, seeds are excluded from the econometric model. In estimation, draught power and irrigation machinery are treated as components of a fixed input, capital. The cost of irrigation services such as fuel is considered as working capital, another component of capital. Land is also a fixed factor in the short run. To save degrees of freedom, capital is further aggregated with land. Thus, the model contains only one fixed factor, a composite of land and capital. The variable inputs are fertilizer and labour. The final exogenous factor in the model is technology which is proxied by time.

The variable profit function in normalized quadratic form in this multi-output multi-input case is given by

$$\Pi^* = a_0 + \sum_{i=1}^{4} \alpha_i P_i + \sum_{k=1}^{2} \alpha_k Z_k + 0.5 \sum_{i=1}^{4}\sum_{j=1}^{4} \beta_{ij} P_i P_j + .5 \sum_{h=1}^{4}\sum_{k=1}^{2} \gamma_{hk} Z_h Z_k + \sum_{i=1}^{4}\sum_{k=1}^{4} \gamma_{ik} P_i Z_k \qquad (4.7)$$

where Π^* is normalized profit divided by the price of a numeraire variable. All the P_is are similarly normalized, i.e., they are nominal prices of outputs and variable inputs divided by the nominal price of the numeraire variable. For notational convenience, P is a netput vector in the empirical model, and it includes prices of both outputs, P_i, and variable inputs, R_j, as was defined in equation (4.4), i being extended to cover 1 to n variables. Since the empirical model considers three outputs and two variable inputs, in equation (4.7), n = 4, consisting of three outputs, rice, jute and the `other' crops, and one variable input, fertilizer. The fifth variable, labour, is implicitly present in the model, by being the numeraire input, and all nominal prices are divided by the wage rate. Composite fixed factor and time are represented by the Zs.

The first derivatives of (4.7) with respect to normalised output prices and normalised variable input prices give the output supply and (negative) input demand equations. The equations are linear in normalised prices of inputs and outputs, the fixed input quantity and technology.

$$X_i = \alpha_i + \sum_{j=1}^{4} \beta_{ij} P_j + \sum_{k=1}^{2} \gamma_{ik} Z_k \qquad i=1,...3 \qquad (4.8)$$

$$- X_i = \alpha_i + \sum_{j=1}^{4} \beta_{ij} P_j + \sum_{k=1}^{2} \gamma_{ik} Z_k \qquad i=4 \qquad (4.9)$$

Equation (4.8) is a set of output supply equations for each i, i being rice, jute and `other' crops, respectively. Equation (4.9) is the negative of the fertilizer demand function. Note that, again for notational convenience, X in the empirical model is a netput vector including output and input quantities, Y_i and X_j respectively, as were defined in equations (4.5) and (4.6).

The numeraire input demand equation for labour can be derived by substituting (4.8) and (4.9) into (4.7)[3] as

$$X_5 = \alpha_0 + \sum_{k=1}^{2} \alpha_k Z_k - 0.5 \sum_{i=1}^{4}\sum_{j=1}^{4} \beta_{ij} P_i P_j + 0.5 \sum_{h=1}^{2}\sum_{k=1}^{2} \gamma_{hk} Z_h Z_k \qquad (4.10)$$

From the symmetry property of the profit function it follows that $\beta_{ij} = \beta_{ji}$ across equations (4.8) to (4.10) and $\gamma_{hk} = \gamma_{kh}$ in (4.10). These symmetry conditions can be imposed during estimation.

The own- and cross-price elasticities of fertilizer demand and crop supply are obtained from equation (4.8) and (4.9) in the following way:

$$\eta_{ij} = (\delta X_i/\delta P_j).P_j/X_i$$

$$= \beta_{ij}.P_j/X_i \qquad i,j=1,...,4 \qquad (4.11)$$

---

[3] Normalized variable profit Π in (4.7) can be written as

$$\Pi = \sum_{i=1}^{n-1} X_i P_i + X_5,$$

therefore,

$$X_5 = \Pi - \sum_{i=1}^{n-1} X_i P_i$$

Equation (4.10) is derived by substituting (4.7), (4.8) and (4.9) in this expression (Shumway, Jegasothy and Alexander 1987, Coxhead 1988).

The own- and cross-price elasticities of labour demand are derived from equation (4.10) as

$$\eta_{5i} = (\delta X_5/\delta P_i).P_i/X_5 \qquad (4.12)$$

To estimate η_{5i} for i=1 to 4 and η_{55}, however, it is not essential to include equation (4.10) in the estimation model. The linear homogeneity property of the profit function, which is ensured during estimation by the normalization process, makes it possible to recover all η_{5i}s and η_{55} from equations (4.8) and (4.9). With homogeneity, the sum of price elasticities appearing in each equation is zero. Thus the parameters of the labour demand equation can be recovered from (4.8) and (4.9) using the following steps:

$$\delta X_5/\delta P_i = \sum_{j=1}^{4} \beta_{ij}.P_j \qquad i=1,\dots,4$$

$$= X_i \left[\sum_{j=1}^{4} \eta_{ij} \right] \qquad (4.13)$$

And using homogeneity, $\sum_{j=1}^{4} \eta_{ij} = - \eta_{i5}$ (4.14)

Therefore, $\delta X_5/\delta P_i = - X_i.\eta_{i5}$ (4.15)

$$\eta_{5i} = - \eta_{i5}.X_iP_i/X_5 \qquad i=1,\dots,4 \qquad (4.16)$$

and $\eta_{55} = - \left[\sum_{j=1}^{4} \eta_{5j}\right]$ (4.17)

However, if either the numeraire equation (4.10) or the profit function (4.7) is not included in the estimation, some loss in efficiency occurs. Because of the small size of the data set attempts to estimate a system including (4.8) to (4.10) were not successful. Therefore, (4.10) was dropped and equations (4.8) and (4.9) formed the final model estimated.

This system requires 28 parameters to be estimated. The symmetry restrictions reduce the number to be estimated to 22. However, *a priori* knowledge about the nature of cropping patterns in Bangladesh agriculture suggests that the only competitor of jute in land use is rice; jute does not compete with other crops. Thus it is assumed that $\beta_{23} = \beta_{32} = 0$, reducing the total number of parameters to be estimated to 26, and with symmetry imposed, to 21.

Estimating equations (4.7) and (4.8) represents a system of seemingly unrelated regressions where contemporaneous correlation among the equations is likely. This is because parameters are shared across equations and production decisions for one crop are likely to be related to decisions about others. Use of OLS in this situation would cause inefficiency as the error correlation would be ignored. In such cases, Zellner (1962) suggests that efficiency in estimation can be gained if the model is viewed as a single large equation estimated through the use of generalised least-squares estimation where the possibility of non-zero cross-equation errors is explicitly taken into account. Therefore, the Zellner estimation technique for seemingly unrelated regressions has been followed. The assumptions about the stochastic structure is that errors are additive and normally distributed with zero means and positive semi-definite variance-covariance matrix.

Data

The model uses annual aggregate time series data for the variables over the period 1971 to 1985 (Appendix A provides the final dataset used in the estimation). Quantities and prices of crop production, prices of fertilizer and its consumption, and wage rates are available in various yearbooks of the Bangladesh Bureau of Statistics. Data on labour is available in several issues of the United Nations *Statistical Year Books* of Asia and Pacific.

Capital includes irrigation machinery, livestock used for draught power and working capital. The construction of any time series of quantity and price indices of capital needs a series of price and quantity data for all the components in the index. Several sources are exploited to obtain the relevant data. The Bangladesh Agricultural Development Corporation has provided data on the number of tubewells and pumps used in irrigation. Using this information to make a weighted average, a composite price for irrigation equipment is obtained for 1980-81 on the basis of data on prices of irrigation equipment of different types and capacities provided by Rab (1981) for that year. The composite price of irrigation equipment thus obtained, together with data on an international machinery price index provided by the International Economic Data Bank, at the Australian National University, is used to construct a price series of irrigation equipment. Various issues of the United Nations *Statistical Year Books* of Asia and Pacific provided data on draught power. The price index of beef, published in several issues of the *Yearbook* of the Bangladesh Bureau of Statistics, is used as a proxy for the price of draught animals over the relevant years. Fuel consumption and prices of electricity and diesel were collected from the Bangladesh Power Development Board and Petrobangla by interview.

The model was run with two different sets of fixed factors. The first run used two distinct fixed factors: a capital index and a land index which considered the physical quantity of land alone. The other treatment of the fixed factors was to take a composite of land and capital, which was proxied by total cropped acreage. Total cropped acreage is computed by multiplying the physical area of cultivated land by cropping intensity. To the extent that the total cropped acreage is larger than aggregate physical land, the difference is mostly an outcome of investment in irrigation. Thus the total cropped acreage can be viewed as the physical quantity of land with capital embodied into it. The second set of fixed factors which took land and capital as one composite fixed factor worked better. Therefore, individual capital and land indices were not used in the final estimation.

The relevant prices for farmers are assumed to be one year lagged output prices and current input prices. Except for rice, all other output prices are harvest prices. The rice price is the wholesale price. The price and quantity of `other' crops are composite price and quantity indices constructed by applying the Fisher (1922) formula to data on price and production quantities of individual crops other than rice and jute.

Since the study uses aggregate time-series data, the question of exogeneity of prices is important. Output prices being lagged, they do not pose any problem. Among the variable input prices, fertilizer price for the relevant period was more or less government determined. Thus, the only variable that may have an endogeneity problem is the wage rate. A test of exogeneity proposed by Hausman (1978) was conducted by using cost of living index of agricultural workers (Table 2.15, Chapter 2), and linear and quadratic time trends as the instrumental variables. The test confirmed for each equation the exogeneity of wage rate as the added variable (the residual from the regression of wage rate upon the set of instrumental variables) was statistically insignificant and asymptotically uncorrelated with the true disturbances.

Results and interpretations

The model was estimated using the SHAZAM (White 1978) software package. Initially OLS estimates were obtained for each individual equation. The estimates and diagnostics of single-equation OLS are presented in Tables 4.1 to 4.4.

Table 4.1 **Ordinary Least Squares estimation of output supply equation for rice**

Regressor	Coefficient	t-ratio
Constant	29.3	0.7
Rice price	10.8	2.2*
Jute price	-2.0	-0.4
Other crop price	-2.7	-0.6
Fertilizer price	-3.7	-0.7
Composite fixed factor	0.6	1.3
Time	2.2	2.4*
Test statistics		
R-Bar squared	0.88	
F-Statistics	18.45(3.58, 6 & 8)	
LM for Serial Correlation(chi-square)	0.45(3.84, 1)	
Ramsey's RESET test(chi-square)	4.80(5.99, 2)	
Normality test(chi-square)	0.23(5.99, 2)	
Heteroscedasticity(chi-square)	3.13(3.84, 1)	

* implies significant at 5% or less

Values in the parentheses are critical values at 5% significance level and degrees of freedom, respectively.

Table 4.2 **Ordinary Least Squares estimation of output supply equation for jute**

Regressor	Coefficient	t-ratio
Constant	-107.4	-1.2
Rice price	-9.9	-1.0
Jute price	21.6	2.1*
Other crop price	0.0	0.0
Fertilizer price	1.7	0.1
Composite fixed factor	2.1	2.1*
Time	-3.2	-1.5
Test statistics		
R-Bar squared	0.54	
F-Statistics	2.14(3.48, 5 & 9)	
LM for Serial Correlation(chi-square)	1.63(3.84,1)	
Ramsey's RESET test(chi-square)	4.96(5.99, 2)	
Normality test(chi-square)	0.48(5.99, 2)	
Heteroscedasticity(chi-square)	0.16(3.84, 1)	

* implies significant at 5 % or less

Values in the parentheses are critical values at 5% significance level and degrees of freedom, respectively.

Table 4.3 **Ordinary Least Squares estimation of output supply equation for `other' crops (other than rice and jute)**

Regressor	Coefficient	t-ratio
Constant	-27.2	-0.4
Rice price	-7.0	-0.8
Jute price	0.0	0.0
Other crop price	7.2	0.9
Fertilizer price	-2.7	-0.3
Composite fixed factor	1.3	1.6
Time	-1.2	-0.7
Test statistics		
R-Bar squared	0.40	
F-Statistics	1.20(3.48, 5 & 9)	
LM for Serial Correlation(chi-square)	0.03(3.84, 1)	
Ramsey's RESET test(chi-square)	12.91(5.99, 2)	
Normality test(chi-square)	0.47(5.99, 2)	
Heteroscedasticity(chi-square)	10.40(3.84, 1)	

* implies significant at 5 % or less

Values in the parentheses are critical values at 5% significance level and degrees of freedom, respectively.

Table 4.4 **Ordinary Least Squares estimation of input demand equation for fertilizer**

Regressor	Coefficient	t-ratio
Constant	-93.4	-0.4
Rice price	-12.9	-0.5
Jute price	-24.9	-1.0
Other crop price	34.4	1.5
Fertilizer price	94.6	3.4*
Composite fixed factor	-0.2	-0.1
Time	-32.9	-6.5*
Test statistics		
R-Bar squared	0.97	
F-Statistics	50.26(3.58, 6 & 8)	
LM for Serial Correlation(chi-square)	6.00(3.84, 1)	
Ramsey's RESET test(chi-square)	2.73(5.99, 2)	
Normality test(chi-square)	0.64(5.99, 2)	
Heteroscedasticity(chi-square)	0.06(3.84, 1)	

* implies significant at 5 % or less

Values in the parentheses are critical values at 5% significance level and degrees of freedom, respectively.

The t statistics are not significant for most of the variables. The only equation that satisfies all the diagnostic tests reported here is rice supply function. The Lagrange Multiplier for first-order autocorrelation is not significantly different from zero for any of the equations except for fertilizer. All the equations except for `other' crops pass normality, heteroscedasticity and Ramsey's RESET test for functional form.

The values of the parameters estimated using the Zellner estimation are presented in Table 4.5. The chi-square test for all the slope coefficients to be zero is 80.99 compared with the critical value of 27.59 at the 5 per cent significance level.

Table 4.5 **Parameter Estimates maintaining symmetry and homogeneity**

Parameter	Estimate	t-ratio	Parameter	Estimate	t-ratio
α_1	37.8	0.9	α_3	-63.4	-0.7
β_{11}	14.3	3.5*	β_{31}	-6.8	-1.9*
β_{12}	-2.4	-0.6	β_{32}	0.0	0.0
β_{13}	-6.8	-1.9*	b_{33}	8.3	1.0
β_{14}	-3.8	-0.8	b_{34}	10.6	1.2
γ_{11}	0.5	1.1	γ_{31}	1.6	1.6
γ_{12}	2.0	2.3*	γ_{32}	-3.1	1.7*
α_2	-85.1	-0.9	α_4	-64.0	-0.3
β_{21}	-2.4	-0.6	β_{41}	-3.8	-0.8
β_{22}	13.8	1.5	β_{42}	-8.8	-0.8
β_{23}	0.0	0.0	β_{43}	10.6	1.2
β_{24}	-8.8	-0.8	β_{44}	98.8	4.1*
γ_{21}	1.9	1.8*	γ_{41}	-0.5	-0.2
γ_{22}	-1.6	-0.8	γ_{42}	-34.9	-7.8*

* Implies significant at 10 % or less

Of the 21 parameters estimated from these equations, about 33 per cent are significant. The elasticities calculated from the parameters using mean values are presented in Table 4.6 and Table 4.7. All the own price elasticities are of expected sign. Among the cross-price elasticities, jute-labour and fertilizer-`other' crops come up with `wrong' signs.

Table 4.6 **Own- and cross-price elasticities with symmetry and homogeneity**

	Elasticities with respect to the price of				
Output/input	Rice	Jute	Other	Fertilizer	Labour
Rice	0.184	-0.029	-0.056	-0.075	-0.023
Jute	-0.043	0.232	0.000	-0.243	0.055
Other	-0.118	0.000	0.094	0.284	-0.261
Fertilizer	0.022	0.048	-0.040	-0.889	0.859
Labour	0.027	-0.044	0.149	3.443	-3.575

Table 4.7 **Elasticities with respect to the fixed factors with symmetry and homogeneity**

	Elasticities with respect to the quantity of	
Output/input	Composite of land and capital	Technology
Rice	0.44	0.17
Jute	2.39	-0.20
Other	1.93	-0.37
Fertilizer	0.20	1.38

All the output and input variables show a positive relationship with the quantity of land. Rice supply and fertilizer demand demonstrate a positive trend over time, but the production of jute and other crops show a decline. The observation in Chapter 2 about cropping patterns supports this finding. Fertilizer and labour appear to be substitutes which is consistent with Abedin (1985) who, using a variable profit function approach from cross-section data, found labour and fertiliser as substitutes in irrigated cultivation. The positive cross-price elasticity of `other' crops with respect to fertilizer price can be argued in the following way. Since rice is intensive in fertilizer use, as the fertilizer price goes up, rice production falls (from a negative sign of rice-fertilizer cross elasticity) and `other' crops replaces rice production. Although `other' crops also use fertilizer, the expansion effect dominates the substitution effect and the cross-price effect between `other' crops production and fertilizer price becomes positive.

The model was tested to see whether the theoretical properties, described earlier, of the indirect profit function held. The tests were performed for the properties of symmetry, monotonicity and convexity. As homogeneity was maintained in the model, this property could not be tested. The likelihood ratio test was applied to test the validity of the assumption of symmetry, subject to homogeneity. The test is based on the value of $-2\log\lambda$, where λ is the ratio of the restricted to the unrestricted maximum likelihood. The value - $2\log\lambda$ is asymptotically distributed as a chi-square distribution with degrees of freedom equal to the number of restrictions. The likelihood ratio test result for the symmetry restriction was 26.94 against a critical value of 11.07 at 5 per cent with 5 degrees of freedom. Thus the null hypothesis that symmetry holds was rejected.

The property of monotonicity requires that the estimated quantities of output supply must be positive and input demand must be negative at all data points. The model satisfies this property.

For the profit function to be convex in prices, the hessian of its second-order partial derivatives must be positive semi-definite. The hessian of the second-order partial derivatives of (4.7) is as follows:

$$P_5^{-1}.[\beta_{ij}] \qquad i,j=1,2,3 \qquad (4.18)$$

Following Strang (1976), positive semi-definiteness was checked on (4.18) for every data point and it was satisfied.

The estimated coefficients when symmetry is not imposed and the price elasticities derived from them are listed in Tables 4.8 and 4.9.

Table 4.8 **Parameter Estimates without maintaining symmetry**

Parameter	Estimate	t-ratio	Parameter	Estimate	t-ratio
α_1	25.6	0.6	α_3	-63.4	-0.7
β_{11}	10.8	2.2*	β_{31}	-6.0	-0.6
β_{12}	0.5	0.1	β_{32}	0.0	0.0
β_{13}	-3.2	-0.8	b_{33}	5.3	0.7
β_{14}	-3.5	-0.7	b_{34}	-2.8	-0.3
γ_{11}	0.6	1.3	γ_{31}	1.3	1.6
γ_{12}	2.1	2.3*	γ_{32}	-1.2	-0.7
α_2	-111.3	-0.4	α_4	-64.0	-0.3
β_{21}	-10.1	-1.0	β_{41}	-26.3	-1.1
β_{22}	23.5	2.3*	β_{42}	-30.2	-1.3
β_{23}	0.0	0.0	β_{43}	59.9	3.9*
β_{24}	1.9	0.2	β_{44}	95.5	3.5*
γ_{21}	2.1	2.0*	γ_{41}	0.4	0.2
γ_{22}	-3.2	-1.5	γ_{42}	-31.7	-6.5*

* Implies significant at 5 % or less

Table 4.9 **Own- and cross-price elasticities without symmetry**

	Elasticities with respect to the price of				
Output/input	Rice	Jute	Other	Fertilizer	Labour
Rice	0.138	0.001	-0.026	-0.069	-0.043
Jute	-0.181	0.396	0.000	0.053	-0.268
Other	-0.104	0.000	0.060	-0.075	0.120
Fertilizer	0.153	0.166	-0.228	-0.860	0.769
Labour	0.027	0.213	-0.068	3.083	-3.256

The signs of own- and cross-price elasticities do not change markedly when symmetry is not imposed. The exceptions are elasticities of rice and labour with respect to jute prices and elasticities of jute and 'other' crops with respect to fertilizer prices. Although elasticity of rice with respect to jute prices is positive here, the value is near zero. The elasticity of jute with respect to rice prices has the expected sign and the value is much bigger when symmetry is not imposed. The observed pattern and empirical works in rice-jute relation also suggests higher responsiveness of jute production to rice prices compared to rice production to jute prices (Abedin 1985). The positive value of elasticity of labour with respect to jute price, calculated residually, is of the expected sign (although the assumption of symmetry was not imposed in estimation, it was used in computing the elasticities of the numeraire input, labour, which was not included in the estimation). Also, as expected, the elasticity of labour demand with respect to jute prices is greater than for rice prices because of the higher labour use in jute production (Ahmed, R. 1981). In contrast to positive elasticity of 'other crops' with fertilizer prices when symmetry was maintained, it is negative now as symmetry is not maintained. Also, jute supply which was found to be negatively related with fertilizer prices when symmetry was a maintained property, is positive now when symmetry is not imposed. Similar reasoning applies to explain the positive relation between jute production and fertilizer prices as was given for the positive relation between 'other' crops and fertilizer prices.

Test of structure: separability and non-jointness

The multi-output multi-input aggregate profit function described in equation (4.4) rejects the assumptions of input-output separability and non-jointness in allocation decisions. Although these assumptions are frequently maintained in studies that deal with aggregate output or separate production functions for each crop, empirical tests of them are very rare (see Shumway 1983 and Livernois and Ryan 1989 for examples of tests).

Weak separability in prices

If the production technology is separable into outputs and inputs, the transformation function becomes

$$G(Y) - H(X, Z) = 0 \qquad (4.19)$$

and (4.4) reduces to

$$\Pi(P, R; Z) = G(g(P), R; Z) \qquad (4.20)$$

where g(P) is the price index for composite output. The proof that output separability in the transformation function implies output-price separability in the variable profit function is given in Livernois and Ryan (1989).

Equation (4.20) implies that for a normalized profit function to be separable in a subset k of normalized output or input prices, all derivatives of ratios of partial derivatives with respect to prices and quantities not in the subset must be zero (Lau 1978a: 160-163). For the normalised profit function described by (4.7) weak separability implies that the ratio $(\delta\Pi/\delta P_i)/(\delta\Pi/\delta P_j)$, for i,j = 1, 2, 3 and $i \neq j$, is independent of other price and quantity arguments in (4.7). Thus, the partial derivatives of this ratio with respect to P_4 and Z_1 must all be zero.

In other words,

$$\delta(X_i/X_j)/\delta P_4 = 0 \quad \text{and} \qquad (4.21)$$

$$\delta(X_i/X_j)/\delta Z_1 = 0 \qquad (4.22)$$

or

$$X_j.\beta_{i4} - X_i.\beta_{j4} = 0, \text{ and } X_j.\gamma_{i1} - X_i.\gamma_{j1} = 0 \qquad (4.23)$$

For the empirical model given in (4.7), the i and j are rice, jute and `other' crops. Separability is tested with respect to two inputs, fertilizer and the composite of land and capital.

These conditions are satisfied globally by a set of linear restrictions

$$\beta_{i4} = \beta_{4i} = \gamma_{i1} = 0 \quad \text{for} \quad i = 1, 2,3 \qquad (4.24)$$

The likelihood ratio test values for weak separability with symmetry imposed and without symmetry are presented in Table 4.10. These values are compared with the value of -2logλ, where λ is the ratio of the restricted to the unrestricted maximum likelihood, and the value is asymptotically distributed as a chi-square distribution with degrees of freedom equal to the number of restrictions.

Table 4.10 **Likelihood ratio tests of separability and non-jointness with and without imposing symmetry**

Assumption	Likelihood ratio statistics	Degrees of freedom	Critical value at 5%
Separability			
1. With symmetry	6.88	6	12.59
2. Without symmetry	31.30	9	16.92
Non-jointness			
1. With symmetry	0.44	2	5.99
2. Without symmetry	4.20	4	9.49

The assumption of weak separability in output and input decisions is strongly rejected when symmetry is not a maintained hypothesis (Table 4.10). However, as pointed out earlier, separability is a maintained hypothesis in profit functions belonging to the group of linear flexible functional forms to which a normalized quadratic also belongs (Lopez 1985). The acceptance of sperability when symmetry is imposed provides empirical support to this theoretical derivation. However, rejection of separability assumption by the data when symmetry is not imposed indicates probable specification error in the model.

One point to note is that the test is confined to the inputs and outputs at the top level of the technology. Thus the test is conducted to find out whether production decisions about three outputs, rice, jute and other, are made independent of the price of fertilizer and the quantity of the composite of land and capital. Using a composite of land and capital implies separability of the outputs from land and capital individually, although they are not necessarily so with the composite itself. The aggregation of minor crops into one single crop called `other' implicitly assumes that allocation decisions about crops inside the group is independent of prices of inputs and outputs outside the group. Thus weak homothetic separability is assumed so far as the minor crops and land and capital are concerned.

Non-jointness

Non-jointness can be of various forms of which particularly relevant to agriculture is non-jointness in input quantities. If the assumption of non-jointness in input quantities holds, production decision about one output can be taken independent of other product decisions, and instead of multi-output technology embodied in the variable profit function given in (4.4), a separate production function for each individual output can be obtained and (4.4) takes the form

$$\sum_{i=1}^{m} \Pi^*_i(P_i, R; Z) \qquad (4.25)$$

The envelope theorem (Silberberg 1974) implies that non-jointness in input quantities is equivalent to

$$\delta X_i/\delta P_j = \delta^2\Pi^*_i(P_i, R; Z)/\delta P_i\delta P_j = 0 \qquad \text{for } i = j \qquad (4.26)$$

The test of non-jointness in input quantities in the case of technology underlying a normalized quadratic profit function given in (4.7) requires that all interaction terms between p_i and p_j for i,j=1...,3 must be zero. Therefore,

$$\beta_{12} = \beta_{21} = \beta_{13} = \beta_{31} = 0 \qquad (4.27)$$

The likelihood ratio test for non-jointness (similarly defined as for test of separability) given in Table 4.10 does not reject the assumption of non-jointness in input quantities at a 5% critical value. As in the case of the separability assumption, the test result is invariant to the restriction of symmetry.

A comparison with other available findings and some caveats

Several studies have estimated the price elasticities of outputs and inputs. Most of the studies on input demand confined their analyses to two inputs, fertiliser and labour, and one output, rice or jute. Most of the output supply elasticities have been calculated for rice and jute only. The exceptions are Cummings (1974) and Rahman (1986) which estimated own-price elasticities of other products. However, as already mentioned, all these studies with the exception of Abedin (1985) use a production function approach and are not directly comparable with the estimates of this study. It is nevertheless, worthwhile to look at some of their findings to determine the extent of divergence from the present estimates.

Table 4.11 **Available estimates of own-price elasticities in Bangladesh**

	Rice	Jute	Other	Fertilizer	Labour
Cummings(1974)	0.13	0.40	0.23[c]	-	-
Ahmed(1979)	0.18	0.25	-	-	-
Rabbani(1965)	-	0.40	-	-	-
Abedin(1985)	0.07	-	-	-0.70	-0.23
Hussain(1964)	0.09 to 0.38	0.36	-	-	-
Hossain(1985a)	-	-	-	-0.54 to -0.71	-
IFDC(1984)	-	-	-	-0.26	-
Rahman(1986)	0.06	0.51	0.20[c]	-	-
This study[a]	0.18	0.23	0.09	-0.89	-3.57
This study[b]	0.14	0.39	0.06	-0.86	-3.26

[a] with symmetry, [b] without symmetry, [c] vegetables only

In contrast to most of these studies which estimated elasticities from *ad hoc* equations, this study estimated them from equations derived under optimization behaviour. Also, the approach being dual, some of the pitfalls of the primal approach using production functions, as noted earlier in the chapter, was expected to be avoided. The performance, however, is not as satisfactory as was expected. Many coefficients are not statistically significant. But most of the elasticity values obtained were of expected sign and the exceptions were not that serious, except for jute-labour which is of correct sign when symmetry was not maintained. The own-price elasticity values for the crops lie within the range provided by the other studies (Table 4.11). The input demand elasticities, especially the own-price elasticity of labour, are larger than what available studies suggest. Although labour demand is expected to be negatively related with wage rate, an elasticity value of more than three is probably on the higher side, compared to the available estimate of -0.23 for Bangladesh presented here and also compared to available estimates for India which is less than -1.00 (Evenson and Binswanger 1984, Bardhan 1984a).

The model has several weaknesses. First, the rejection of symmetry violates one of the properties of the profit function itself from which the output supply and input demand equations are derived. However, symmetry is a more valid assumption when individuals are concerned, and it is not always expected to be preserved in functions aggregated across individuals. This study uses time-series data aggregated across individual farmers. Second, the assumption of jointness, which is the basis of multi-output production technology embodied in (4.7) did not hold. In the case of agriculture in Bangladesh, the fixed factor is land, and crops compete with each other for acreage allocation. The `jointness' between rice and jute in

Bangladesh agriculture has been established empirically and the trade-off between rice and jute cultivation has generated a policy debate in the country for a long time. The studies of output supply elasticities referred to in Table 4.11 have used output prices normalized by competing output prices. This recognizes that jointness is a valid assumption in Bangladesh agriculture.

The main source of the weakness of the model is its very small and incomplete data set. The incompleteness was mostly due to the lack of reliable information on various components of capital and their prices to form a suitable capital index. The small size of the data set has forced an aggregation over many commodities. As Fuss (1977) and Lawrence (1988) have demonstrated, the optimization process with many outputs and inputs can be modelled as a multi-stage event by using an aggregator function. For the aggregation to hold consistently, it is required that homothetic separability assumption holds among the products in the group and products outside the group (Wall and Fisher 1987). It was not possible to test the empirical validity of this assumption as there were not enough degrees of freedom. The poor performance of the equation for other commodities suggests the need for respecification of the model in terms of minor commodities. The aggregation of rice across all its varieties is another potential source of problems. The competition of jute historically has been mainly with *aus* variety of rice, but more recently, HYV *boro* has become another competitor. *Boro* also competes with wheat. Thus the aggregations made for this study may not have been consistent, and in that case a specification problem remains.

Despite these limitations, the exercise in this chapter indicates that the assumption of input-output separability does not hold for the technology structure of Bangladesh agriculture. It provides evidence that farmers are quite responsive to price changes. The insights derived from the study about the technology structure and the estimated elasticity values are used in formalizing the agricultural sector in the economy-wide model developed in the following chapters. Although jointness was found not to be valid, the production technology in agriculture is modelled assuming jointness to hold. Given the possibility of specification errors in the model, the rejection of jointness is ignored. The argument is mainly derived from the knowledge that the presence of constraints on an allocatable fixed factor, such as land, is a potentially important source of jointness in agriculture (Pfouts 1961). When so many farmers are producing multiple crops and are operating subject to the fixed supply of land, jointness appears to be a more valid description of technology than non-jointness (Shumway, Pope and Nash 1984).

CHAPTER 5

A COMPUTABLE GENERAL EQUILIBRIUM MODEL FOR BANGLADESH

This chapter develops a computable general equilibrium (CGE) model for the Bangladesh economy to evaluate the effects of agricultural price policy on production, employment, trade balance, government budget, growth, and income distribution. Issues in general equilibrium modelling of agricultural price policies for developing countries and of the current state of CGE modelling in Bangladesh are briefly discussed before the actual model structure and its theoretical foundations are outlined.

Issues in modelling agricultural price policy

Johansen (1960) initiated empirical general equilibrium modelling by developing a multi-sector price-endogenous general equilibrium model for Norway to analyze resource allocation issues. This was followed by Harberger's model (1962) analyzing tax policy issues in the United States in a two-sector general equilibrium framework. Since then a large literature has developed analyzing a wide range of issues with different model specifications. Modelling has gone beyond single-country analysis. Multi-country models are frequently used for addressing issues which are deemed to be global in nature (for example, Gunning et al 1982, Fischer et al 1988, and Parikh, Frohberg and Gulbrandsen 1988). Surveys of CGE modelling in developing countries can be found in Shoven and Whalley (1984), de Melo (1988), Robinson (1989), Bautista (1988), Decaluwe and Martens (1988), and Devarajan (1989). De Janvry and Sadoulet (1987) have surveyed six agricultural policy models in developing countries.

CGE studies of developing countries with price distortions commonly conclude that economy's performance would improve if distortions are removed or reduced. Agricultural incentives tend to move from taxation in lower income countries to subsidization in richer countries (Anderson and Hayami 1986). The equilibrium ratio of agricultural to non-agricultural marginal value products for factors of uniform quality, evaluated at world prices, tends to exceed one in the former group of countries and fall below one in the latter group. Hence, a change in policy that encourages resources to move into agriculture is welfare improving for the countries where agriculture is initially disadvantaged.

The estimated welfare gain, measured in terms of per cent of GNP, however, is not large. Srinivasan and Whalley (1986), after surveying a variety of single-country and multi-country CGE models, noted that the welfare gain from trade liberalization seldom amounts to as much as 1 per cent of GNP. Robinson (1990) defends the policy advice arising from CGE modelling by noting that while aggregate welfare may not improve markedly (due to one of the robust properties of CGE models by which substitution possibilities in production, consumption and trade allow for a large amount of adjustment flexibility), the impact on sectoral resource movement, production and trade is significant. An assessment of a policy reform inducing a particular change in sectoral structure requires an explicit introduction of a social welfare function with appropriate distributional weights into the model.

Hertel (1990b) has pointed out several issues in modelling agriculture in CGE frameworks. These are issues of aggregation, technology specification, time horizon, factor market operations, and the modelling of economywide policies. The issue of aggregation arises because a CGE model focusing on agriculture needs to have the sector sufficiently disaggregated, because interventions vary widely across different agricultural commodities, with some receiving positive incentives and some negative or no incentives. By adding them all together a large part of the distortionary wedge is missed. Also, in a model focusing on agriculture, non-agricultural sectors are often treated as a residual and are all lumped together in one or a few sectors. In practice, the dividing line between the agricultural and non-agricultural economy is not all that clear. Sectoral disaggregation at this level fails to trace the effects of farm and food policy completely since different industries, especially industries in food manufacturing, are affected differently by a particular commodity market intervention.

A detailed sectoral disaggregation, however, requires a very large dataset. To minimize data requirements, many CGE models have used restricted functional forms to represent the production technology and consumer preferences. Flexibilities such as non-separability in input and output decisions and jointness in input quantities are empirically realistic, especially in agriculture as shown in the previous chapter. Ignoring the flexibility may lead to misleading simulation results. Substitution among intermediate inputs and between intermediate inputs and primary factors are important at the farm level. Empirical work on the United States finds larger values for such substitution than for substitution within primary factors (Hertel et al 1989). A study of the United States manufacturing has demonstrated that for a removal of factor subsidies on electricity, the decline in electricity demand is 80 per cent larger when a restrictive, instead of a flexible, functional form is used to model the technology (Hertel 1985). The formulation of consumers preferences also has an important bearing on the model simulation results. While food products in general tend to be relatively income and price inelastic, individual elasticity values vary considerably among groups, and a restricted functional form such as Cobb-Douglas has the tendency to overstate the price elasticity values, leading to overstated consumer response to a policy shock (Hertel 1990b).

Another issue in CGE modelling of agricultural price policy is to make a distinction between which policies affect incentives and create an incentive wedge and which policies are lump-sum transfers without effects on decisions at the margin. An example can be given by subsidies on fertilizer and credit. Fertilizer subsidies in most cases create incentive effects by directly reducing the purchasers' price. In contrast, subsidies on credit, especially in developing countries, are mainly infra-marginal because of the presence of a secondary credit market to meet unsatisfied credit demand when credit rationing is introduced.

In modelling exchange rate and foreign trade regimes attention needs to focus on existing institutional rigidities. Quantitative restrictions on imports have been characteristically present in many developing countries. A large number of CGE models focusing on trade related issues have incorporated quantitative restrictions (some examples are Dervis, de Melo and Robinson (1982), Lewis and Urata (1984), Condon, Robinson and Urata (1985) and Grais, de Melo and Urata (1986) for Turkey, Ahmed *et al* (1985) for Egypt, Robinson and Tyson (1985) for Yugoslavia, Kis, Robinson and Tyson (1989) for Hungary, Martin (1989) for China, and Hossain (1989), Chowdhury (1990) and Lewis (1990) for Bangladesh). In these models quantitative restrictions have been treated in either of two ways: a fix-price system and a flex-price system (Dervis, de Melo and

Robinson 1981). In the models which use a fix-price system, importers receive a direct allocation of imports which is some fraction of their desired imports, and sale of the allocation is not allowed. Under flex-price rationing, a free market for foreign exchange is allowed to develop. The scarce foreign exchange is priced at a premium which raises the price of imports and acts as the equilibrating variable to clear the excess demand for imports.

Another common event in foreign trade and exchange rate regimes in developing countries is a multiple or dual exchange rates system. Usually exporters are allowed to retain a certain proportion of their export earnings and can sell this foreign exchange in the free market with a premium attached to it. The operation is similar to selling foreign exchange allocation for importing discussed above. The export premium acts as a hidden subsidy by raising the revenue earned by exporters to the extent that they are able to retain foreign exchange (see Martin 1989 for an example).

CGE modelling in Bangladesh

The first CGE study of Bangladesh was conducted by Keyzer (1986). The model aimed to evaluate the nutritional effects of food price changes. It disaggregates the agricultural sector into 17 sub-sectors and the rest of the economy is lumped into two more sectors: tradable non-agricultural goods and non-tradable non-agricultural goods and services. The non-agricultural sectors are modelled to have excess capacity. The parameters in the supply functions in agriculture were derived from a detailed linear programming model. One interesting feature of the model is that it permits the trade regime to be endogenously determined through endogenous processing costs of imports and exports.

Keyzer's model was later used by the Planning Commission of Bangladesh for its Third Five-Year Plan (Bangladesh, Ministry of Planning 1985). The non-agricultural sector was disaggregated further to make a total of 39 sectors. The agricultural supply functions were modelled independently of the linear programming model that Keyzer used. Instead, land development plans of the government were incorporated as policy parameters in the supply functions.

Lewis (1990) models the foreign trade regime of Bangladesh with import controls, high tariffs, overvalued currency, and a system of multiple exchange rates. He models the import and foreign exchange control regime as a flex-price system with the rate of the premium varying across sectors. The model is used mainly to examine the revenue implications of trade and industrial policy reforms.

Chowdhury (1990), on the other hand, models the trade and foreign exchange regime as a flex-price system with a uniform premium rate for all sectors. The premium consists of the difference between the official and secondary exchange rate. His model analyzes the economic effects of various tax policies on resource allocation and income distribution in Bangladesh. Hossain (1989) studies the effects of trade liberalization in Bangladesh and models the trade sector in a similar way to Chowdhury.

The production technology applied in these studies does not allow scope for substitution between intermediate inputs or between intermediate and primary inputs. Except for Keyzer, the studies use either Cobb-Douglas or fixed proportion input demand behaviour. Keyzer uses a complete demand system with an Almost Ideal Demand System functional form. Also, Keyzer's model differs from the other models cited above in distinguishing imported and domestic goods. While Keyzer treats domestic and imported goods as perfect substitutes, the other studies use Armington's (1969) assumption of imperfect substitution between them. Lewis has additionally introduced imperfect transformation between export and domestic production in his model.

The general equilibrium model developed and used in this study (hereafter called the Bangladesh model), is closer in structure to the trade-oriented models than the model developed by Keyzer. However, the Bangladesh model looks at issues which have not been covered by other CGE studies in Bangladesh, and as discussed in the following section, the model allows greater flexibility in agricultural production structure than is common in these other models.

Broad features of the Bangladesh model

The model is a small open economy model with 35 commodities and 25 sectors. Agricultural production takes place in the first sector only; the remaining 24 sectors produce manufacturing commodities and services. Unlike prior CGE work on Bangladesh, this study treats agriculture as a multi-product industry producing 11 commodities. The remaining sectors are single-product industries. Each sector employs intermediate inputs along with a mobile primary factor, namely labour, and two industry-specific primary factors, namely capital and land. Household consumption is represented by the demand of one agent, the household sector. The government collects revenue and spends it on current consumption, investment expenditure and transfer payments. Households own all of the primary factors. The model records trade flows of imports and exports along with financial capital inflows in the form of aid and remittances.

So far as the non-agricultural sector is concerned, the basic structure of the model is similar to other CGE models such as the ORANI model of the Australian economy by Dixon et al (1982) and its fiscal extension by Dee (1989). The agricultural sector is modelled differently to allow for greater flexibility in producers' decision making. Many CGE models, including the ORANI model, impose *a priori* restrictions on production technology by using restrictive functional forms (some exceptions for some sectors are Hertel and Tsigas 1988, Bautista 1986 and Coxhead 1989). The Bangladesh model introduces a more general functional form for the agricultural sector and allows greater flexibility in production structure. In modelling farmers' behaviour, the present study allows for non-separability and jointness in farm allocation decisions so that the optimal output mix is not restricted to be invariant to changes in relative input prices.

In addition, several key extensions have been made so that the model structure better fits the particular institutional characteristics of the Bangladesh economy. They include an explicit treatment of import rationing, foodgrains rationing, and two-tier pricing of foreign exchange.

The import control mechanism in Bangladesh contains both fix- and flex-price rationing elements. The government initially allocates import quotas commodity-wise at the official exchange rate, and some commodities get preference according to priorities set by government. The legal secondary market in foreign exchange and import quota certificates enables a potential importer to import beyond the quota limit at the secondary foreign exchange rate. However, although there is no allocation of foreign exchange at the secondary rate to import a specific commodity, as it is in the case of importing at the official rate, importers cannot import unlimited amounts. The total amount of foreign exchange available at the secondary market is also determined by the government, and importers can use it until the limit is reached. Thus, even for the flex-price system, some quantitative constraints are present, and the market clears at a price which contains a scarcity premium. The scarcity premium, as defined in this study, has two components: the import scarcity premium (which is commodity-specific) and the foreign exchange premium (which is not commodity-specific). While the existence of the import scarcity premium depends on the existence of binding import quota constraints that restrict the volume and/or mix of specific imports, the existence of the foreign exchange premium reflects a general scarcity of foreign exchange. Figures 5.1a, 5.1b and 5.1c respectively illustrate the exchange market operation and the impact of different systems of foreign exchange allocations on import market.

Similar to Figure 3.1 in Chapter 3, DD and SS in Figure 5.1a respectively indicate foreign exchange demand and supply curves. For a given level of absorption, DD represents substitution between imported and nontraded goods at a given level of tariff. If the amount of foreign aid is held constant, supply of foreign exchange is determined by export earnings and remittances received. As the price of foreign exchange increases, exporting and remittances become more profitable, and they respond positively. At an officially fixed exchange rate e_1, available foreign exchange is OE_1. If a secondary exchange rate e_2 is allowed to clear the market, the relevant supply curve looks like e_1AS.

At the exchange rate e_2, amount of foreign exchange supplied is OE_2, which is allocated between two commodities, 1 and 2. For commodity 1, the entire import demand is met at the official exchange rate e_1, and the intersection of demand and supply schedules in 5.1b determines the import

Figure 5.1: Foreign exchange and import market operations in Bangladesh

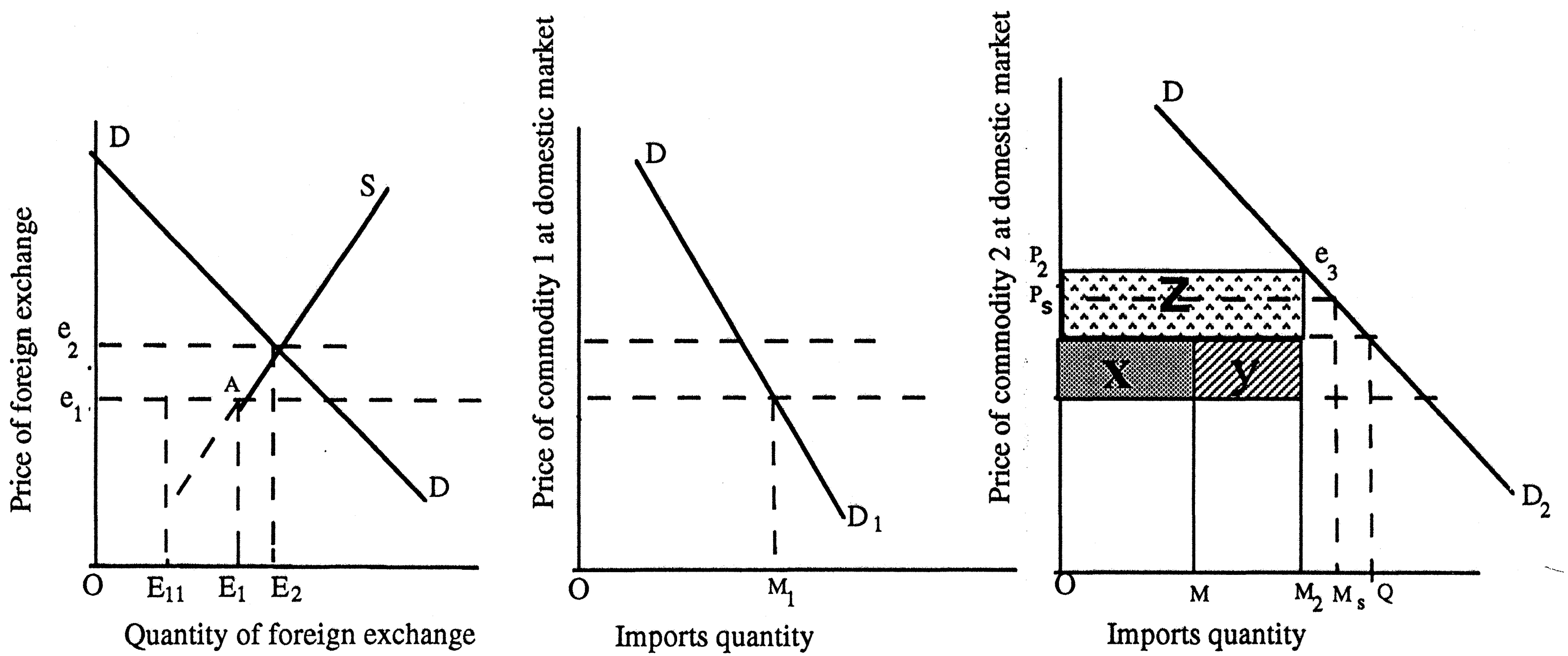


Figure 5.1a

Figure 5.1b

Figure 5.1c

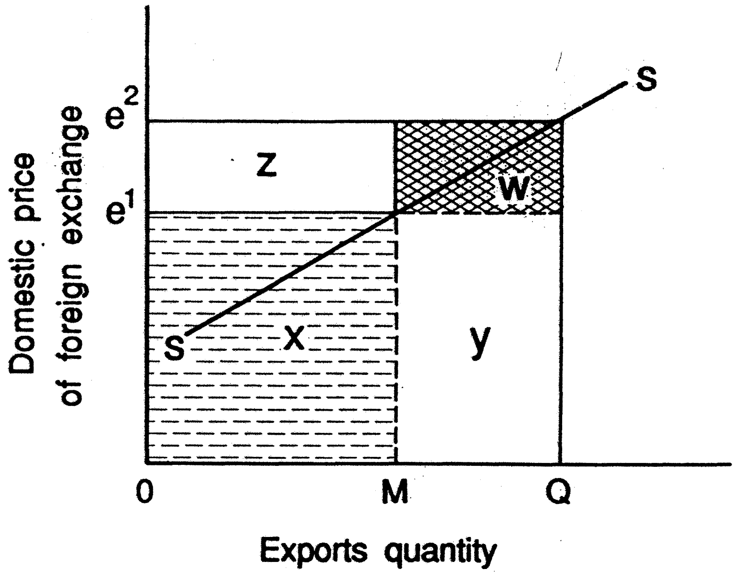
at OM_1. In 5.1a, this uses up foreign exchange up to OE_{11}. Commodity 2 is subject to quantitative control, and the remaining available foreign exchange at official exchange rate e_1, i.e., $E_{11}E_1$, is spent for importing up to OM quantity of commodity 2. A further import of MM_2 is possible by spending E_1E_2, an additional amount of foreign exchange available at e_2. The market clearing price for commodity 2 at OM_2 is OP_2, which includes foreign exchange premium (e_2 - e_1) and import scarcity premium (e_3 - e_2). A further import of M_2M_s at the secondary exchange rate of e_2 sets the domestic price at OP_s, reflecting a lower scarcity premium than OP_2. If imports at secondary market were uncontrolled, imports of commodity 2 would have been at Q, and the scarcity premium would reflect the foreign exchange premium only.

The scarcity premium accrued to a specific commodity thus varies depending on the final limit to its import and whether foreign exchange is available at the official or secondary rate. The scarcity premium, defined as the difference between unit cost of importing a commodity at the official exchange rate and its market price, both net of tariffs, can be considered as a supplemental tariff with rates varying among commodities. In diagram 5.1c, the difference between the cost of importing OM_2, at the official exchange rate and at the market price, is given by the area (x+y+z) which is the scarcity premium for this commodity, and the proceeds are distributed among government and importers in the following way. The licensed importers obtaining cash licenses to import up to OM at the official exchange rate receive the rent denoted by area x. Area y is received by the government as sale proceeds of foreign exchange of $E_{11}E_1$ to the importers of commodity 2 at the secondary exchange market. The remaining area z consists of scarcity premia received by private importers.

The model, however, does not take account of rent-seeking activities that are likely to follow quantitative rationing of imports (Krueger 1974). Rent seeking is expected to be intensive when an import quota system is first introduced, because of fierce competition for obtaining scarce foreign exchange. But once the rules of allocation are settled, `there should be no more efficiency losses from rent seeking associated with import quotas than with any other government entitlement programme' (Robinson 1990:208). However, in the case of Bangladesh, the rules of allocation appear not to be settled even after four decades of continued import rationing. As described in Chapter 3, the discretionary powers left in the hands of the controlling authority are considerable. An analysis of the effective protection rates in manufacturing industries in Chapter 3 indicates a wide degree of dispersion for the same commodity catering to different markets, reflecting considerable room for discretion and rent seeking. The reason for not incorporating rent seeking in the Bangladesh model is the lack of data on the technology of rent seeking.

In addition to import premia, the model allows for foreign exchange subsidies or export premia to exporters. As explained in Chapter 3, export premia emerge from the government's export performance licensing scheme in a dual exchange rate system.

Figure 5.2: **Export subsidies under the foreign exchange retention scheme**



In Figure 5.2, ss is the export supply curve and e_1 and e_2 are official and secondary exchange rates respectively. Area (x+y) is the local currency value of exporting OQ when the retention parameter value is zero and area (x+y+z+w) is the export revenue when the retention parameter value is 1. For a certain value of the retention parameter, say a (a=MQ/OQ), the export revenue earned from exporting up to OQ is (x+y+w), and w is the export premium received by exporters from the government.

Quantity rationing in the food market is modelled in a similar way except for the fact that no scarcity-induced premium is assumed to arise. In Bangladesh, along with a rationed market of foodgrains, a free market for the purchase and sale exists where producers and consumers can transact any amount without restrictions. In the presence of free markets where purchases and sales are allowed without any set limits, government-controlled prices and quotas cannot directly affect prices and production and consumption levels at the margin (Sicular 1988). The ration quota generates rents to ration card holders to the amount of the quota multiplied by the subsidy rate. Hence the food subsidies become infra-marginal, and without affecting consumers' marginal decisions directly, enter into the budget as a transfer of income and influences allocation decisions indirectly through distribution effects. The model captures this by linking consumption with disposable income inclusive of food subsidies.

Similarly, credit subsidies are modelled as infra-marginal transfers (Brandao 1988) and have little effect on production levels in agriculture at the margin. Their income effects could not be included in the model because of a lack of data on the size or distribution of credit subsidies.

Other interventions are covered in a conventional way. The subsidy on fertilizer is treated as a negative tax on its purchase. Since 1984, no subsidy has been involved in the purchasers' price of fertilizer, and the subsidy that appears in the budget is given to the dealers by setting the issue price to them at a level below procurement cost. The ultimate incidence of the subsidy depends on the elasticities of demand and supply of fertilizer. Until very recently supply of fertilizer at the national level has been managed by the Bangladesh Agricultural Development Corporation and there has not been any serious shortages in any year, (Quasem 1985a, Hossain 1985c). Thus in the face of a supply curve which is more or less horizontal, the incidence of the subsidy is ultimately shifted to the final buyers and dealers get only the normal trade margins. In the case of irrigation equipment, government expenditure on the irrigation subsidy is modelled as a negative tax on the purchase of irrigation equipment.

Model notation

The variables at level form are written in upper case letters. Lower case letters are used to express the percentage change in the corresponding upper case variable. Thus the percentage change in variable X is represented by x where

$$x = (dX/X).100$$

An extensive system of subscripts and superscripts is used to distinguish variables by their source of origin or use in a particular industry. x^{k}_{isj} expresses demand for the ith input from source s used by industry j for purpose k. The letter i refers to each of the g commodities distinguished in the model. The letter s is the source from which commodity i can be procured : domestic when s=1 and imported when s=2. The possible values for k are 1 (current production), 2 (capital creation), 3 (household consumption), 4 (export demand) and 5 (government demand).

The theoretical structure and equations of the model

The equations of the model presented in Appendix A1 can be classified into eight groups :

- equations describing industry demands for intermediate inputs and primary factors;
- equations describing product transformation possibilities;
- equations describing household and other final demands for commodities;
- equations describing market clearing for commodities and primary factors;
- pricing equations setting pure profits from all economic activities to zero;
- government budget equations;
- external trade equations;
- equations describing macroeconomic aggregates such as GDP, the consumer price index etc.

Industry input and output equations

The model assumes production to be competitive and efficient. Competitiveness is ensured by the fact that no single producer can influence commodity prices. Efficiency is implied because producers are assumed to be optimizing agents who either minimize the cost of production or maximize profit.

The specification of technology differs between agricultural and non-agricultural industries. While all non-agricultural industries are single product industries, the agricultural sector is assumed to have multi-product technology and the boundary of the production possibilities set determines the substitution possibilities between different crops and between different inputs in response to input and output price changes.

The production technology in non-agricultural industries exhibits constant returns to scale and is of a two-level nested form. At the upper level the production function is Leontief, with no substitution between different intermediate inputs or between intermediates and an aggregate of primary factors.

At the lower level, constant elasticity of substitution (CES) functional forms are assumed to describe the substitution possibilities between domestic and imported sources of each intermediate[1], and the substitution possibilities among different types of primary factors.

Given the substitution possibilities between domestic and imported intermediates and between different primary factors, the problem faced by each non-agricultural industry is to choose these inputs so that total production cost is minimized for a given output level. To be precise, for

[1]Although the CES functional form for the import-aggregation function has been criticised for being highly restrictive (Alston 1990), its choice in this study is guided by the availability of elasticity estimates.

any given level of activity, Z_j, industry j chooses material inputs X^1_{isj}, i=1,...,g, s=1,2, from domestic and imported sources, and its inputs of primary factors, X_{vj}, v=1,2,3, where 1 stands for labour, 2 for capital and 3 for land, to minimize its total costs, TC_j,

$$TC_j = \sum_{i=1}^{g} \sum_{s=1}^{2} (P^1_{isj} X^1_{isj}) + \sum_{v=1}^{3} (P_{vj} X_{vj}) \qquad (5.1)$$

subject to the following production relationships:

$$\text{Leontief}(X^1_{ij}) = Z_j \qquad i=1,...,g+1 \qquad (5.2)$$

$$X^1_{ij} = CES_s(X^1_{isj}) \qquad i=1,...,g,\ j=2,...,h \qquad (5.3)$$

and

$$X^1_{g+1,j} = CES_v(X_{vj}) \qquad j=2,...,h \qquad (5.4)$$

In equation (5.2) there are g+1 inputs. The first g inputs refer to directly used intermediate inputs and the remaining input is a composite of primary factors aggregated by equation (5.4). P^1_{isj}, for i = 1,...,g, and s = 1,2, is the purchasers' price to industry j of good i from source s for use as an intermediate input, and P_{vj} is the price of factor v to industry j.

The solution to the cost minimization problem is derived in stages. First, it follows from (5.2) and (5.3) that X^1_{i1j} and X^1_{i2j} are chosen to minimize

$$P^1_{i1j} X^1_{i1j} + P^1_{i2j} X^1_{i2j} \qquad (5.5)$$

subject to

$$Z_j = CES_s(X^1_{isj}) \qquad j=2,...,h \qquad (5.6)$$

The next problem is to minimize

$$\sum_{v=1}^{3} P_{vj} X_{vj} \qquad (5.7)$$

subject to

$$Z_j = CES_v(X_{vj}) \qquad j=2,...,h \qquad (5.8)$$

The first order condition to these optimization problems, written in percentage change form, are given by equation M.1 and M.2 in Appendix A1; the coefficients and parameters operating in these equations are explained in Appendix A3.

Later in the model equation M.12 associates output levels and activity levels in non-agricultural industries.

The choice problem in the agricultural sector, however, is different from that in the non-agricultural sectors. The first point of difference is that agriculture is a multi-output industry in contrast to single-output non-agriculture. While in non-agricultural production producers choose the optimal mix of inputs alone for a given level of output, the agricultural sector chooses an output mix as well as an input mix. The second difference lies in the number of stages in allocation decisions. Agricultural output is broadly grouped into three crops: two major crops and one composite crop which is an aggregate of the remaining nine crops. There is only one material input which is a composite of all inputs used. The only variable factor is labour and the single fixed factor is a composite of land and capital. The production technology is a three-level nested form. At the top level of the technology, farmers choose the production levels of the three crops as defined and determine labour employment and use of the composite input in such a way that `variable' profit from agricultural activity as a whole is maximized, given a fixed supply of the composite of land and capital, given output and variable input prices, and given an exogenous technology. At the second level, the composite crop is described by a CET aggregator function. Individual material inputs are combined into the composite in fixed proportions while the fixed factors are described by the CES aggregator function. At the lowest level, farmers' choice of individual intermediate inputs by source is governed by a CES rule between foreign and domestic sources of supply.

Thus, for a given level of technology, T, and a composite quantity of land and capital, W, farmers make decisions about the supply of two main crops, X_{i1j} for i=1 and 2, the supply of a third composite crop, Q_1, the demand for a composite intermediate input, Q_2, and the demand for labour, X_{vj} for v=1 and j=1, to maximize variable profit

$$\sum_i P^0_{i1}X_{i1j} + P_1Q_1 - P_2Q_2 - P_{vj}X_{vj} \qquad i \in \text{agriculture} \qquad (5.9)$$

subject to

$$F(X_{i1j}, Q_1, Q_2, X_{vj}; W, T) = 0 \qquad i=1,2, j=1 \;\&\; v=1 \qquad (5.10)$$

where

$$Q_1 = CET_i(X_{i1j}) \qquad i \in \text{agriculture}, j=1 \qquad (5.11)$$

$$Q_2 = Leontief_i(X^1_{ij}) \qquad i=1,...,g, j=1 \qquad (5.12)$$

$$W = CES_v(X_{vj}) \qquad v=2,3, j=1 \qquad (5.13)$$

and

$$X^1_{ij} = CES_s(X^1_{isj}) \qquad i=1,...,g, j=1 \qquad (5.14)$$

P^0_{i1} is the producers' price of the major agricultural products, P_1 and P_2 are the producers' price of composite output and purchasers' price of composite input respectively, and P_{vj} (v=1, j=1) is the cost of labour.

The first-order conditions to the problem produce a set of input demand and output supply equations. Chapter 4 exclusively deals with the derivation and estimation of the equations.

The derived input demand function for composite input Q_2 is as follows:

$$Q_2 = \alpha_{q2} + \sum_k \alpha_{q2k} P^0_{k1} + \alpha_{q2q1} P_1 + \alpha_{q2q2} P_2 + \alpha_{q2v} P_{vj} + \alpha_{q2w} W + \alpha_{q2t} T \qquad k \in \text{agriculture} \qquad (5.15)$$

The a_{ij} 's are the coefficients estimated in Chapter 4. The percentage change form of (5.15) is given by M.3 and its derivation and the description of the coefficients are given in Appendices A5 and A3 respectively.

Equation M.4 in Appendix A1 describes the fixed proportion relationship between the composite input and its constituents. The CES aggregation between domestic and imported inputs is described by equation M.5 where σ^1_{ij} is the elasticity of substitution.

The labour demand function in level form, derived in Chapter 4, takes the following form:

$$X_{vj} = a_v + \sum_k a_{vk} P^0_{k1} + a_{vq1} P_1 + a_{vq2} P_2 + a_{vv} P_{vj} + a_{vw} W + a_{vt} T \qquad k \in \text{agriculture} \qquad (5.16)$$

Equation M.6 in Appendix A1 describes it in percentage change form details of which are provided in Appendix A5.

Equation M.7 describes the aggregation of land and capital to form the composite of fixed factors.

The composite prices P_1, P_2 and P^* (price of composite of land and capital) and P^1_{ij} are the share-weighted sum of individual prices and are expressed in linear percentage change form by equation M.8, M.9, M.10 and M.11.

The level form of the output supply functions derived from the first-order conditions to the problem outlined in (5.9) to (5.14) are as follows:

$$X^1_{ij} = \alpha_i + \sum_k \alpha_{ik} P^0_{k1} + \alpha_{iq1} P_1 + \alpha_{iq2} P_2 + \alpha_{iv} P_{vj} +$$
$$\alpha_{iw} W + \alpha_{it} T \qquad k \in \text{agriculture}, i=1,2, j=1 \quad (5.17)$$

and

$$Q_1 = \alpha_{q1} + \sum_k \alpha_{q1k} P^0_{k1} + \alpha_{q1q1} P_1 + \alpha_{q1q2} P_2 + \alpha_{q1v} P_{vj} +$$
$$\alpha_{q1w} W + \alpha_{q1t} T \qquad k \in \text{agriculture} \quad (5.18)$$

The percentage change form of these equations are represented by M.13 and M.14.

Equation M.15 describes the CET aggregation among the minor crops and σ_q is the elasticity of transformation.

Final demand equations

Underlying the household demand functions is the assumption of utility maximization subject to an expenditure constraint. The single representative consumer chooses X^3_i, i=1,...,g to maximize the utility function

$$U=U(X^3_1,...,X^3_g) \quad (5.19)$$

given

$$\sum_{i=1}^{g}\sum_{s=1}^{2} P^3_{is} X^3_{is} = C \quad (5.20)$$

and

$$X^3_i = CES_s(X^3_{is}) \qquad i=1,...,g, s=1,2 \quad (5.21)$$

X^3_{is} and P^3_{is} are the quantities consumed and prices paid by households for the ith commodity from source s, and C is the aggregate consumption expenditure, the behaviour of which is specified later in the model. It is assumed that consumers choose each composite product which is an aggregate of domestic and imported products to maximize utility, and they minimize their expenditure on the composite by substituting between domestic and imported sources according to a CES formulation.

The solution of the constrained maximisation problem in (5.19) to (5.21) gives the demand equations for composite commodities and commodities differentiated by source as

$$X^3_i = f(P^3_i, C) \qquad i=1,...,g \qquad (5.22)$$

$$X^3_{is} = f(P^3_{i1}, P^3_{i2}, X^3_i) \qquad i=1,...,g, s=1,2 \qquad (5.23)$$

In linear percentage change form (5.22) and (5.23) become M.16 and M.17 in Appendix A1. The variables and coefficients appearing in these equations are described in Appendices A2 and A3 respectively.

The second set of final demand equations describes the representative household's demand for investment goods. In the absence of any suitable theory behind investment in Bangladesh, private investment spending in each investment commodity is assumed to move in parallel with aggregate capital stock in the economy. The representative consumer, however, minimizes expenditure on composite investment good i by choosing between domestic and imported sources following CES substitution possibilities. The equations in percentage change forms are given in M.19 and M.20 in Appendix A1.

The third set of final demand equations are government demands for current consumption and capital goods described in equations M.21 through M.24. As with private investment demand, government investment expenditure on each commodity is linked with aggregate capital stock. Government current consumption, on the other hand, is linked with aggregate real private consumption, C^r. Both of these demands, however, can be held fixed in the model simulations by assigning the value of zero to the indexing parameters h^2_i and h^5_i. Provision is also made for an exogenous shift in government demands through the inclusion of shift variables f^2_i and f^5_i.

The last set of final demand equations are export demands. They take the simple partial equilibrium form

$$P^e_{i1} = f_i(X^4_{i1}, F^4_{i1}) \qquad (5.24)$$

where P^e_{i1} is the free on board (f.o.b.) foreign currency price of good i, P^e_{i1} is a non-increasing function of X^4_{i1}, the volume of exports of good i, and F^4_{i1} is a shift variable to introduce an exogenous shift in the export demand. Equation M.25 is the percentage change form of (5.24) where γ_i is the reciprocal of the foreign elasticity of demand for exports of good i.

Market clearing

Equation M.26 and M.27 describe the equilibrium in the market for domestically produced commodities. The percentage change in the demand, given by equation M.26, is a share-weighted sum of the percentage changes in all types of demand: intermediate, household consumption, government consumption, capital creation by private households and government, and exports. The percentage change in supply in domestic commodity i is a share-weighted sum of the percentage changes in the supplies of i by each industry, given by equation M.27.

The equilibrium in factor markets, equations M.28 to M.31, is specified in level form as

$$\sum_{j=1}^{h} X_{vj} = L \qquad v=1 \qquad (5.25)$$

$$\sum_{j=1}^{h} K_j = K \qquad (5.26)$$

$$X_{vj} = K_j \qquad v=2, j=1,...,h \qquad (5.27)$$

$$X_{vj} = N_j \qquad v=3, j=1,...,h \qquad (5.28)$$

The left hand sides of (5.25) to (5.28) are respectively the aggregate demand for labour and capital, and industry-specific demand for capital and land. On the right hand side, the equations are total employment of labour, aggregate capital stock and industry-wise use of capital and land.

The price system or zero pure profit conditions

The model uses several sets of prices: producers' prices of domestic goods, importers' prices of foreign goods, f.o.b. prices of exports, and purchasers' prices.

Producers' prices of domestic goods are prices received by producers and do not include taxes on sales. However, they include trade and transport margins which is treated as a separate input cost of production for domestically produced commodities sold in the domestic market. Importers' prices are the c.i.f. (cost, insurance and freight) value of imported goods plus tariffs and scarcity premia, and they do not include trade and transport margins. The trade and transport margins on imports are considered as purchases of this services as intermediate and final demand to facilitate the delivery of imports for intermediate and final demand. The f.o.b. price of exports is the price of exports at the port and it includes payments for domestic taxes, transport and other margins involved in delivering the exports from producers to ports. Thus, the differences between producers' and purchasers' prices in the case of domestically produced goods, and between importers' and purchasers' prices in the case of imported goods, are solely driven by the extent of domestic taxes on the purchase of the commodities.

Thus, the assumptions made about the point in the price chain are as follows: all domestically produced goods reach the market at a producers' price which includes trade and transport margins. If the good is exported, an export tax (negative tax if subsidy) is added to the producers' price. For domestically sold goods, sales tax (negative tax if subsidy) is added to the producers' price before it reaches the final consumer. Imported goods brought to the market are inclusive of taxes and scarcity premia, and do not include trade margins. Sales tax (or negative tax if subsidy) are added to the import price before they reach the final purchasers. The trade and transport margins involved in processing the imported products to reach the market is sold as a separate domestically produced service item to its buyers.

The producers' prices of domestically produced goods and the importers' prices of imports are assumed to be uniform across users. However, the taxes on consumption are user-specific so that purchasers' prices can vary among end-users. The price relations specify these relationships between producers' prices or importers' prices on the one hand, and purchasers' prices on the other.

The price relations also ensure that no pure profit is earned in any economic activity. Hence, total revenue is equal to total cost in all activities: current production, capital creation, importing, and exporting.

In current production the price relations can be stated as

$$\sum_{i=1}^{g} P^{0}_{i1} X^{0}_{i1j} = \sum_{i=1}^{g} \sum_{s=1}^{2} X^{1}_{isj} P^{1}_{isj} + \sum_{v=1}^{3} X_{vj} P_{vj} \quad j=1,\ldots,h \qquad (5.29)$$

In percentage change form equation (5.29) is described by equations M.32 and M.33 in Appendix A1. Equation M.32 is relevant for the non-agricultural sectors. The non-agricultural industries exhibit constant returns to scale. This makes average cost equal to marginal cost, which in turn equals average revenue or price. Therefore, both revenue and costs per unit of activity are independent of the activity level. Thus, the percentage changes in revenue and costs per unit of activity are share-weighted averages of input and output prices only.

In agriculture, the flexible functional form used to represent the production technology does not necessarily imply constant returns to scale. As such, the percentage change form of the zero pure profit condition in agriculture, given by equation M.33, contains quantity variables.

The zero pure profit in capital creation, expressed in equation M.34, essentially defines the cost of a unit of capital. Because of lack of data on capital creation at the industry level, the unit cost of capital in each industry is assumed to equal Π, the economy-wide average unit cost of capital. Equation M.34 is derived from

$$\Pi.K = \sum_{i=1}^{g}\sum_{s=1}^{2} P2_{is}X2_{isH} + \sum_{i=1}^{g}\sum_{s=1}^{2} P2_{is}X2_{isG} \tag{5.30}$$

equating the value of aggregate capital stock to the sum of investment expenditure on all commodities.

The importers' price of imports is defined given by the following relation

$$P0_{i2} = Pm_{i2}\Phi_1(1+T^*_i+SP^*_i) \tag{5.31}$$

where $P0_{i2}$ is the importers' price of imported good i, Pm_{i2} is the foreign currency c.i.f. price of imported good i, and Φ_1 is the official exchange rate.

As already discussed, the import rationing mechanism is assumed to be premia rationing and therefore the importers' price of foreign goods at the margin is tariff (T^*_i) and scarcity premium (SP^*_i) inclusive. The linear percentage change form of (5.31) is given by equation M.35 in Appendix A1, where the lower case variables t_i and sp_i are the percentage changes in the power of the tariff ($1+T^*_i$) and the power of the scarcity premium ($1+SP^*_i$) respectively.

Equation M.36, zero pure profit in exporting, is derived from

$$P^e_{i1}\Phi_2 A_i + P^e_{i1}\Phi_1(1 - A_i) = P^0_{i1}(1 + ES^*_i) \qquad (5.32)$$

The expression on the left hand side is local currency receipts from exporting one unit of good i. The official exchange rate is represented by Φ_1, the secondary exchange rate by Φ_2, and the foreign exchange retention parameter by A_i. Recall that under the government's export performance licensing scheme, exporters are allowed to retain a certain proportion of their foreign exchange earnings. They are free to sell this amount of foreign exchange in the open market, or they can use it for importing permitted items of similar value, either for domestic resale or for use as inputs into production. Whatever may be the case, exporters earn a premium on this foreign exchange in addition to its official price. The premium is the difference between the secondary market price and the official price of foreign exchange. Thus for items which are under the scheme the actual export receipts are a share-weighted sum of receipts at the official rate and receipts at the secondary rate. The weights are the A_is, the rate of retention of foreign exchange that exporters are allowed to hold, and these are policy variables. On the right hand side of equation (5.36) is the unit cost of exporting domestic product i. This equals P^0_{i1}, the producers' price of domestic good i plus taxes ES^*_i. In equation M.36 in Appendix A1, the lower case variable es_i is the percentage change in the power of the export tax $(1+ES^*_i)$.

The next three price equations M.37 to M.39 associate producers' prices with purchasers' prices. In the absence of any explicit trade and transport margins, it is the taxes on purchases of commodities that drive a wedge between the two sets of prices. In level form the price relations are

$$P^1_{isj} = P^0_{is}(1+G^1_{isj}{}^*) \qquad (5.33)$$

$$P^2_{is} = P^0_{is}(1+G^2_{is}{}^*) \qquad (5.34)$$

$$P^3_{is} = P^0_{is}(1+G^3_{is}{}^*) \qquad (5.35)$$

where $G^1_{isj}{}^*$, $G^2_{is}{}^*$ and $G^3_{is}{}^*$ are taxes on purchases of commodities for intermediate, investment and household usage respectively. In the percentage change forms of these equations the lower case variables g represent the percentage change in the power of the tax $(1+G^*)$.

The government budget

The model incorporates a full accounting of the government budget. This is done with the objective of exploring the implications of different policy shocks for the net budgetary position, to ascertain whether the policy options are sustainable in a budgetary sense.

The budgetary situation is represented by a set of equations keeping account of the many separate government revenue and expenditure items. These equations are of a book-keeping nature. Table 5.1 shows the fiscal accounting framework that is used in the model. The breakdown of some items in the table differs from that in actual government budget documents, but is chosen to improve the measurement of the budgetary implications of specific policy instruments. Nevertheless, aggregate government receipts and expenditures match the control totals from the budget documents.

Table 5.1 **Accounting framework of the government budget**

Government revenue	Government expenditure
1.Direct taxes on income	1.Consumption expenditure
2.Tariffs on imports	2.Investment expenditure
3.Commodity taxes and subsidies	3.Food subsidy
4.Taxes on export revenue	4.Subsidy under export performance licensing scheme
5.Proceeds from sale of foreign exchange at the secondary rate	5.Miscellaneous expenditure (linked to movements in nominal GDP)
6.Other government revenues (linked to movements in nominal GDP)	6.Remittance payments
7. Remittance receipts	
8. Foreign aid	
Aggregate revenue	Aggregate expenditure

Government revenue

The set of equations ranging from M.40 to M.48 in Appendix A1 represents the various sources of government revenue identified in the table above.

Equation M.40 describes nominal income tax revenue, RY. In level form it is:

$$RY = Y_{ft}.T_{fy} + Y_{nft}.T_{nfy} \qquad (5.36)$$

where Y_{ft} is the aggregate nominal taxable income accrued to farm people, Y_{nft} is the aggregate nominal taxable income accrued to non-farm people, T_{fy} is the income tax rate applied to farm income, and T_{nfy} is the income tax rate applied to non-farm income. The definition of these incomes by source is provided later in the model through equations M.67 and M.70.

Revenue from tariffs on imports is described in equation M.41. The level form version is

$$RT = \sum_{i=1}^{g} Pm_{i2}X_{i2}\Phi_1(1+T_i) - \sum_{i=1}^{g} Pm_{i2}X_{i2}\Phi_1 \quad (5.36)$$

The derivation is similar for the revenue from commodity taxes and subsidies on intermediate goods, investment goods, household and government consumption goods and exports. The level forms are

$$RS1=\sum_{j=1}^{h}\sum_{i=1}^{g}\sum_{s=1}^{2} X1_{isj}P0_{is}(1+G1_{isj}{}^{*}) - \sum_{j=1}^{h}\sum_{i=1}^{g}\sum_{s=1}^{2} X1_{isj}P0_{is} \quad (5.37)$$

$$RS2=\sum_{i=1}^{g}\sum_{s=1}^{2} X2_{isH}P0_{is}(1+G2_{is}{}^{*}) + \sum_{i=1}^{g}\sum_{s=1}^{2} X2_{isG}P0_{is}(1+G2_{is}{}^{*}) -$$

$$\sum_{i=1}^{g}\sum_{s=1}^{2} X2_{isH}P0_{is} - \sum_{i=1}^{g}\sum_{s=1}^{2} X2_{isG}P0_{is} \quad (5.38)$$

$$RS3=\sum_{i=1}^{g}\sum_{s=1}^{2} X3_{is}P0_{is}(1+G3_{is}{}^{*}) + \sum_{i=1}^{g}\sum_{s=1}^{2} X5_{is}P0_{is}(1+G3_{is}{}^{*}) -$$

$$\sum_{i=1}^{g}\sum_{s=1}^{2} X3_{is}P0_{is} - \sum_{i=1}^{g}\sum_{s=1}^{2} X5_{is}P0_{is} \quad (5.39)$$

$$REXP=\sum_{i=1}^{g} X4_{i1}P0_{i1}(1+ES_i{}^{*}) - \sum_{i=1}^{g} X4_{i1}P0_{i1} \quad (5.40)$$

The percentage change forms are shown as equations M.42 to M.45 in Appendix A1.

Equation M.46 in Appendix A1 describes PS, the proceeds from the sale of foreign exchange in the secondary market. Revenue from this source arises from the government's decision to sell a certain amount of foreign exchange to potential importers at the secondary exchange rate. The underlying level form equation behind M.46 is as follows:

$$PS = \sum_{i=1}^{g} X_{i2}Pm_{i2}R_i(\Phi_2 - \Phi_1) \quad (5.41)$$

where R_i is the proportion of imports of commodity i financed by foreign exchange bought in the secondary market. PS is in fact the area y in Figure 5.1.

Workers' remittances sent from abroad pass through the government. For accounting purposes, remittance receipts represent a category of earnings, converted at the official exchange rate, as described in equation M.47 in Appendix A1. The receipts are balanced by a payment to the private sector, converted at the secondary rate, described in equation M.54. The difference between the two exchange rates forms a wedge between receipts (REM) and payments (ER) which is a subsidy from the government to the private sector.

Other government revenue, RO, represents all remaining sources of government revenue not explained in the model. These sources can be divided into two types. The first type of revenue consists of transfers to government not associated with any flow of goods and services, but unlike income tax which falls into the same category, the amounts involved are too small to be worth modelling separately. These transfers include estate and gift duties, taxes from property and land tax. The second type of miscellaneous revenue is the income generated from the profit of nationalized financial institutions, revenue from stamp duty, revenue from government provided utilities etc.

The omnibus category of other government revenue is modelled as moving in line with nominal GDP, as shown in equation M.48 in Appendix A1. A definition of nominal GDP is provided later in the model in equation M.65. However, other government revenue must be a transfer from some entity elsewhere in the economy, and as such it is deducted from household income in equation M.67 and M.70.

The various sources of government revenue, together with foreign aid received by the government, are added to form a measure of total government revenue described by equation M.49.

Government expenditure

The next set of equations describing government expenditure ranges from M.50 to M.55 in Appendix A1. The first two types of expenditure are current expenditure on goods and services, GC, and investment expenditure, GI, both valued at purchasers' prices. In percentage change form they are described by equation M.50 and equation M.51 respectively. The next two expenditure items are government transfer payments in the form of the food subsidy and the subsidy under the export performance licensing scheme. Food subsidies are given on two major cereals, wheat and rice. In level form, expenditure on food subsidies is given by

$$FS = \sum_{i=1}^{2} X^{q}_{i} P^{3}_{i} - \sum_{i=1}^{2} X^{q}_{i} P^{3}_{i} (1 - E^{q}_{i}) \qquad (5.42)$$

where X^{q}_{i} and E^{q}_{i} are ration quota and subsidy rate, respectively. In percentage change form this is expressed as equation M.52, where the lower case variable e^{q}_{i} in that equation represents the percentage change in the power of the subsidy $(1 - E^{q}_{i})$

The subsidy provided under the export performance licensing scheme accrues to exporters as an export premium, distinct from the explicit export taxes or subsidies (ES_i^*) encountered in equation M.53 in Appendix A1. Government expenditure on this hidden subsidy, defined as RS, can be written as

$$RS = \sum_{i=1}^{g} X^{4}_{i1} P^{e}_{i1} . A_i (\Phi_2 - \Phi_1) \qquad (5.43)$$

where A_i is the foreign exchange retention parameter decided by the government. The subsidy is actually the area z in Figure 5.2 and is computed by first collecting the first and second part of the second term in the left hand side of equation (5.32) which give per unit subsidy value and then multiplying them by the export volume of commodity i and finally summing them over all commodities. Equation M.53 in Appendix A1 expresses (5.43) in percentage change form.

Like other revenue, other expenditure, OE, is also an omnibus item which covers all government expenditures not modelled explicitly. Again, like other revenue, it is linked to the movement of nominal GDP, as shown in equation M.55. Also, as other government revenue is an expenditure made by some entity elsewhere in the economy, other government expenditure must accrue as income to some entity. It is hence treated as a part of income of the households later in the model.

All the expenditure items are added together to obtain a measure of aggregate government expenditure expressed in equation M.56. The government nominal borrowing requirement, expressed by equation M.57, is the difference between aggregate government revenue and aggregate government expenditure. The equation, however, defines the nominal borrowing requirement as an absolute change rather than a percentage change because of the possibility that the variable will pass through a value of zero.

Foreign trade

Equations M.58 to M.61 in Appendix A1 cover external trade. Equation M.58 defines the percentage change in the import volume of the ith commodity as a share-weighted sum of percentage changes in demand for intermediate use, for current consumption and for capital creation by household and government. Equations M.59 and M.60 describe the percentage changes in the foreign currency value of aggregate imports and exports. Equation M.61 describes the current account surplus as export earnings, foreign currency value of remittance receipts (RM) and foreign aid (FA), net of import payments.

Macro closure and miscellaneous equations

Equation M.62, M.63 and M.65 in Appendix A1 are percentage changes of total absorption, real GDP and nominal GDP.

Total absorption is a simple aggregation of all consumption and investment expenditure, both private and public, undifferentiated by source. The measurement of GDP is obtained from the expenditure side. Thus nominal GDP is measured as :

household consumption at purchasers' prices +

investment expenditure at purchasers' prices +

government expenditure at purchasers' prices +

export demands at border prices (inclusive of domestic taxes) +

imports at border price (exclusive of domestic taxes).

The measure of the GDP deflator given in equation M.64 is consistent with this expenditure concept of nominal GDP.

The next six equations in Appendix A1 define income and its household distribution. Equations M.66 and M.67 describe farmers' taxable income and disposable income respectively. Taxable income accruing to farm households comprises value added from agriculture and share of farm households in income received from other government expenditure. Farmers' disposable income includes two terms in addition to tax-deducted income: positive receipts from food subsidies and negative receipts on spending which generates a part of other government revenue. In level form they are

$$Y_{ft} = \sum_{v=1}^{3} X_{vj}P_{vj} + OE.V \qquad j=1 \qquad (5.44)$$

$$Y_{fd} = Y_{ft}(1 - T_{fy}) + B.FS - RO.U \qquad (5.45)$$

where V and B are shares of farm households in total transfer payments made by government through other government expenditure and food subsidies respectively. Similarly, U is the share of contributions made by farm households in other government revenue.

Equations M.68 and M.70 define respectively taxable income and disposable income accrued to non-farm households. Non-farm taxable income includes non-agricultural value added, share of non-farm households in income received from other government expenditure, and premia earned from importing. Export premia do not appear explicitly in the definition since they are already included in the value added from exported products through equation M.36 in Appendix A1. Income earned from scarcity premia (including both import and foreign exchange scarcity premia) received by private importers, the area x+z in Figure 5.1c, is assumed to accrue to non-farm households only, and is given in level form by

$$YSP = \sum_{i=1}^{g} X_{i2}Pm_{i2}\Phi_1 SP_i^* - \sum_{i=1}^{g} X_{i2}Pm_{i2}.R_i(\Phi_2 - \Phi_1) \qquad (5.46)$$

The second term in the right hand side of (5.46) is PS, the government's proceeds from sale of foreign exchange in the secondary market. Hence (5.46) can be rewritten as

$$YSP + PS = \sum_{i=1}^{g} X_{i2} Pm_{i2} \Phi_1 SP_i^* \qquad (5.47)$$

The percentage form of this expression is given by equation M.69 in Appendix A1.

Non-farm disposable income includes three terms in addition to tax-deducted income. They are: two positive entries describing income from food subsidies and receipts from remittances, and one negative entry describing non-farm households' spending to generate the remaining portion of other government revenue. In level form these two equations are given below:

$$Y_{nft} = \sum_{j=2}^{h} \sum_{v=1}^{3} X_{vj} P_{vj} + YSP + (1\text{-}V).OE \qquad (5.48)$$

$$Y_{nfd} = Y_{nft}(1 - T_{nfy}) + (1\text{-}B).FS + ER - (1\text{-}U).RO \qquad (5.49)$$

Equation M.71 defines percentage change in aggregate disposable income which is a share-weighted sum of percentage changes in disposable farm and non-farm income.

Equation M.72 describes aggregate consumption expenditure as moving in line with aggregate disposable income. The term f_c denotes the percentage change in average propensity to consume, and acts as a shifter in the model.

Equation M.73 defines percentage changes in aggregate real consumption as percentage changes of nominal consumption net of percentage changes in consumer price index. The latter, defined by equation M.74, is a share weighted sum of the prices of household consumption goods, both domestic and imported.

Equation M.75, which describes the percentage changes in the real rates of return on capital in each industry, is derived from the following level form relationship:

$$R_j = (P_{vj}/\Pi) - d_j \qquad v=2, j=1,...,h \qquad (5.50)$$

where R_j is the rate of return on capital in industry j, P_{vj}/Π is the ratio of the rental price of a unit of capital in industry j to the average cost of a unit of capital, and d_j is the industry-specific rate of depreciation. The values of d_j are assumed to be technologically determined, and so exogenous to the model.

Equation M.76 describes the wage setting mechanism. In the absence of any available theory of wage determination applicable to Bangladesh[2], the model makes provisions for nominal wages to be linked to the consumer price index. If the indexing parameter h^1_j is set to one and the variables f^1_j and f^1 are exogenously fixed, full wage indexation follows, implying fixed real wages in all industries. If, on the other hand, h^1_j assume the value of zero, the nominal wage rate remains constant. Exogenously held shift variables f^1_j and f^1 can be used respectively to experiment with changes in wage relativities and an economy-wide wage shift.

2 The labour market is found not to be competitive (Ahmed, I. 1981, Cain and Mojumdar 1980), but the classical theories of institutional wage setting are also found not to operate in the labour market in Bangladesh (Rahman 1990). Ahmed, R. (1981) and Boyce and Ravallion (1988) found wage rates in the country to vary with foodgrain prices. The estimated elasticities in the former study were 0.22 and 0.43 for short and long run respectively, and 0.88 and 0.57 in the latter. The lower elasticity values in the long run in Ahmed is argued to reflect the higher pressure from the increasing labour force in the long run. Official statistics show that both general money wages and the consumer price index have risen in Bangladesh during the period 1969-70 to 1988-89, and in some of the recent years the former has exceeded the latter (Bangladesh, Bureau of Statistics 1990).

The final equation, M.77, describes the ratio between the official and the secondary market exchange rate, converted to percentage change form. This allows experiments with exchange rate policy.

Model closure

The complete model as specified in Appendix A1 contains 5gh + 24g + 8h +54 equations with 7gh + 37g + 11h + 71 variables. To close the model, it is required to set 2gh + 13g + 3h + 17 variables exogenous. These variables could be chosen in a number of ways. The choice of closure is user-specific and one possible closure is given in Appendix A4.

Some of the choices directly follow from the way the model is structured. The foreign currency price of imports, p^m_{i2}, is an example. There is no equation in the model to deal with foreign supply behaviour. Hence world import prices are exogenous, implying the small country assumption for Bangladesh. A possible exercise using exogenous import prices could be to simulate a change in the terms of trade.

The second set of exogenous variables are the export volumes of commodities which are not determined within the model. This group consists of commodities whose exports account for a small share in their respective production. This is to avoid the possibility of any unusual expansion in exporting as a result of policy reforms. The only commodities whose exports are endogenous in the model are raw jute, tea, fish, clothing, jute textiles, and leather. These items are identified as being endogenous on the basis of their export share in production.

The next set of exogenous variables are the policy variables. They are: the scarcity premium rate on imports (sp_i), the tariff rate (t_i), the exchange rate ratio (d), the export tax, the commodity tax and subsidy rates on imports and domestic sales (e_i, es_i, g^3_{is}, g^2_{is}, and g^1_{isj}), the foreign exchange retention parameter (a_i), the unit subsidies on food (eq_i), the ration quota (xq_i), the proportion of food subsidy going to farmers (b), the proportion of other government expenditure received by farmers (v), the proportion of farmers' spending in other government revenue received by the government (u), the proportion of imports purchased at the secondary rate of foreign exchange (r_i), the income tax rate on farm income (t_{fy}). and the income tax rate on non-farm income (t_{nfy}).

An exogenous premium rate (sp_i) and endogenous import volumes (x_{i2}) imply that the government exerts the controls necessary to allow imports to vary to a level that will be consistent with a given rate of premium. Hence, although quantity control on imports is a reality, by allowing import volumes to be endogenous, this particular closure choice assumes some relaxation in import controls sufficient to keep the per foreign currency unit import premium rate, sp_i, and the exchange rate ratio, d, fixed. This relaxation is necessary to carry out partial reforms such as a cut in tariff or a removal of fertilizer subsidies. A withdrawal of subsidies on imported fertilizer, for example, is expected to lead to a fall in fertilizer imports. It will be meaningless to do simulations with partial price reforms unless at least some relaxation of imports are not allowed. However, a policy simulation of an elimination of import control will require an independent reduction in sp_i. A policy simulation driving the exchange rate ratio, d, down to 1 produces effects of unifying both the exchange rates.

The export tax rate, es_i, is exogenous for only the six endogenous export items listed in the previous paragraph. It is endogenous for the rest of the products whose exports are held to be exogenous in the model. Setting the tariff, subsidy and tax rates as exogenous, the model is able to answer questions related to the general equilibrium effects of having a change in the incentive structure. Variable r_i can assume different values which will have bearing on the government's earnings from the sale of foreign exchange at the secondary rate, and a change in a_i will change the profitability of exporting different commodities so long as the dual exchange rate system prevails.

The income tax rates and food subsidy rate and ration quota can be used to simulate the effects of changes in transfer income. By changing the value of b, the effects of reallocating food subsidies to different social groups can be measured. Other government revenue and expenditure are kept exogenous to reflect the fact that these sources of income and expenditure are not explained in the model. But they need to be incorporated for the sake of completeness of the definition of income and expenditure and to keep consistency with the database in which they appear.

Both foreign aid and remittances are exogenous in the model. Although the government introduced the secondary exchange rate to attract remittance inflows, no empirical work is available to support a causal relationship between remittances inflow and economic incentives in Bangladesh. A study on Turkey (Straubhaar 1986) does not find any evidence that Turkish remittances are sensitive to economic benefits of remitting more; the confidence in the stability of the Turkish government appears to be much more important. Therefore, in the Bangladesh model, remittances are treated as exogenous.

Next on the list of exogenous variables is technological change and miscellaneous income received by farmers and non-farmers. Technological change, t, appears only in agriculture, and the model does not explain it. Exogenous technological change allows the examination of the effects on income, employment and growth of an increase in productivity in agriculture.

The next group of variables are industry capital stocks and industry land. In agriculture, land and capital are treated as a composite variable. Increase in acreage can result from increased irrigation, and therefore, an increase in the composite of land and capital would simulate effects of augmenting existing capital stocks in agriculture. The fixity of these two factors describes a short-run environment. The rate of return on capital and the rental price of land are endogenous and they would vary across sectors in response to changes in industry profitability. Swapping rates of return with industry capital stocks on the exogenous list can create a long run environment where capital is mobile across sectors and countries. While industry capital and land are held fixed, the aggregate employment level is treated endogenously by setting the economy-wide wage shift term, f^1, in the exogenous list. Thus the model assumes a slack labour market where employment levels are determined by labour demand alone. Given the size of chronic under- and unemployment figures noted in Chapter 2, the assumption is not likely to be far from reality.

The next exogenous variables are the shift terms, f_c, f^2_i, f^5_i, f_g and f^4_{i1}. Although government consumption and investment demands are endogenous in the model, by assigning the value of zero to the indexing parameters h^2_i and h^5_i, these two variables are held fixed in the simulation experiments. Thus, a change in the government nominal borrowing position is due either to a change in the price level or to changes in other components of the revenue and expenditure accounts. By making f_c

exogenous, household nominal consumption expenditure is allowed to vary with income, the average propensity to consume being assumed to be constant.

Since there is no money supply in the model to determine the absolute price level, one nominal price variable has to be chosen as the numeraire for a model solution. The GDP deflator is chosen to act as the numeraire. In this way a change in the real exchange rate for imports is directly tied to movements in the nominal official exchange rate, and the real exchange rate for exports will depend on the share-weighted sum of movements in the official and secondary exchange rates, the share dictated by the retention parameter, a_i. Alternatively, either of the exchange rates or the consumer price index could serve as the numeraire.

CHAPTER SIX

MODEL DATABASE AND SOLUTION METHOD

Model database

The entire database needed to run the model is organised into three separate files: an input-output data file, a government budget file and an elasticities file. The first file contains the flows of goods and services among the industries for intermediate usage and deliveries to final consumers. These data are needed to compute the cost, revenue and sales shares as they appear in model equations described in Appendix A1. The budget file provides an account of government revenue earned from various sources and its allocation to different items of expenditure. The data are used to compute the revenue and expenditure shares in the government budget equations. The elasticities file stores the values of numerous behavioural elasticities and indexing and other parameters used in the model. These include the elasticities of substitution between domestic and imported products by end use, the elasticity of substitution among primary factors in industries, the export demand elasticities, household expenditure elasticities and own- and cross-price elasticities, farmers' input demand and output supply elasticities, the value of different indexing parameters, the ratio of various sources of income in aggregate income and its distribution between the farm and non-farm sector. The way in which the model coefficients are calculated from the data in these files is explained in detail in Appendix A3.

The input-output file

The model's input-output file is created mainly from the information contained in a social accounting matrix (SAM) for 1984-85 provided by the

World Centre for Food Studies at the Free University of Amsterdam. This matrix was constructed to undertake simulation of a computable general equilibrium model used in the Third Five-Year Plan of Bangladesh (Bangladesh, Ministry of Planning 1985).

As social accounting matrices differ according to the objectives of models, the SAM provided by the World Centre for Food Studies needed some modifications to suit the specific issues the Bangladesh model intends to cover. This model assumes imperfect substitution between domestic and imported products, and requires data on usage by source. The original SAM lacked this distinction. Further, instead of giving data separately for exports and imports, the SAM aggregated imports and exports and simply recorded net imports. In the Third Five-Year Plan data, domestic currency value of exports was obtained by multiplying foreign currency value by the official exchange rate. The effect of the secondary market exchange rate in raising the value of exports covered by the export performance licensing scheme was not taken into account in the data. Since the subsidy to non-traditional exports through the export performance licensing scheme has been explicitly formalized in the model, the exclusion of the effect of the scheme is unsatisfactory for the purpose of the analysis.

Therefore, in developing a model of the Bangladesh economy that focuses on sectoral as well as trade and exchange rate policies, the following compromises and adaptations in the Third Five-Year Plan data are made.

First, the net import vector is first extended into two separate vectors, one for imports and one for exports. Entries with negative signs in the net import vector now form the new export vector and entries with positive signs form the new import vector. Following this division, only five commodities are found to be exportables. They are jute, jute textile, fish, tea, and leather. In reality, Bangladesh does export some manufactured products and the export performance licensing scheme is meant to encourage these exports. To reflect this fact, the export and import vectors are further adjusted by the 1984-85 trade data obtained from Bangladesh Bureau of Statistics (1986c). Hence the export and import figures for individual items as well as aggregate imports and aggregate exports are different from those recorded by the original SAM. The net import data, both for individual products and the aggregate, remain unchanged. Finally, the export vector thus derived is again modified by adding to it export premia accruing from the export performance licensing scheme based on the retention ratio for holding the foreign exchange. The data on foreign exchange retention ratio are taken from a government document on export policy for the year 1984-85 (Bangladesh, Ministry of Commerce 1984). As a result of the final adjustment, the aggregate net export figure no longer remains the same as in the original source.

Second, the input-output flow matrix and delivery for final demand in the Third Five-Year Plan data are valued at purchasers' prices without making any distinction between domestic and imported sources of supply. To arrive at a flow matrix disaggregated by source and converted to producers' prices the following computations have been made. First, in the absence of any better information, the aggregated flow matrix is allocated into domestic and import components on an arbitrarily chosen *pro rata* basis. The ratio of total imports of i to total intermediate and domestic final use of i from both domestic and imported sources provides the basis for the decomposition. Next, the import values are deflated by trade and transport margins available in input-output data for 1976-77 (Bangladesh, Ministry of Planning 1980) to obtain the value of imports at importers' prices. As mentioned in the previous chapter, the trade and transport margins on imports are actually purchases of trade and transport services to facilitate the delivery of imports. The netting out of trade and transport margin is necessary in the case of imports to arrive at their c.i.f. value to estimate the trade balance. Since this reason does not apply to the domestic flow matrix, it is adjusted for the sales tax margin only to arrive at their basic value. Thus the producers' price of domestic products in the modified database includes the value of trade and transport margins. As a result of treating trade margins on imports as a separate purchase of service item, in the modified database the intermediate and final input demand of domestic trade and transport services are adjusted upward respectively by the amount of trade and transport margins on imports for intermediate and final uses.

Next, the importers' price, as defined in equation (5.35) in Chapter 5, includes tariff as well as scarcity premia on imports. To arrive at separate accounts for tariffs and scarcity premia, the following steps are taken. The Third Five-Year Plan data reports c.i.f. and retail prices of imports along with tariffs. The tariff is first added to the c.i.f. value to obtain the landed cost value of the import. The cost due to trade and transport margin is added to the landed cost to obtain the retail price value of imports in the absence of the premium. The difference between the actual and derived retail price is assumed to be the premia on imports. These values are applied to import values to arrive at the tariff and scarcity premium rates for individual items.

The tariff and scarcity premium rates thus obtained are provided in Table 6 in Appendix C. They differ markedly in their values from effective protection rates appearing in Table 3.1 of Chapter 3. Two factors explain this difference. First, the Third Five-Year Plan data appear to be conservative in their estimation of scarcity premia on imports. The perception that protection is high in Bangladesh where importing is characterized by quantitative controls and foreign exchange rationing (Bangladesh, Trade and Industrial Reform Programme 1987, Bhuyan, Haq and Rashid 1985), is not strongly supported by the data. The recorded c.i.f. and retail values, net of tariff, differ only a little for some imported items in the data, implying a small scarcity premium rates for those imported items. Second, the adjustments made to the data, as described above, have made the premium and tariff rates look smaller for some items. The creation of two separate export and import vectors from the net import vector and the adjustment of these vectors with trade data obtained from the Bureau, have increased the trade value of some items. Using the tariff and premia values obtained from the original data to these increased import values produces a smaller tariff and premium rate for some imported items. An extreme example is textiles. In the Third Five-Year Plan data, textiles is an imported item only and its c.i.f. import value is 965 million Taka. Against this value of imports, a tariff worth of Taka 516 million is collected, implying a tariff rate of 53 per cent on textiles. Also, the derived scarcity premia value on textiles is Taka 260 million, implying a premium rate of 27 per cent. Together these two rates make a protection rate of over 80 per cent which comes close to figures on effective protection rates appearing in Table 3.1 in Chapter 3. In the modified data, the export vector has an entry of Taka 3248 million as clothing exports. Given the way these trade vectors are reconstituted, this means adding this figure to the corresponding entry in the import vector, making the import figure of textiles appear more than

400 times larger than originally it was. Consequently, the tariff and premium rates appear to be very small, only around 12 and 6 per cent respectively. The tariff and premium rates for all manufactured goods except for jute textiles, fish, tea, and leather, are affected in a similar way, although to a smaller extent. Thus in model simulations the economy appears to be less distorted than it actually is.

The final modification to the data follows from the way changes in stock are treated in the model. Because the model does not contain a treatment of stock changes, the corresponding columns of stock changes in the Third Five-Year Plan data have been ignored and arbitrarily set to zero (see Dixon et al 1982 for similar treatment of Australian data).

The sectoral breakdown has been redefined to suit better the focus of the present model. The original input-output table in the Third Five-Year Plan data had a 67 sector and 39 commodity disaggregation. Out of these 67 sectors, 29 sectors were engaged in production and processing of 11 crops. Since in the present model agriculture is viewed as a single industry producing multiple outputs, the 29 crop producing and processing sectors from the original data are merged together in the modified data to form one single industry called agriculture, producing 11 different crops. The crops are, wheat, rice, jute, coarse grains, oilseeds, protein feed, sugarcane, vegetables, fruits, cotton, and tobacco.

A few more mergers are carried out to make a one to one mapping between commodities and industries, consistent with having no multi-product technology outside agriculture. The definition of agriculture, however, is somewhat different from its conventional definition in national income accounting. While crop production, forestry, fishing and livestock production form the agricultural sector in the national income accounts of Bangladesh, in this model specification the definition is modified to restrict agriculture to crop production only. Forestry, fishing and livestock production are shown as separate industries. The new definition of agriculture excludes tea production as well. Production of tea is treated as different from agriculture for two reasons: first, there is little substitution between tea and other crop production, and second, it grows in plantations owned and run by tea estate owners who are economically, socially and culturally different from farmers.

In the final form the modified input-output table contains 25 sectors producing 35 commodities. The only multi-output industry is agriculture, producing 11 crops. The remaining 24 industries possess single-output technology. A list of the sectors and commodities identified in the model is provided in Appendix B.

The input-output data file, when reconstructed, appears as in Figure 6.1. Matrix A shows the intermediate use of domestic goods and services in production valued in producers' prices. Column 1 in A shows the use of each intermediate input in total production of all crops in the agricultural sector. Vectors B, C, D, E and F are the flows of domestically produced commodities to household consumption, private investment, export, government consumption and government investment, respectively. Again, these vectors contain only direct flows valued at producers' prices and do not include the sales tax margin.

In model notations, the contents of these matrices and vectors are as follows:

$A = (P^0 i1X^1 i1j)_{g*h}$

$B = (P^0{}_{i1}X^3{}_{i1})_{g*1}$

$C = (P^0{}_{i1}X^2{}_{i1H})_{g*1}$

$D = (P^0{}_{i1}X^4{}_{i1})_{g*1}$

$E = (P^0{}_{i1}X^5{}_{i1})_{g*1}$

$F = (P^0{}_{i1}X^2{}_{i1G})_{g*1}$

where g is the number of commodities and h is the number of industries. As already noted, the dimensions of g and h are 35 and 25 respectively.

Similarly, matrices G, H, I, J, and K show the imported counterparts of A, B, C, E and F. The value of imports at importers' prices is duty and scarcity premium inclusive, as defined in equation M.35 of Appendix A1.

Thus, in model notation,

$G = (P^0{}_{i2}X^1{}_{i2j})_{g*h}$

$H = (P^0{}_{i2}X^3{}_{i2})_{g*1}$

$I = (P^0{}_{i2}X^2{}_{i2H})_{g*1}$

$J = (P^0{}_{i2}X^5{}_{i2})_{g*1}$

$K = (P^0{}_{i2}X^2{}_{i2G})_{g*1}$

The vectors - Z_1 and - Z_2 show respectively the negative of the import duty and premium paid on imports of commodity i. Thus summation across the rows of G, H, I, J, K, - Z_1 and - Z_2 gives value of import of i at c.i.f.. prices.

Figure 6.1 Input-output data for the Bangladesh model

	Domestic Industries (current production)	Household consumption	Private investment	Exports	Government consumption	Government investment	
	← h →	← 1 →	← 1 →	← 1 →	← 1 →	← 1 →	
Domestic commodities	g A	B	C	D	E	F	Row sums = total direct usage of domestic commodities
Imports	g G	H	I		J	K	-Tariffs $-Z_1$; - Premia $-Z_2$; Row sums = total imports (c.i.f.)
Taxes on domestic flows	g K_t	L_t	M_t	N_t	O_t	P_t	Row sums = total tax on sales of each domestic commodity
Taxes on import flows	g Q_t	R_t	S_t		T_t	U_t	Row sums = total tax on sales of each imported commodity
Premia on export flows	g			$-N_{t+1}$			Row sums = - export premia
Primary inputs: Labour	1 V						
Primary inputs: Capital	1 W						
Primary inputs: Land	1 X						
	Column sums = outputs of domestic industries at producers' prices	Column sums = total household consumption expenditure	Column sums = total private investment expenditure	Column sums = total exports evaluated at official exchange rate	Column sums = total government consumption expenditure	Column sums = total government investment expenditure	

Domestic commodities	g Y (product-mix matrix)	Row sums = domestic output by commodity
	Column sums (of Y) = output by industry	

The matrices K_t, L_t, M_t, O_t and P_t of row three show taxes on domestically produced goods used domestically. The other matrix in row three, N_t, contains the export tax on exported goods. Similarly, matrices Q_t, R_t, S_t, T_t and U_t in row four contain taxes/subsidies (other than tariffs) on the sale of imported goods.

Row five has only one non-zero matrix, $- N_{t+1}$, which contains negative of the export premia resulting from the foreign exchange retention scheme. The sum of the ith elements in D, N_t, and $- N_{t+1}$ gives the f.o.b. value of exports of good i at the official exchange rate.

The set of row vectors V, W and X provide a disaggregation of industry value added into labour, capital and land, respectively. Thus element V_k is payment to labour in industry k, element W_k is rental value of the kth industry's fixed capital, and X_k is rental value of land in industry k. Except for agriculture, livestock, fishing and forestry, the entries in X are zero. The absence of primary factor entries in investment, consumption and export columns is due to the maintained assumption that primary factors are directly required only in current production.

The last matrix Y shows commodity composition of the output of each industry. In model notation,

$$Y = (P^0_{i1}X^0_{i1j})_{g*h}$$

Since agriculture is the only multi-product industry producing commodities 1 to 11, the north-west quadrant of Y is a column vector, showing the value of production of each agricultural commodity produced by the agricultural industry in the base year. This vector is followed by a diagonal submatrix in the south-east quadrant showing value of production in the remaining sectors. The diagonal form of the south-eastern quadrant follows from the assumption that non-agricultural sectors are single output sectors. Both the north-east and south-west quadrants have zero entries.

The Third Five-Year Plan data do not provide a distribution of value added across different primary factors of production. However, they gives sector-wise employment figures to which the wage rate data provided in Bangladesh Bureau of Statistics publication (1986c) can be applied to obtain a measure of labour value added. The agricultural wage rate is taken directly from the Bureau's data, while some of the other industry wage rates need further information. This is true for livestock, dairy, fishing, forestry, leather, textiles, and wood and other industries which belong mostly to the cottage and small industries group. More than 90 per cent of employment in the textile industry are in the handloom plants which belong to the cottage industry group. As stated in Chapter 2, most of the cottage industries are of a residual type in employment generation and are constrained by low labour productivity. Consequently wage rates in these industries are lower than in large and medium-scale manufacturing or agriculture. Data on daily wage rates in cottage and handloom industries (Hossain 1984a) are about half of what is reported for agricultural wage labourers in the Bureau's publication. The wage rates used for estimating the value added to labour in these industries are, therefore, adjusted downward to take note of this fact.

The entire non-labour value added is attributed to fixed capital in industries other than agriculture, fishing, livestock and forestry. For these industries, non-labour value added is further disaggregated between land and capital. This is achieved assuming a 60:40 ratio between returns to land and capital on the basis of data on costs and returns in several crops published by the Ministry of Agriculture (Bangladesh, Ministry of Agriculture 1985).

The plausibility of the decomposition of industry value added outlined above is cross-checked by deducing short-run industry supply elasticities from the computed functional distribution of value added. Under constant elasticity of substitution specifications, a short-run industry supply elasticity for industry j can be derived as

$$\varepsilon_j = \sigma(1-S_k)/S_{kj}.S_{vj}$$

where σ is the elasticity of substitution between fixed and variable primary factors, S_{kj} is the fixed factor share in industry j's total primary factor costs and S_{vj} is the share of primary factor cost in the total cost of the industry (Dixon et al 1982). On the basis of the value of σ to be 1.00 as used in model simulations, and an alternate value of 0.6, the elasticities of supply, ε_j, are derived in Table 6.1.

Table 6.1 **Industry supply elasticities**

Industry	ε_j (σ=1.0)	ε_j (σ=0.6)
Tea	0.27	0.16
Livestock	4.04	0.42
Poultry	12.44	7.47
Dairy	2.61	1.57
Fish	2.21	1.35
Forestry	0.36	0.22
Cotton yarn	6.81	4.09
Textiles	11.38	6.83
Jute Textile	1.85	1.11
Paper	0.92	0.55
Leather	2.67	1.60
Fertilizer	0.16	0.09
Chemical	1.03	0.62
Cement	0	0
Steel and basic metal	0.27	0.16
Machinery	0.96	0.58
Wood and other	28.13	16.88
Urban house building	4.27	2.56
Rural house building	2.48	1.48
Other building	4.07	2.44
Electricity	0.33	0.20
Housing	0.00	0.00
Public administration	5.10	3.06
Trade & transport	0.77	0.46

Source: Model data.

Some of the supply elasticities, for example, for poultry, textiles and wood are much higher than for other industries. The reason lies in the much higher proportion of labour cost and smaller primary factor cost in these industries. The elasticity is positively related to the share of variable factors in the cost of primary factor cost and negatively related with the share of primary factor cost in the total cost. As such, a higher value for elasticity of supply in these industries is not unexpected. Simulations with Australian data have come out with much higher supply elasticities, ranging from 23.6 to 636.8, for some industries (Martin et al 1988). The zero supply elasticity of the housing sector is an outcome of zero labour cost for this industry in the data. The supply elasticity for tea of 0.27 is comparable with econometrically estimated supply elasticities ranging from 0.15 to 0.36 for Indian tea (Askari and Cummings 1976).

Balancing the data

Figure 6.1 should obey some adding up properties which ensure that the data are consistent.

By summing down the jth column of matrices A, G, K_t, Q_t, V, W, and X we obtain the base-period producer-price value of output of industry j. This can also be obtained by summing the value of commodities produced by industry j, i.e., by summing the jth column of Y. Also, the producer-price value of each domestic commodity can be derived in two ways. It can be obtained by summing the usage of commodity i by taking the sum across the ith rows of A, B, C, D, E, and F. Alternatively, we can sum each industry's production of commodity i, i.e., we can sum the ith row of matrix Y. However, to the extent that the export value is inflated by the amount of subsidy through the export performance licensing scheme in the modified data, the summation across the row of matrices A, B, C, D, E and F will not equal the sum of the ith row of Y. Finally, the base-period value of aggregate investment is given by the sum of C, F, I, K, M_t, P_t, S_t and U_t; the base-period value of household consumption is given by the sum of B, H, L_t and R_t; total exports are the sum of D and N_t; and government consumption is the sum of E, J, O_t and T_t.

The elasticities and parameters file

The elasticity of substitution between domestic and imported commodities

Although in the model specification, provision is made for the elasticity of substitution to vary depending upon the user category, in practice a common value of σi is chosen. Thus,

$$\sigma^1_{ij} = \sigma^3_i = \sigma^2_{iH} = \sigma^2_{iG} = \sigma_i, \quad i=1,\ldots,g$$

which implies the same value for the elasticity of substitution between domestic and foreign sources of product i for all users. In defence of this assumption it can be said that most of the major imports into the country have only one end use. However, data are lacking even for values of σ_i. They are borrowed from a recent CGE work on Bangladesh estimating effects of various tax policies on resource allocation (Chowdhury 1990). The elasticity values are reported in Table 6.2.

Table 6.2. **Elasticity of substitution (σ_i) and investment coefficient (Q_j)**

Sectors	σ_i^a	Q_j^b
Wheat	1.80	
Rice	1.80	
Jute	1.61	
Grains	1.80	
Oils	1.80	
Protein feeds	1.80	
Sugarcane	1.80	1.33
Vegetables	1.80	
Fruits	1.80	
Cotton	1.61	
Tobacco	1.61	
Tea	1.61	1.33
Livestock	1.80	1.33
Poultry	1.80	1.33
Dairy	1.80	1.33
Fishery	1.80	1.33
Forestry	1.61	1.53
Cotton yarn	1.61	1.33
Textiles	1.30	1.60
Jute textiles	1.30	1.20
Paper	1.30	1.40
Leather	1.61	1.40
Fertilizer	1.20	1.47
Chemicals	1.20	1.40
Cement	1.20	1.20
Steel and basic metals	1.20	1.33
Machinery & metal products	1.20	1.27
Wood & other industries	1.30	1.46
Urban house building	1.20	1.40
Rural house building	1.20	1.40
Other building	1.20	1.53
Electricity and gas	1.20	1.33
Housing	-	1.20
Public administration	-	1.33
Trade and transport	-	1.20

Source: a: Chowdhury, O.H., 1990. Tax policy analysis in Bangladesh: a computable general equilibrium approach, PhD dissertation, University of the Philippines, Diliman, Quezon City.
b: Own computation.

The investment coefficient, Qj

Q_j is computed as $Q_j = (R_j + d_j)/R_j$, where Rj is the industry rate of return, and d_j is the rate of depreciation of fixed capital in industry j. In the absence of data on industry rates of return, the model takes the opportunity cost of capital as a proxy. A market rate of interest of 15 per cent deflated by an average inflation rate of 10 per cent during the period (Bangladesh, Ministry of Planning 1990) is accepted as the real opportunity cost of capital, and this is the same for all industries. Thus $R_1 = R_2 = R_j = 0.05$. The industry depreciation rates are taken from the base run solution of the macro model of Third Five-Year Plan. The resulting values for Q_j are reported in Table 6.2.

Household expenditure and price elasticities of demand

Several recent works are available on complete demand systems estimation for Bangladesh households (Chowdhury 1982, Kennes 1984, Ahmad et al 1985). Using the Almost Ideal Demand System, Kennes's complete demand system includes nine major commodities and uses pooled time-series cross-section data. Ahmad et al (1985) extend Kennes's estimate to cover 14 commodities using a two-tier nested system, 13 agricultural commodities and a 14th being a composite of all non-agricultural products.

Chowdhury (1982), on the other hand, uses a linear expenditure system to estimate a complete consumer model for Bangladesh. The expenditure elasticities of 25 commodities are first estimated using a log-linear functional form. Applying the Frisch method (1959), the own- and cross-price elasticities of the commodities are estimated from these expenditure elasticities.

The present model uses the expenditure elasticities estimated by Chowdhury (1982) for two reasons. First, although Kennes (1984) and Ahmad et al (1985) use a flexible functional form in the estimation of the demand system, they do not impose symmetry condition. The linear expenditure system, in contrast, satisfies all theoretical demand function restrictions. Second, the expenditure elasticities for cereals claiming nearly 50 per cent of consumers' budget appear to be of significantly smaller value in Ahmad et al's (0.35) and Kennes's (0.37 for rice only) studies. Other estimates of income or expenditure elasticities of food grains are much larger; 0.55 (Mahmud 1979), 0.81 (Chowdhury 1982), and 1.19 (Pitt 1983, for rice only). Kennes himself was aware of the unconventional small magnitude of expenditure elasticity of foodgrains found in his complete demand system using an Almost Ideal Demand System functional forms, and reported in the same study another set of elasticities estimated from a linear expenditure system which is closer to other available estimates (0.57).

The Bangladesh model, however, does not take the price elasticities directly from Chowdhury (1982). The expenditure elasticities are adjusted to match the commodity disaggregation in the model data and to satisfy the condition that

$$\sum_{i=1}^{g} \varepsilon_i . S^3{}_i = 1$$

when $S^3{}_i$'s are taken from the model data. Applying a Frisch parameter value of - 2.54, found from another study (Chowdhury 1981), to these elasticities, own- and cross-price elasticities are estimated from the budget shares derived from the model data according to the following formulae:

$$\mu_{ik} = - \varepsilon_i . S^3{}_k \, (1+\varepsilon_k / \varpi) + \delta_{ik} . \varepsilon_i / \varpi \qquad i,k=1,\dots,g$$

where δ_{ik} has the value 1 for i=k and zero otherwise, $S^3{}_k$ is the household budget share for good i, both domestic and imported, and ϖ is the Frisch parameter. The $S^3{}_k$s are computed from data recorded in matrices B, H, L_t and R_t. The elasticities are reported in Table 6.3.

Table 6.3 Expenditure and own- and cross-price elasticities of household demand

	Expenditure elasticities	Own- and cross-price elasticities Wheat	Rice	Jute	Grains	Oil	Feed	Sugar	Vegetable	Fruits	Cotton	Tobacco	Tea	Beef	Poultry	Dairy	Fish	Forestry
Wheat	0.57	-0.24984	-0.06643	-0.18056	-0.00024	-0.00395	0	-0.00225	-0.01871	-0.00258	0	-0.00269	-0.00022	-0.00191	-0.00151	-0.00215	-0.00976	-0.00023
Rice	0.81	-0.02391	-0.53414	-0.09552	-0.00053	-0.00845	0	-0.00483	-0.04001	-0.00553	0	-0.00575	-0.00047	-0.00409	-0.00324	-0.00460	-0.02088	-0.00050
Jute	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grains	0.67	-0.01183	-0.07028	-0.24639	-0.26434	-0.00418	0	-0.00239	-0.01980	-0.00273	0	-0.00284	-0.00023	-0.00202	-0.00160	-0.00228	-0.01033	-0.00024
Oil	1.082	-0.01983	-0.11777	-0.37875	-0.00043	-0.44294	0	-0.00400	-0.03318	-0.00458	0	-0.00477	-0.00039	-0.00339	-0.00269	-0.00382	-0.01731	-0.00041
Feed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sugar	1.247	-0.02247	-0.13348	-0.44653	-0.00049	-0.00794	0	-0.50203	-0.03760	-0.00519	0	-0.00541	-0.00045	-0.00385	-0.00304	-0.00433	-0.01962	-0.00047
Vegetables	0.67	-0.01405	-0.08345	-0.19023	-0.00031	-0.00496	0	-0.00283	-0.31386	-0.00324	0	-0.00338	-0.00028	-0.00240	-0.00190	-0.00270	-0.01226	-0.00029
Fruits	0.702	-0.01269	-0.07538	-0.25028	-0.00028	-0.00448	0	-0.00256	-0.02123	-0.28353	0	-0.00305	-0.00025	-0.00217	-0.00172	-0.00244	-0.01108	-0.00026
Cotton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tobacco	1.23	-0.02226	-0.13223	-0.43790	-0.00049	-0.00787	0	-0.00449	-0.03725	-0.00514	0	-0.49732	-0.00044	-0.00381	-0.00302	-0.00429	-0.01944	-0.00046
Tea	1.128	-0.01992	-0.11830	-0.41495	-0.00044	-0.00704	0	-0.00402	-0.03332	-0.00460	0	-0.00479	-0.44493	-0.00341	-0.00270	-0.00383	-0.01739	-0.00041
Beef	1.032	-0.01853	-0.11009	-0.37123	-0.00041	-0.00655	0	-0.00374	-0.03101	-0.00428	0	-0.00446	-0.00037	-0.41405	-0.00251	-0.00357	-0.01618	-0.00039
Poultry	1.175	-0.02102	-0.12485	-0.42492	-0.00046	-0.00743	0	-0.00424	-0.03517	-0.00486	0	-0.00506	-0.00042	-0.00360	-0.46955	-0.00405	-0.01835	-0.00044
Dairy	1.63	-0.02934	-0.17430	-0.58449	-0.00065	-0.01037	0	-0.00592	-0.04910	-0.00678	0	-0.00706	-0.00058	-0.00503	-0.00398	-0.65554	-0.02562	-0.00061
Fish	1.209	-0.02341	-0.13907	-0.39072	-0.00051	-0.00827	0	-0.00473	-0.03918	-0.00541	0	-0.00563	-0.00046	-0.00401	-0.00317	-0.00451	-0.52305	-0.00049
Forestry	1.83	-0.03232	-0.19195	-0.67309	-0.00071	-0.01142	0	-0.00653	-0.05407	-0.00747	0	-0.00778	-0.00064	-0.00554	-0.00438	-0.00622	-0.02822	-0.72191
Yarn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles	1.22	-0.02337	-0.13880	-0.40086	-0.00051	-0.00826	0	-0.00472	-0.03910	-0.00540	0	-0.00562	-0.00046	-0.00400	-0.00317	-0.00450	-0.02040	-0.00049
Jute textile	1.83	-0.03226	-0.19161	-0.67463	-0.00071	-0.01140	0	-0.00651	-0.05398	-0.00746	0	-0.00776	-0.00064	-0.00553	-0.00437	-0.00621	-0.02817	-0.00067
Paper	1.83	-0.03229	-0.19180	-0.67378	-0.00071	-0.01141	0	-0.00652	-0.05403	-0.00746	0	-0.00777	-0.00064	-0.00553	-0.00438	-0.00622	-0.02819	-0.00068
Leather	1.83	-0.03263	-0.19379	-0.66474	-0.00072	-0.01153	0	-0.00659	-0.05459	-0.00754	0	-0.00785	-0.00065	-0.00559	-0.00442	-0.00628	-0.02849	-0.00068
Fertilizer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pharmacy	1.83	-0.03312	-0.19670	-0.65167	-0.00073	-0.01171	0	-0.00669	-0.05541	-0.00765	0	-0.00797	-0.00066	-0.00567	-0.00449	-0.00638	-0.02891	-0.00069
Cement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	1.83	-0.03266	-0.19401	-0.66377	-0.00072	-0.01154	0	-0.00660	-0.05465	-0.00755	0	-0.00786	-0.00065	-0.00559	-0.00443	-0.00629	-0.02852	-0.00068
Wood	0.75	-0.01379	-0.08190	-0.26134	-0.00030	-0.00487	0	-0.00278	-0.02307	-0.00318	0	-0.00332	-0.00027	-0.00236	-0.00187	-0.00265	-0.01204	-0.00029
Urbanhse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruralhse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	0.601	-0.01060	-0.06299	-0.22126	-0.00023	-0.00375	0	-0.00214	-0.01774	-0.00245	0	-0.00255	-0.00021	-0.00181	-0.00143	-0.00204	-0.00926	-0.00022
Housing	0.715	-0.01334	-0.07923	-0.24410	-0.00029	-0.00471	0	-0.00269	-0.02232	-0.00308	0	-0.00321	-0.00026	-0.00228	-0.00181	-0.00257	-0.01164	-0.00028
Health	1.92	-0.03411	-0.20262	-0.70062	-0.00075	-0.01206	0	-0.00689	-0.05708	-0.00788	0	-0.00821	-0.00068	-0.00584	-0.00462	-0.00657	-0.02978	-0.00071
Trade&trans	1.83	-0.03284	-0.19509	-1.38719	-0.00072	-0.01161	0	-0.00663	-0.05496	-0.00759	0	-0.00791	-0.00065	-0.00563	-0.00445	-0.00633	-0.02868	-0.00069

Table 6.3 Expenditure and own- and cross-price elasticities of household demand

	Own- and cross-price elasticities																	
	Yarn	Textiles	Jute Text	Paper	Leather	Fertilize	Pharm	Cement	Steel	Machinery	Wood	Urbanhse	Ruralhse	Constr	Elec	Housing	Health	Tr&trans
Wheat	0	-0.00857	-0.00006	-0.00015	-0.00118	0	-0.00	0	0	-0.00129	-0.004	0	0	0	-0.00016	-0.00580	-0.00083	-0.00184
Rice	0	-0.01834	-0.00012	-0.00033	-0.00252	0	-0.00	0	0	-0.00276	-0.009	0	0	0	-0.00034	-0.01240	-0.00178	-0.00395
Jute	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grains	0	-0.00907	-0.00006	-0.00016	-0.00125	0	-0.00	0	0	-0.00136	-0.004	0	0	0	-0.00017	-0.00613	-0.00088	-0.00195
Oil	0	-0.01521	-0.00010	-0.00027	-0.00209	0	-0.00	0	0	-0.00229	-0.007	0	0	0	-0.00029	-0.01028	-0.00148	-0.00327
Feed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sugar	0	-0.01724	-0.00012	-0.00031	-0.00237	0	-0.00	0	0	-0.00259	-0.008	0	0	0	-0.00032	-0.01165	-0.00168	-0.00371
Vegetables	0	-0.01077	-0.00007	-0.00019	-0.00148	0	-0.00	0	0	-0.00162	-0.005	0	0	0	-0.00020	-0.00728	-0.00105	-0.00232
Fruits	0	-0.00973	-0.00006	-0.00017	-0.00134	0	-0.00	0	0	-0.00146	-0.004	0	0	0	-0.00018	-0.00658	-0.00094	-0.00209
Cotton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tobacco	0	-0.01707	-0.00012	-0.00031	-0.00235	0	-0.00	0	0	-0.00257	-0.008	0	0	0	-0.00032	-0.01154	-0.00166	-0.00367
Tea	0	-0.01527	-0.00010	-0.00028	-0.00210	0	-0.00	0	0	-0.00230	-0.007	0	0	0	-0.00029	-0.01032	-0.00148	-0.00329
Beef	0	-0.01421	-0.00010	-0.00026	-0.00195	0	-0.00	0	0	-0.00214	-0.007	0	0	0	-0.00027	-0.00961	-0.00138	-0.00306
Poultry	0	-0.01612	-0.00011	-0.00029	-0.00222	0	-0.00	0	0	-0.00242	-0.008	0	0	0	-0.00030	-0.01090	-0.00157	-0.00347
Dairy	0	-0.02251	-0.00015	-0.00041	-0.00310	0	-0.00	0	0	-0.00338	-0.011	0	0	0	-0.00042	-0.01521	-0.00219	-0.00485
Fish	0	-0.01796	-0.00012	-0.00032	-0.00247	0	-0.00	0	0	-0.00270	-0.008	0	0	0	-0.00034	-0.01214	-0.00175	-0.00386
Forestry	0	-0.02479	-0.00017	-0.00045	-0.00341	0	-0.00	0	0	-0.00373	-0.012	0	0	0	-0.00047	-0.01675	-0.00241	-0.00534
Yarn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles	0	-0.52202	-0.00012	-0.00032	-0.00246	0	-0.00	0	0	-0.00269	-0.008	0	0	0	-0.00034	-0.01211	-0.00174	-0.00386
Jute textile	0	-0.02474	-0.72063	-0.00045	-0.00340	0	-0.00	0	0	-0.00372	-0.012	0	0	0	-0.00047	-0.01672	-0.00241	-0.00533
Paper	0	-0.02477	-0.00017	-0.72134	-0.00341	0	-0.00	0	0	-0.00372	-0.012	0	0	0	-0.00047	-0.01674	-0.00241	-0.00533
Leather	0	-0.02502	-0.00017	-0.00045	-0.72884	0	-0.00	0	0	-0.00376	-0.012	0	0	0	-0.00047	-0.01692	-0.00243	-0.00539
Fertilizer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pharmacy	0	-0.02540	-0.00017	-0.00046	-0.00349	0	-0.73	0	0	-0.00382	-0.012	0	0	0	-0.00048	-0.01717	-0.00247	-0.00547
Cement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	-0.02505	-0.00017	-0.00045	-0.00345	0	-0.00	0	0	-0.72965	-0.012	0	0	0	-0.00047	-0.01693	-0.00244	-0.00539
Wood	0	-0.01057	-0.00007	-0.00019	-0.00145	0	-0.00	0	0	-0.00159	-0.308	0	0	0	-0.00020	-0.00715	-0.00103	-0.00227
Urbanhse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruralhse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	0	-0.00813	-0.00005	-0.00014	-0.00112	0	-0.00	0	0	-0.00122	-0.004	0	0	0	-0.23691	-0.00549	-0.00079	-0.00175
Housing	0	-0.01023	-0.00007	-0.00018	-0.00140	0	-0.00	0	0	-0.00154	-0.005	0	0	0	-0.00019	-0.29798	-0.00099	-0.00220
Health	0	-0.02616	-0.00018	-0.00048	-0.00360	0	-0.00	0	0	-0.00394	-0.013	0	0	0	-0.00049	-0.01769	-0.76203	-0.00563
Trade&trans	0	-0.02519	-0.00017	-0.00046	-0.00347	0	-0.00	0	0	-0.00379	-0.012	0	0	0	-0.00048	-0.01703	-0.00245	-0.00542

The export demand elasticities

Except for jute and jute products, Bangladesh falls into the small country category. Therefore, the reciprocals of export elasticities for all commodities except for jute and jute goods are assumed to be 0.05.

A few studies estimate export demand elasticities for jute and jute goods (Imam 1970, Thomas 1979). The absolute values range between 0.66 to 1.1 for raw jute and 5.1 to 13.3 for jute goods. The model assumes export demand elasticities of -1.00 for raw jute and -7.00 for jute goods.

The elasticities of factor demand and output supply in agriculture

As already noted, the production technology in agriculture is assumed to be of a three-level nested form. Chapter 4 has econometrically estimated the production relationships at the topmost level. However, the estimation is applied for allocation decisions in the production activity only, while the CGE model input-output data aggregate producing and processing activities as a single activity. As a result, the number of material inputs varies between the two definitions. While the econometric model of the agricultural sector has only one material input, fertilizer, the CGE model input-output data show additional input flows of items such as packaging materials, trade and transport services etc. To have consistency between the two definitions, all material inputs in the CGE model are aggregated into a single composite input whose price elasticity is approximated by the price elasticity for fertilizer estimated in Chapter 4.

For the first-level parameters, Chapter 4 presents two sets of estimates, one with symmetry and the other without it. The CGE model simulations use elasticity values obtained when symmetry is not imposed. The estimates with symmetry imposed generate an unexpected sign for jute-labour cross-price elasticities. Given the importance of jute in labour employment, the estimates without symmetry in which the jute-labour elasticities are of the expected signs, are considered. The values of the estimates, however, are adjusted for use in the model. The elasticity of jute output with respect to fertilizer prices is made equal to zero instead of positive as estimated in Chapter 4. The positive estimate, however, was not statistically significant. Given the caveats in the estimation described in that chapter and the competition between rice and jute crops, it is judicious to overlook the positive jute-fertilizer price response to avoid any exaggerated outcome of fertilizer pricing policy on rice output. On similar grounds, the negative response of fertilizer demand with a rise in the price of `other' is made equal to zero. Also, the near-zero positive value of elasticity of rice with jute price is made negative with a larger absolute value attached to it. Furthermore, an overall conservative approach is taken to lower the elasticity values in the model simulation to keep them within the range provided by other studies. This is especially true for own-price elasticity of labour, which is very much on the higher side as derived in Chapter 4, compared to other studies. Thus the economy is made to appear less `flexible' than the elasticity estimates would have suggested for some variables. However, given the weakness of the econometric model, such a caution is warranted. The adjusted price elasticities used in the model are presented in Table 6.4.

Table 6.4. **Own- and cross-price elasticities of input demand and output supply in Bangladesh agriculture**

	Rice	Jute	Other	Material	Labour
Rice	0.120	-0.036	-0.026	-0.049	-0.019
Jute	-0.181	0.344	0	0	-0.163
Other	-0.104	0	0.118	-0.01	-0.004
Material	0.076	0	0.076	-0.643	0.491
Labour	0.022	0.043	0.019	0.218	-0.299

Source: Chapter 4

In the second stage, the components of the composite are assumed to be combined with some degree of flexibility. Land and capital are aggregated with a CES function assuming an elasticity of substitution value of 1.00. The components of the composite crop `other' are assumed to behave in a constant elasticity of transformation (CET) fashion with arbitrarily chosen parameter values of 0.50. At the lowest level, the CES elasticity parameter between domestic and imported sources of material inputs are assumed to be of the same values as reported in Table 6.2.

Ideally the elasticity values should come from an econometric estimation in multiple-stage formulation, using an aggregator function as demonstrated by Fuss (1977) and Lawrence (1990). However, because of data limitations the elasticity values were chosen arbitrarily.

The elasticities of substitution in primary factors

A few studies are available to provide these parameter values (Rahman 1973, Demery and Jahangir 1974, Rushdi 1982). Rushdi (1982) uses a translog cost function to estimate the elasticity of substitution between capital, labour and material inputs. While both Rahman (1973) and Demery and Jahangir (1974) use a CES functional form for the estimation, the latter introduces adjustment lags in the model. The elasticities estimated are presented in Table 6.5.

Table 6.5 **Elasticity of substitution among factors**

Industry	σ^a	σ^b	σ^c
All manufacturing	.6163	1.68	.146
Food	.1853	2.73	
Sugar	.6921		
Edible oils	.8642		
Tea	.5225		
All textiles	.7068	2.61	
Cotton textiles	.9504		
Jute textiles	.7992		
Footwear	.7643		
Leather	1.4428		
Chemicals	.3608	1.01	
Non-met products	.6132	1.52	
Glass	1.3263		
Paper	.4337		
Metal	1.2961	1.16	
Transport	1.1766		
Jute pressing	1.2421		

Source: [a] Rahman, A.N.M.A., 1973. `Elasticities of substitution in manufacturing industries of Bangladesh: an international comparison', *Bangladesh Development Studies*, 1(2):173-85.

[b] Demery, L. and Jahangir, H., 1974. `Adjustment dynamics and the elasticity of substitution: the case of manufacturing industry in Bangladesh', *Bangladesh Development Studies*, 2(3):725-32.

[c] Rushdi, A.A., 1982. `Factor substitutability in the manufacturing industries of Bangladesh: an application of the translog cost model', *Bangladesh Development Studies*, 10(2):85-106.

Since Rushdi allows for substitution possibilities between factors and materials, his estimates are not consistent with the technology assumptions built into the Bangladesh model. Considering the estimates from the other two sources, the present model assumes elasticity value of 1.00 for all the sectors.

Transfer income and payment parameters

The share of transfer incomes and payments in the incomes of farm and non-farm households are derived from data on income generated to different types of households, disaggregated by source, given in the SAM used for Third Five-Year Plan.

The government budget file

The macro model of Third Five-Year Plan provides data on tariffs, excise revenues, income taxes, export taxes, fertilizer subsidies, food subsidies, remittances subsidies, government consumption and investment expenditure, foreign aid flows, external borrowing and remittances received. Data on irrigation subsidies, `other' revenues and `other' expenditures are taken from the government budget (Bangladesh, Ministry of Finance 1985). In the model data, excise taxes, irrigation and fertilizer subsidies are grouped together as net commodity taxes. The judgement about how much of `other' revenue is collected from, and how much of `other' expenditure is going to, farm versus non-farm households, is made from disaggregated households income data given in the SAM.

Figure 6.2 is a diagrammatic representation of the budget file. Some of the matrices are derived from data in the input-output file.

The elements in matrix B_1 are taxes on consumption which is the sum of the ith rows of L_t, R_t, O_t, and T_t from Figure 6.1. Matrix B_2, taxes on purchases of investment goods, is the sum of the ith rows in M_t, S_t, P_t, and U_t from Figure 6.1. Matrix B_3, the row sum of K_t and Q_t, gives net taxes on purchases of intermediate inputs. Matrix B_4, taxes on exports, is the same as N_t in input-output file. Matrix B_5, tariff revenues, is Z_1 in the input-output file, while B_6, the proceeds from the sale of foreign

Figure 6.2 **Government budget file for the Bangladesh model**

Revenue	Expenditure
B_1 (Taxes on consumption goods)	E_1 (Food subsidies)
B_2 (Taxes on investment goods)	E_2 (Consumption expenditure)
B_3 (Taxes on intermediate goods)	E_3 (Investment Expenditure)
B_4 (Export taxes)	E_4 (Export subsidies through foreign exchange retention scheme)
B_5 (Tariffs)	E_5 (Remittance payments)
B_6 (Proceeds from sales of foreign exchange at the secondary market)	E_6 (Other expenditure)
B_7 (Other revenue)	
B_8 (Revenue from income tax)	
B_9 (Foreign aid converted at official exchange rate)	
B_{10} (Remittance receipts converted at official exchange rate)	
Column sums = Aggregate government revenue	Column sums = Aggregate government expenditure

exchange at wage earners' scheme rate, is calculated as R.(G + H + I + J + K).(Φ_1 - Φ_2), where R is the proportion of imports at the secondary rate in the wage earners' market. The values of R and Φ_1 are taken from the Bangladesh Economic Survey 1986/87 (Bangladesh, Ministry of Finance 1987). The value of Φ_2 is obtained from Bangladesh (central) Bank. Matrices B_7, B_8, B_9 and B_{10} contain data on other revenues, income taxes, foreign aid, and remittances earnings respectively.

The E matrices contain data on government expenditures. E_1 gives the food subsidy figure. E_2 is government consumption expenditure obtained from row sum of E, J, O_t, and T_t in Figure 6.1. Similarly, E_3 is investment expenditure obtained from the row sum of F, K, P_t, and U_t. E_4 gives the export premia, which are N_{t+1} in Figure 6.1. E_5 represent remittances payments and E_6, `other' expenditure.

Computing solution for the model

The model follows the Johansen solution method which is characteristically different from other non-linear model solution methods. CGE models other than the Johansen class are generally solved in their non-linear forms (examples are Shoven and Whalley 1972, Adelman and Robinson 1978, Clarette 1984, Ezaki 1987a, 1987b). In the Johansen method, the basic non-linear structure of the model is approximated by a system of equations that is linear in percentage changes and the solution is based on a matrix inversion and a matrix multiplication (examples of a Johansen class models are Taylor and Black 1974, Vincent 1985, Bautista 1986, and Coxhead 1989). The model can be thought of as a linear system of m equations in n variables with $m < n$ as:

$$F_1(z_1,....,z_n) = 0 \quad (1.7)$$

$$F_n(z_1,....,z_n) = 0 \quad (1.8)$$

The z's are the model variables as presented in their percentage change form in Appendix A1. Since n is greater than m, (n-m) variables have to be chosen to be exogenous for a model solution to be derived. There are different ways of selecting the (n-m) components variables. The choice depends on the model user's purpose. In Chapter 5, one possible set of exogenous variables for the Bangladesh model has been identified.

Once the exogenous variables are selected, the equation system in (1.7) to (1.8) can be written as

$$Az_1 + Bz_2 = 0 \quad (1.9)$$

where z_1 and z_2 are the vectors of endogenous and exogenous variables respectively, and A and B are the corresponding columns in matrix F. Equation (1.9) can be solved as

$$z_1 = - A^{-1}Bz_2 \quad (1.10)$$

The model is soluble so long the inverse A^{-1} exists, i.e., the matrix A^{-1} is non-singular. This condition will typically hold so long as the closure makes economic sense.

The effects of changes in the exogenous variables in z_2 can be calculated once A^{-1} has been evaluated using the data contained in the model database.

The linearization in the Johansen method provides it with some flexibility which cannot be found in a non-linear solution method. The flexibilities are in terms of model size, model modification, and model application. The solution of a constrained maximization problem at each iteration of a large non-linear model involves heavy computer cost. Any revision in non-linear solutions involves high cost since in most cases it requires major rethinking and rewriting of the algorithm. The Johansen solution, on the other hand, does not require any rewriting of algorithms. Most of the modifications or extensions can be done by simply changing the data file and adding new dimensions to the F matrix. The final advantage in terms of policy application lies in being able to swap between the exogenous and endogenous categories. While non-linear solutions require major rewriting of the solution algorithm, linear solutions only require reallocating the columns of the matrix F between the A and B matrices and rerunning the programme by recomputing the matrix - $A^{-1}B$.

One problem with linearized models is that the solution may contain linearization errors. However, the errors are small when the exogenous shocks are small. The computer software for the solution in this study is version 4.2.01 of GEMPACK developed by Codsi and Pearson (1988). A more recent release of the GEMPACK software (version 4.2.02) contains provision for multi-step solutions whereby the linearization errors can be essentially eliminated.

CHAPTER 7

MODEL RESULTS

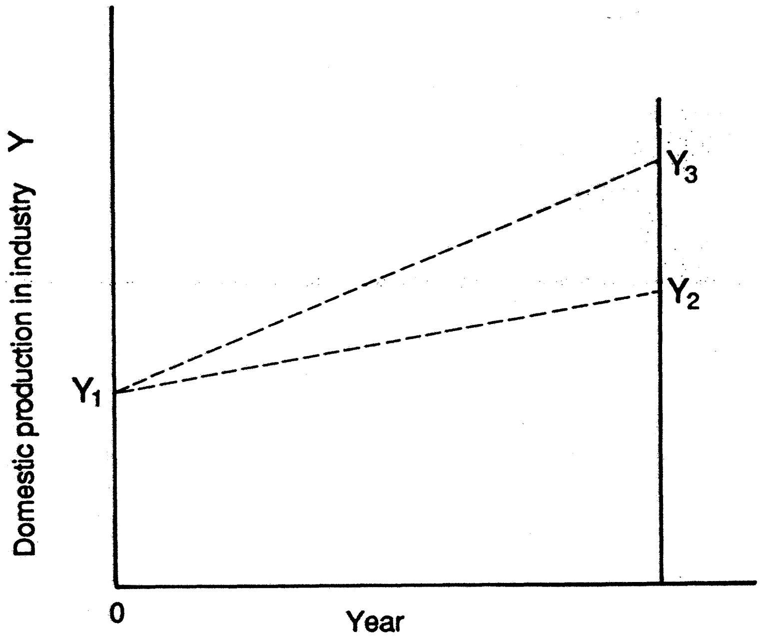
This chapter presents the estimates of the direction and size of agricultural price policy reforms. The estimates are derived from the CGE model developed and initialized in the previous two chapters.

Along with partial microeconomic reforms, the model experiments with policies that dismantle the entire existing incentive structure which was detailed in Chapter 3. The macro environment underlying the policy experimentations has been discussed in Chapter 5. The model analyzes the effects of different policy shocks in terms of their effects on macro variables such as real GDP, real income, employment, consumption, investment, trade balance and government borrowing requirements. At the micro level, the model looks at intersectoral effects on industry prices, output, employment, and value added.

In the absence of any absolute price setting mechanism, the GDP deflator serves as the numeraire in the model. Therefore, all changes in prices in the simulation results are real and relative to the GDP deflator. An improvement in the country's competitive position in the world market is represented by a depreciation in the official and/or secondary market exchange rates.

The simulation results are comparative static, that is, the model applies to only one point in time, the outcome year. This year is far enough in the future to allow all adjustments initiated by the change to occur and a new equilibrium to be reached. The differences in the values of variables between the new equilibrium and the `control' equilibrium, the solution which would have been reached if the general economic conditions had been allowed to evolve without any interruption, are then analyzed. The model, however, does not attempt to track the movement of variables over time in their transition to the new equilibrium solution.

Figure 7.1. Interpretation of comparative static



Suppose the policy question is to see the effect of a certain policy change on production in industry Y, the current production being at Y_1. In the absence of policy change, output would grow to Y_2 after a period of T years. Suppose the effect of the policy change is to raise equilibrium output in year T to Y_3. The model evaluates the effect of policy change as the percentage difference in the alternative equilibria Y_2 and Y_3, all other things being equal. The model does not track the time path of output in moving from Y_1 to Y_2 or from Y_1 to Y_3 (Figure 7.1).

In the comparative static analysis, the model distinguishes between short- and long-run time horizons. The short run is defined as a period shorter than the gestation period of investment, i.e., a period long enough to make investment plans and carry out investment spending but not long enough to generate additional capacity. The time frame to allow this to happen varies across industries, and Cooper, McLaren and Powell (1985) found a little less than two years as the relevant period for a typical industry in Australia. The time span for the long-run simulations is defined as long enough to allow investment to add to capital stock and generate additional production capacity.

A feature that can also distinguish a short-run model closure from a long-run one is the treatment of wage rates. The nominal wages are kept constant in the short-run experiments in this Chapter while in the long run they are fully indexed to the consumer price index, implying a constant real wage. Thus in the short run any change in policies affects the welfare of labour through their effects on employment and commodity prices. De Janvry and Subbarao (1986) used a constant nominal wage setting in their model for India to evaluate the effects of agricultural price policy. Their choice of the closure was influenced partly by the study of Bardhan (1984a) which observed that, for India, labour employment is markedly influenced by labour demand conditions. An increase in demand for labour causes a shift in its supply curve without a change in the nominal wage rate, and nominal wages remain constant over a wide range of employment levels. Another study of India shows that welfare effects of food subsidies and agricultural development policies are mainly created by price effects, with nominal wages remaining largely unaffected (Quizon and Binswanger 1983).

The long-run model closure allows inter-sectoral and international mobility of capital, and thereby forces domestic rates of return in each industry to be in line with the going world rates of return. Hence, industry rates of return are exogenous in the long run with industry capital stocks being endogenous. The assumption of exogenous rates of return allows for foreign investment coming into the country as capital inflow. This implies that a part of the growth in national income accrues to foreigners. The present model does not distinguish between foreign and domestic sources of savings, and hence does not distinguish between real GDP, the income generated in Bangladesh, and real GNP, the income accruing to Bangladesh residents.

The long-run experiments use the short-run price elasticities in the agriculture sector that were estimated in Chapter 4. The long-run elasticities can be derived from the short-run ones if the profit function itself (equation 4.7) or the numeraire equation (equation 4.10) is included in the estimation (Squires 1987). However, an attempt to do so did not produce any plausible estimates (see Chapter 4). Hertel (1987), by using a quadratic profit function and a single fixed factor, has shown that the long-run own price responses are larger than short-run ones, and that all products become net complements in the long run. The effect of changes in the relative price structure, therefore, would be stronger in the long run than in the model.

The experiments conducted in this study are designed to answer two questions. First, have the agricultural price policies pursued in Bangladesh constrained the growth of the economy in general and agriculture in particular. If they have, the second question is, to what extent. As stated in the introductory Chapter, this particular model, like any CGE model, is somewhat stylized to ensure tractability and transparency, and so the results produced are only illustrative, indicating the likely nature of the economy's responses to policy reforms rather than being precise predictions.

The first set of experiments centre on policies that have indirectly contributed to the changes in relative price structures in agriculture. They include an across-the-board cut in industrial tariff rates, elimination of quantitative controls on imports, and unification of the exchange rates. The tariff confers direct protection to domestic manufacturing and thereby taxes agriculture. Import controls intensify the discrimination against agriculture by creating an import scarcity premium on imports. Dual pricing of foreign exchange with exchange control creates foreign exchange scarcity premia and favours manufactured exports at the expense of agricultural exports. Thus a reform in these policies is likely to reduce the bias against agriculture. An important point to note in analyzing the results of these experiments is that, as indicated in Chapter 6, the model data represent an economy less distorted than it actually is. The protection rates on imports, being smaller than those suggested by studies available, would indicate that the effects of removing these distortions could be larger than reported here. Instead of possibly exaggerating the effects of removing distortions, the simulation results are on the conservative side.

The second set of experiments are concerned with the simulation of policy shocks that directly affect agricultural prices. These are a withdrawal of fertilizer subsidies, a removal of subsidies involved in the sale of agricultural machinery, and a withdrawal of food subsidies. Finally, projections are made of the effects of non-price policy interventions affecting agricultural prices and productivity. They include an exogenous increase in agricultural capital stock and an exogenous technological change causing a rise in agricultural production. The main aim of the technology experiment is to appraise the role of agricultural growth in the acceleration of non-agricultural growth.

The results of each policy shock are reported separately. As noted in Chapter 5 on model closure choice, some degree of relaxation in import control is allowed in all partial reforms to make the analysis meaningful. In reality the decision as to how much partial import liberalization accompanies a particular microeconomic reform, lies with bureaucrats. The relaxation allowed in the model simulation is only to the extent that it keeps the per foreign currency unit import premium rate and exchange rate ratio constant at their current levels. An exception is made when import controls are eliminated, in which case premium rates are targeted directly and reduced by 100 per cent. The exchange rate ratio, however, is kept constant in this experiment. In real life, once flexibility in exchange rates is introduced, market arbitrage would tend to ensure that the two rates converged. The model, however, allows the government sufficient leverage to keep the relativities between the two exchange rates constant while maintaining their flexibility. The purpose of empowering government with such control is to examine the effects of different policy shocks in isolation from the effects of exchange rate unification. Otherwise, with the closure choice of flexible exchange rates, an exchange rate unification policy shock would be common to all experiments, thus confusing the interpretation of the simulation results. In this chapter, the exchange rate ratio is reduced to a value of one only in the exchange rate unification experiments.

In experiments with industrial tariff rates, the rates are reduced by 25 per cent from the existing level. The logic of reducing tariffs by 25 per cent instead of 100 per cent is derived from the fact that government revenue is overwhelmingly dependent on tariff revenue, and although a large reduction in it is expected to generate more revenue by increasing import values in the long run, it may not be feasible in the short- to medium-run.

The model is linear in percentage changes, so that if linearization errors can be ignored, the effects of any across-the-board reduction in assistance can be inferred by scaling the effects reported for each shock. Thus, the effects of a 100 per cent tariff reduction could be calculated by quadrupling the effects of a 25 per cent shock. Also, because of the linearity, the effects of introducing a policy package involving a combination of several policy changes can be deduced by summing over the effects of individual policy shocks on relevant variables.

In the remainder of the chapter, the results of policy changes are reported in sequence. The short- and long-run effects on key macro variables of a 25 per cent across-the-board tariff cut are presented first, followed by a detailed examination at sectoral levels of prices and outputs, and of changes in real disposable income and its various components. Exchange rate unification and import control elimination results are analyzed next, followed by the simulation results of agriculture specific price policy reforms. The effects of non-price measures such as technological growth in agriculture and an increase in agricultural capital stock are discussed afterwards. Finally, tariffs, premia elimination, and exchange rate unification results are grouped together to assess the constraining strength of the indirect policies, as defined in the introductory Chapter. These estimates are compared with the combined results of the direct policies (agriculture specific policies) to assess the relative efficacy of each group in terms of their effects on growth, efficiency, distribution and budgetary and trade balance considerations for both short- and longer-time horizons.

Policy shocks which have indirect effects on the relative price structure in agriculture

An across-the-board tariff cut of 25 per cent

Effects on key macro variable

The short- and long-run macro results of an across-the-board tariff cut of 25 per cent are presented in Table 7.1.

Table 7.1 **Short- and long-run effects on macro aggregates of an across-the-board tariff reduction of 25 per cent***

Macro aggregates	Short-run	Long-run
Real GDP	0.47	8.77
Real absorption	0.51	7.13
Real disposable income	0.66	8.35
Real import	1.88	7.59
Real export	3.46	27.18
Govt borrowing	0.61	-0.10
Current account	-0.12	0.56
Consumer price index	0.90	1.12
Official exchange rate	1.03	3.14
Secondary market exchange rate	1.03	3.14
Aggregate employment	0.79	7.71
Aggregate capital stock	0.00	12.23

* All projections are expressed in percentage changes except for government borrowing and current account, which are percentage points worth of base-period GDP.

A reduction in tariff rates makes imports cheaper and generates an upward pressure on import demand. Given the exogenous nature of remittance earnings and foreign aid receipts assumed in the model, the rise in import demand causes a deterioration in the current account deficit in the short run. However, the extent of deficit is contained because of an expansion in exports. Exports expand as an outcome of two factors. First, the majority of commodities under tariff are of intermediate and capital good types (Table 6 in Appendix C). A decrease in domestic prices of these imported inputs and their domestic substitutes causes a fall in production cost (a reflection that current tariff exemptions/duty drawbacks for exports are not efficient). Second, export revenue per unit depends on both the official and secondary market exchange rates, the weight given to each being determined by the foreign exchange retention parameters set by the government. A simultaneous depreciation of the same order for both exchange rates (the relativity between them being kept constant) increases profitability in exporting to the extent of depreciation. The degree of export expansion, however, is not enough to reverse the deteriorating trend in the current account which is an outcome of increased importing following the tariff cut.

Although the tariff cut induces a fall in domestic price of importables initially under tariff, the accompanied depreciation resulting from the increased demand for cheaper imports brings about an offsetting increase in all import prices. The depreciation-induced price rise is dominated by tariff cut effects in the case of tariff-ridden commodities, and the net outcome is a fall in their prices. The price rise of the remaining importables causes the prices of their domestic substitutes to rise, making some domestic import-substituting industries more profitable. The consumer price index rises despite a fixed GDP deflator, because the depreciation-induced inflationary pressure has not been contained for the 80 per cent of commodities entering the consumption basket not initially subject to tariff. The simultaneous expansion of some import substitutes and exportables brings about a rise in real and nominal GDP and employment in the short run. Aggregate employment exhibits an increase of 0.79 per cent. Since labour is the only variable factor in the short run, the change in aggregate employment is expected to be in the same direction as for real GDP, but larger. The expansion in domestic production activity brings about an increase in real income leading to an increase in aggregate real absorption.

Other than the slight deterioration in the current account deficit (0.11 percentage points worth of the base-year GDP), the only key macro variable that is hard hit as a result of the tariff cut is the government borrowing requirement. A tariff cut requires an increase in government borrowing by 0.61 percentage points worth of the base-year GDP. Government revenue earnings fall mainly because of reduced tariff revenue generated from lowered tariff rates. Tariff revenue accounts for approximately 50 per cent of government revenue from domestic sources. Following the tariff cut it declined by more than 22 per cent.

The long-run effects of tariff reduction are similar in nature to the short run, but of greater magnitude with two exceptions: reduced government borrowing and improvement in the current account balance. Exports expand at a greater rate than in the short-run scenario because in the long run the increase in profitability that has taken place in the short run, increases productive capacity leading to more exports. The expansion in domestic production activities generates an increased demand for raw materials, both imported and domestic. The current account balance improves because exports expand at a higher rate than imports. The increased imports result in a higher tariff revenue even though the rate has been reduced. This is reflected in a reduced government borrowing requirement in the long run. The two other contributors in reducing the government borrowing requirement are an increased export tax revenue because of increased exports and a higher income tax revenue generated from increased nominal taxable income.

Effects on farm-gate prices

The responses of farm-gate commodity prices indicate the adjustment incentives which follow the tariff cut. The relative movement in prices in

Table 7.2 **Short- and long-run effects on farm-gate prices of an across-the-board tariff reduction of 25 per cent[a]**

	Short-run	Long-run
Rice	1.81	5.02
Jute	1.34	0.60
Other	1.34	-4.46
Wheat	1.34	-3.54
Coarse grains	1.34	-4.07
Oils*	0.83	-3.39
Feeds	1.43	-4.02
Sugar	1.40	-2.98
Vegetables	1.37	-5.10
Fruits	1.39	-4.42
Cotton*	1.52	-1.16
Tobacco*	1.34	-3.41
Tea	1.01	2.89
Fish	0.69	0.54
Leather	0.87	-0.41
Textiles*	0.18	0.05
Jute textiles	0.84	-0.23
Livestock*	0.48	-0.34
Poultry	0.12	0.68
Dairy*	0.39	0.14
Forestry*	-0.56	0.57
Cotton yarn*	0.36	0.79
Paper*	-0.83	-0.69
Fertilizer	0.80	-1.30
Chemicals*	-0.13	-0.78
Cement*	-3.30	-0.95
Steel*	-3.79	-1.24
Machinery*	-2.87	-1.06
Wood & other*	-0.57	-0.29
Urban housebuilding	-1.39	-0.45
Rural housebuilding	-1.49	-0.53
Other building	-1.69	-0.72
Electricity	-0.11	-1.31
Housing services	2.25	-1.86
Public administration, health & education	-0.12	0.29
Trade & transport	0.54	-0.56

* Commodities subject to tariff.

[a] All projections are expressed in percentage changes.

turn explains the responses of different industry outputs.

Table 7.2 suggests that among the commodities subject to tariff, it is mainly the intermediate and capital good type of products whose prices fall following the tariff cut. The reduced prices generate a fall in production cost in industries which are intensive in their use of these goods. These industries include building and construction, and power supply.

As exchange rates depreciate, profitability in exporting increases, raising the rent to capital and thereby raising the production cost. However, the price increase is less than the nominal depreciation rate for all manufactured exports. This implies a depreciation in the real exchange rate leading to increased competitiveness in manufactured exports. Table 7.3 reports the foreign currency price of exportables which is a reflection of depreciation in real exchange rates.

Table 7.3 **Short- and long-run effects on foreign currency price of exports of an across-the-board tariff reduction of 25 per cent**[a]

Commodities	Short-run	Long-run
Jute	0.32	-2.54
Tea	0.01	-0.25
Fish	-0.34	-2.60
Textiles	-0.84	-3.09
Jute textiles	-0.19	-3.37
Leather	-0.16	-3.55

[a] All projections are expressed in percentage changes.

All agricultural commodities except for oil experience a price rise which is higher than the depreciation. This is partly a reflection of having a GDP deflator as the numeraire while exchange rates depreciate. As exchange rates fall, prices of some domestic commodities have to go up to hold the `average' output price constant. Among the three crops initially under tariffs, oil, cotton and tobacco, the tariff on cotton is the smallest and negligible (Table 6 Appendix C). The tariff cut has little containing effect on domestic cotton price, and the price is further pushed upward due to increased input demand from domestic textile industry which now gains competitiveness in the world market following the reform and expands. Similarly, the increase in the domestic price of jute is due to an expansion in the exporting jute textile industry which uses 48 per cent of the domestic production of jute. The price increase in tobacco despite the tariff cut is partly due to the increased spending effect and partly due to having GDP deflator as the numeraire. The larger price rise for rice compared with other crops is explained by the fact that rice has higher expenditure elasticity than other grains and it claims 39 per cent of consumers' budget. As disposable income rises, demand for rice increases more than demand for wheat and other grains, causing a larger demand-push rise in producers' price of rice.

The producers' prices of import-competing products in Table 7.2 demonstrate the relative strength of reduced tariffs and higher foreign exchange prices due to depreciation. The higher foreign exchange price is translated into a price rise for imported products not subject to tariffs, and domestic commodities in competition with these imported products record a price rise. For commodities initially under tariff, in some cases the depreciation-induced price rise has been more than offset by the price fall due to the cut in tariffs, and for the rest, the depreciation induced price rise dominates. As a result, while prices fall for the former group, for the latter, they rise.

Among the non-tradables, all prices decline except for housing and trade and transport (Table 7.2). The downward movement in the prices of non-tradables has two sources. First, given the lower demand elasticities for non-tradables relative to tradables the pressure for non-tradables to expand following a tariff cut is less than it is for traded activities. Second, the non-tradables receive most of the flow-on benefits of a tariff cut as they are major users of commodities with tariffs. The rise in prices of trade and transport services, which is directly related to expansion in the traded sector, is expected. The increase in housing price is a result of the inability of this industry to expand as demand for housing rises with a rise in real income. In the database, housing employs no labour. Given that the other two primary factors are fixed in the short run, zero employment of labour allows no output flexibility in this industry.

The long-run effects on commodity-wise farm-gate prices do not follow the short-run trend consistently. Except for rice and jute, all agricultural prices decrease as opposed to their increase in the short run. In response to a highly positive short-run rate of return to capital in agriculture, agricultural capital stock rises in the long run to make the rate of return equal across sectors. Consequently, agricultural supply rises, leading to a fall in prices. The positive change in rice and jute price despite the increased supply is due to a demand pull effect of a similar nature to the short run. While the 7 per cent increase in real absorption contributes to the rice price rise, the increase in jute price is due to increased jute demand from the jute textile sector, which experiences a 21 per cent expansion. The jute price rise in the long run is less than it is in the short run because of supply side adjustment in the long run following from increased capital usage in the agricultural sector. Because the rise in jute price is less than the rate of exchange rate depreciation, there is an increase in competitiveness in raw jute exports, in contrast with the short-run simulation.

For manufactured exports, leather and jute textile prices decrease in the long run, leading to increased competitiveness in the world market. Although producers' prices of tea and fish register an upward trend, as in the short run, a higher nominal depreciation generates an increase in the real exchange rate for all manufacturing exports.

The prices of all products of the remaining manufacturing and service industries decline in the long run except for cotton yarn, dairy and forest products, and public administration, health and education. The rise in the prices of these outputs, however, is much less than the rate of depreciation in the long run, and as a result, competitiveness increases in all these industries.

Effects on industry output

The effects on industry output levels deserve attention for three reasons: for their role in explaining the aggregate results in greater detail, for identifying the sectors which bear most of the burdens of adjustment cost, and most importantly, for explaining welfare results by tracing out the effects of policy shocks on income received by different households. The effects of tariff cuts on the output levels of the industries are shown in Table 7.4.

The relatively small change in the overall agricultural sector in the short run reflects the low supply elasticities assumed for the sector. The responses of the individual crops are an outcome of the production technology in agriculture as detailed in Chapter 4. The three crops identified in the first tier of the nested production function are: rice, jute and `other', a CES aggregate of the remaining eight crops. The responses of supply for the three major crops largely reflect the differences in their

Table 7.4 **Short- and long-run effects on industry output levels of an across-the-board tariff reduction of 25 per cent[a]**

	Short-run	Long-run
All crops	**0.05**	**6.42**
Rice	0.08	5.35
Jute	0.12	14.02
Other	-0.04	7.59
Wheat	-0.04	12.19
Coarse grains	-0.01	9.52
Oils*	-2.55	12.90
Feeds	0.45	9.79
Sugar	0.26	14.96
Vegetables	0.14	4.37
Fruits	0.21	7.77
Cotton*	0.88	24.96
Tobacco*	-0.03	12.81
Manufacturing for export	**2.13**	**20.19**
Tea	0.31	5.84
Fish	1.39	14.83
Leather	1.62	32.47
Textiles*	4.05	21.51
Jute textiles	1.20	21.76
Manufacturing for import substitution	**0.97**	**12.27**
Livestock*	0.71	9.13
Poultry	0.99	10.00
Dairy*	0.98	14.56
Forestry*	-0.21	9.44
Cotton yarn*	3.23	21.29
Textiles*	4.05	21.51
Paper*	-0.23	7.01
Fertilizer	0.13	7.45
Chemicals*	-0.11	12.49
Cement*	0.00	5.70
Steel*	-1.01	4.26
Machinery*	-1.85	3.56
Wood & other*	-0.43	6.19
Services	**0.38**	**8.03**
Urban housebuilding	0.01	11.48
Rural housebuilding	0.00	11.94
Other building	0.02	3.77
Electricity	0.27	4.53
Housing	0.00	6.06
Public administration, health & education	0.30	2.92
Trade & transport	0.57	10.62

* Commodities subject to tariff.

[a] All projections are expressed in percentage changes.

respective supply elasticities. The increase in producers' prices are the same for jute and `other' and slightly higher for rice (Table 7.2). The net supply elasticities for the three crops (by summing over the own- and cross-price elasticities of output supply functions for them given by equation 4.8 in Chapter 4) are approximately 0.058, 0.163 and 0.014 for rice, jute and `other' respectively. Consequently, rice and jute crowd out `other', and even though the rice price shows a higher increase, the three-fold higher supply elasticity of jute dominates and jute production increases the most. In the competition between rice and jute, demand conditions also play a role. As real disposable income rises by 0.66 per cent, an expenditure elasticity for rice of 0.81 increases consumption by (0.66*0.81=0.53) 0.53 per cent. On the other hand, the jute textile sector expands by 1.20 per cent, making the demand-pull effect stronger for jute. The production of `other' crops falls, but its components exhibit different response behaviour according to the strength of their respective price increases and the elasticity of substitution among them. The price increase for all the eight crops have been quite similar, but slightly smaller increases in wheat, feed and tobacco prices have made them lose in the competition.

The overall expansion in manufacturing for export in the short run is caused by an increase in competitiveness in the world market, reflected in the exchange rate depreciation. The largest expansion in the manufactured exports occurs in the textile industry. Textiles are simultaneously an exporting and an import-competing industry. The export segment consists of a flourishing clothing industry and the import-competing side is cloth output. The output expansion in the textile industry is an expansion of both cloth production and clothing. Although cloth is initially subject to a tariff and a tariff cut brings about a fall in the domestic cloth price, the depreciation of exchange rates has more than outweighed the domestic price fall, leading to an increase in its profitability and production. Similarly, clothing production receives a boost when exchange rates depreciate. The data did not permit a disaggregation of the expansion of this industry into its two components. The industry is, therefore, listed twice, once as an export manufacturing industry and later, as an import manufacturing industry throughout the discussions in this Chapter. Thus, the aggregate changes in output levels of export and import manufacturing industries, as reported in the tables of changes in industry output levels, have some element of double counting in them, and the actual changes are somewhat less than reported. This double counting, however, is confined to discussions on industry output levels only, and does not affect estimates of any other model variables such as GDP, employment, or income.

Except for the livestock, dairy, cotton yarn, and textile industries, all industries subject to tariff experience a contraction. The contraction in forestry, paper, chemicals, steel, machinery and wood and other industries is a result of demand switching in favour of imports which are now relatively cheaper following the tariff cut.

The expansion in the livestock and dairy industry is a direct outcome of increased spending effects arising from increased real income. Although textiles are initially subject to a tariff of 10 per cent, the depreciation has more than outweighed the fall in domestic prices, leading to an increase in its profitability. The 4 per cent expansion in the textiles generates a 3.2 per cent growth in the cotton yarn industry. As seen from Table 4 in Appendix C, 99 per cent of the cotton yarn industry's production is supplied as intermediate inputs to the domestic cloth industry.

The domestic fertilizer industry is not subjected to tariffs but is affected by depreciation. It has expanded because of the positive substitution effect in favour of domestic fertilizer as imported fertilizer becomes dearer after the depreciation. The expansion is further encouraged as demand for fertilizer increases with increased production of rice and tea.

The expansion in services is not significant except for trade and transport which have the greatest linkages with the tradable sectors. The small degree of expansion in this sector, despite the increase in real income and absorption, is in response to the movement of resources out of the non-traded sector into the traded sector, whose profitability increases after the tariff cut and the consequent depreciation.

In the long-run simulation, each industry expands and the expansion is significantly higher than it is in the short run. While in the short run the expansion is a function of increased use of labour and material inputs alone, in the long run, capital stock also increases production capacity.

Effects on real income and its components

The short- and long-run effects on real income and its distribution among farm and non-farm households, presented in Table 7.5, highlight the diverse nature of the consequences for income following the reduction in tariffs. The expansion in aggregate production activity has generated an increase in aggregate income. The sources of increased income are mainly increased employment and higher returns to the fixed factors of production.

In the short run, the value added component of farm income rises as a result of an increase in non-labour value added. The increase in real returns to non-labour fixed factors reflects the pressure of adjustment in the short run.

With positive changes in real income, demand for agricultural commodities, which is dominated by foodgrains, increases. Increased demand leads to increases in prices and profitability and induces an expansion in the industry. In the short run, this raises the real returns to factors whose supply is fixed. Real returns to the variable factor, labour, decline as the increase in labour employment is not large enough to compensate for the 0.9 per cent increase in the consumer price index, given fixed nominal wage rates.

Table 7.5 **Short- and long-run effects* on income and its components of an across-the-board tariff reduction of 25 per cent[a]**

	Short-run	Long-run
Real disposable income	0.66	8.35
Farm	1.21	8.13
Non-farm	0.32	8.49
Real agricultural value added	1.22	8.25
Labour	-0.71	5.23
Non-labour	3.05	11.09
Real non-agricultural value added	0.20	13.18
Labour	0.30	9.42
Non-labour	0.10	8.71
Labour employment	0.79	7.71
Agriculture	0.19	5.23
Non-agriculture	1.20	9.42
Capital employment	0.00	12.23
Agriculture	0.00	14.16
Non-agriculture	0.00	11.67

[a] All projections are expressed in percentage changes.

* Figures are deflated using consumer price index.

However, the increase in real returns to land and capital outweighs the fall in real returns to labour, resulting in a significantly positive increase in total real value added accrued to factors owned by farm households.

The improvement in non-agricultural real value added, on the other hand, is a result of increases in both its labour and non-labour components, in real terms. The expansion in non-agricultural employment is large enough to compensate for the decline in real wages. Real returns to non-labour primary factors are negative in all industries that face contraction. However, the positive real returns to fixed factors in expanding industries offset the negative growth in non-labour value added in the remaining industries in the non-agricultural sector. The net result is a small increase in overall non-agricultural non-labour value added.

The significantly higher growth rate in real GDP in the long run can be attributed to the increased supply of capital, which allows the increased competitiveness in export oriented and import-competing industries to be exploited. The expansion in all industries, including the service industries, increases employment of both labour and capital. Since real wage rates are constant in the long run, an increase in employment generates an equiproportional increase in real returns to labour. The returns to non-labour real value added in agriculture are the highest, reflecting the relatively large share of land in this industry. Land is a fixed factor even in the long run, so the increased profitability of agriculture increases returns to land. Not all of the increase in the value added to capital, however, would accrue to domestic capital. In the absence of knowledge about the extent to which the increased capital assets have been financed by residents of foreign countries and the extent to which the GDP growth accrues to this group, an increase in employment levels may provide a supplementary criterion for assessing improvement in the material welfare of the people of Bangladesh. Table 7.5 indicates that the increase in aggregate employment is quite significant. Both agriculture and non-agriculture employment has increased.

Exchange rate unification and elimination of import controls

The short- and long-run effects of these two policy experiments on macro aggregates, sectoral prices and output, and real returns to factors are presented in Tables 7.7 to 7.9. Since the import scarcity premium is defined in the model to be inclusive of the foreign exchange premium (as drawn in Figure 5.1), for a number of commodities, elimination of import scarcity premium implies partial elimination of exchange rate difference. For example, if for some commodity the exchange rate premium accounts for 80 per cent of the total import premium, the exchange rate unification column should ideally report the effects of unification plus an 80 per cent reduction in the import scarcity premium on that commodity, and the import control elimination column should report the effects of the remaining 20 per cent reduction in the import scarcity premium for that commodity - the component due to import controls, over and above exchange controls. However, since data on the proportion of foreign exchange premium and import scarcity premium in the total scarcity premium are missing, the numbers in the exchange rate unification column report the results for unification of exchange rates alone. Also, the numbers in elimination of import premia column report the effects of a 100 per cent removal of the import premia.

The result of each experiment is analyzed separately first, and then in combination.

Exchange rate unification

As the total import scarcity premium includes the foreign exchange premium, exchange rate unification with a constant exchange-premium-inclusive import scarcity premium is in fact equivalent to exchange rate unification with increased absolute stringency of import controls. The ultimate effect of exchange rate unification, keeping sufficient import controls in place to keep the scarcity premium in imports constant, is that the two rates move in opposite directions: the official rate depreciates and the secondary market rate appreciates.

Table 7.6 **Short- and long-run effects on macro aggregates of exchange rate unification and elimination of import control[a]**

	Short-run			Long-run		
	Exchange rate unification	Import Premia	Total	Exchange rate unification	Import Premia	Total
Real GDP	-0.90	1.86	0.96	-9.72	10.97	1.25
Real absorption	-0.68	-0.88	-1.56	-7.65	6.50	-1.15
Real disposable income	-0.89	-1.15	-2.04	-8.97	7.33	-1.64
Real import	-3.87	1.22	-2.65	-10.78	10.00	-0.78
Real export	-11.65	38.17	26.52	-40.07	69.18	29.11
Government borrowing	0.01	-1.17	-1.16	0.77	-1.91	-1.14
Current account	-0.11	2.74	2.63	-0.90	3.35	2.44
Consumer price index	0.02	1.96	1.98	-0.32	2.11	1.79
Official exchange rate	4.11	12.71	16.82	2.67	11.46	14.13
Secondary market exchange rate	-7.09	12.71	5.62	-8.53	11.46	2.93
Aggregate employment	-1.56	4.21	2.65	-8.99	10.65	1.66
Aggregate capital stock	0.00	0.00	0.00	-12.97	14.76	1.79

[a] All projections are expressed in percentage changes except for government borrowing and current account which are percentage points worth of base-period GDP.

The appreciation of the secondary rate adversely affects the profitability of export manufactures that were initially advantaged under the foreign exchange retention scheme. Assistance through the foreign exchange retention scheme is not negligible for the majority of manufactured exports (Table 6 in Appendix C). Unification of exchange rates affects profitability in these industries in two ways. First, the cost of imported inputs rises following the depreciation of the official rate. Second, the export revenue per unit, which is a weighted sum of official and secondary market exchange rates with greater weights for the secondary rate, falls as the secondary rate appreciates. The degree of contraction is in proportion to foreign exchange retention entitlement. Industries with higher retention entitlement suffer more as they experience relatively less increase in revenue. The appreciation of the secondary rate, however, does not weaken profitability in jute and jute textile production since these are not covered under the scheme. As revenue from exports of jute and jute textiles is converted at the official exchange rate, its depreciation improves the profitability of jute exports. The increased export of jute and jute textiles in the event of termination of the dual exchange rate system reflects the discrimination faced by these industries under the current export incentive scheme.

The increased production of raw jute, however, reallocates acreage away from rice production. Given that rice is more intensive in fertilizer use, profitability in rice production is reduced as both the domestic and imported price of fertilizer rises. The direction of overall agricultural production is largely dictated by changes in rice production which account for 67 per cent of agricultural revenue. A 0.22 per cent contraction in rice production as such causes overall agricultural production to decline by 0.04 per cent.

Among the import-competing industries, except for cotton yarn, all other intermediate and capital goods industries register some expansion. This is a result of the increased competitiveness of domestic industries through depreciation of the official exchange rate. The cotton yarn industry has the largest linkage with the domestic textile industry, and hence

Table 7.7 **Short- and long-run effects on industry output levels of exchange rate unification and elimination of import control[a]**

	Short-run			Long-run		
	Exchange rate unification	Import premia	Total	Exchange rate unification	Import premia	Total
All crops	**-0.04**	**-0.10**	**-0.14**	**-6.06**	**5.76**	**-0.30**
Rice	-0.22	-0.50	-0.72	-5.35	4.46	-0.89
Jute	1.60	4.48	6.08	-10.16	16.86	6.70
Other	0.11	0.08	0.19	-7.00	6.92	-0.08
Wheat	2.09	5.82	7.91	-8.50	14.94	6.44
Grains	1.50	5.04	6.54	-6.81	12.28	5.47
Oils	1.54	-5.88	-4.34	-12.29	-6.74	5.55
Feeds	0.58	2.65	3.23	-8.51	10.76	2.25
Sugarcane	0.25	-1.66	-1.41	-13.41	-11.56	1.85
Vegetables	-0.38	-0.35	-0.73	-4.50	-3.91	0.59
Fruits	-0.46	-2.77	-3.23	-7.72	-4.61	3.11
Cotton	-3.08	28.40	25.32	-27.51	248.07	0.56
Tobacco	-0.38	-2.96	-3.34	-12.55	-9.18	3.37
Manufacturing for exports	**-5.29**	**15.43**	**10.14**	**-26.55**	**39.56**	**13.01**
Tea	-0.86	3.62	2.76	-8.13	16.13	8.00
Fishery	-5.09	11.57	6.48	-22.39	27.03	4.64
Leather	-7.16	17.29	10.13	-55.01	71.76	16.75
Textiles	10.59	22.72	-12.13	-32.48	41.17	8.69
Jute textiles	4.04	11.93	15.97	-4.86	41.01	36.15
Manufacturing for import substitution	**-3.15**	**7.01**	**3.86**	**-16.31**	**18.74**	**2.43**
Livestock	-0.73	-0.71	-1.44	-9.67	-7.90	1.77
Poultry	-0.95	-0.50	-1.45	-10.69	-8.75	1.94
Dairy	-0.24	-5.03	-5.27	-14.42	-5.65	8.77
Forestry	0.04	-1.62	-1.58	-10.37	-8.32	2.05
Cotton yarn	-9.17	23.04	13.87	-31.79	42.55	10.76
Textiles	10.59	22.72	-12.13	-32.48	41.17	8.69
Paper	-0.29	1.02	0.73	-8.56	8.86	0.30
Fertilizer	0.50	-0.08	0.42	-4.96	5.98	1.02
Chemical	0.28	1.34	1.62	-13.19	14.72	1.53
Cement	0.00	0.00	0.00	-5.10	-2.99	-8.09
Steel	0.96	0.82	1.78	-4.70	8.48	3.78
Machinery	1.26	-0.05	1.21	-4.87	5.94	1.07
Wood & other	1.17	-7.35	-6.18	-6.03	-1.60	-7.63
Services	**-0.77**	**1.27**	**0.50**	**10.04**	**-9.24**	**0.80**
Urban housebuilding	-0.01	0.02	0.01	13.61	-12.16	1.45
Rural housebuilding	0.00	0.00	0.00	-12.65	14.32	1.67
Other building	-0.03	0.05	0.02	-4.01	4.56	0.55
Electricity	-0.25	1.85	1.60	-4.01	6.86	2.85
Housing	0.00	0.00	0.00	-6.23	5.21	-1.02
Public administration	-0.32	-0.01	0.31	-3.14	2.78	-0.36
Trade & transport	-1.29	2.18	0.89	-12.64	13.87	1.23

[a] All projections are expressed in percentage changes.

contracts approximately in similar proportion to the contraction in the latter. The shrinking of livestock, poultry and dairy industries are a direct outcome of a reduced spending effect arising from reduced disposable income.

Reduced production activities and final demand bring about a reduction in service industries. Again, the decline is most noticeable for the trade and transport sector which has the largest linkage with the traded sector.

The overall effect of contraction in domestic production activities is a decline in real GDP. Real disposable income is reduced as real GDP declines. As Table 7.8 indicates, non-agricultural employment and real non-agricultural value added both decline. The only factor of production that gains in this experiment is agricultural labour. Labour employment rises as a direct consequence of jute acreage expansion which is more labour-intensive than rice. The small increase in the consumer price index is offset by the relatively larger gain in employment leading to a rise in real labour value added in agriculture.

In the long run, the contractionary effects of exchange rate unification are larger, pervading all industries. An exogenous rate of return to capital, equal across industries, causes a decline of capital stock in industries that are not profitable in the short run. Consequently, capital accumulation falls in all export industries except for jute textiles, import-competing industries such as livestock, poultry, dairy, and wood, and all service industries. The contraction in these industries brings about a decline in both domestic and import demand of commodities with large linkages to these industries. Import demand is reduced enough to cause a smaller rate of depreciation in

Table 7.8 **Short- and long-run effects* on real income and its components of exchange rate unification and elimination of import control[a]**

	Short-run			Long-run		
	Exchange rate unification	Import Premia	Total	Exchange rate unification	Import Premia	Total
Real disposable income	-0.89	-1.15	-2.04	-8.97	7.33	-1.64
Farm	-0.04	0.09	0.05	-7.78	8.01	0.23
Non-farm	-1.42	-1.92	-3.34	-9.72	6.89	-2.83
Real agricultural value added	-0.07	0.06	-0.01	-7.91	8.10	0.19
Labour	0.13	-0.85	-0.72	-4.55	5.32	0.77
Non-labour	-0.26	0.92	0.66	-11.07	10.72	-0.36
Real non-agr value added	-2.45	4.00	1.55	-16.78	20.12	3.34
Labour	-2.77	4.39	1.62	-12.05	14.33	2.28
Non-labour	-2.12	3.60	1.48	-11.00	13.39	2.39
Labour employment	-1.56	4.21	2.65	-8.99	10.65	1.66
Agriculture	0.15	1.11	1.26	-4.55	5.32	0.77
Non-agriculture	-2.75	6.35	3.60	-12.05	14.32	2.27
Capital Stock	0.00	0.00	0.00	-12.97	14.76	1.79
Agriculture	0.00	0.00	0.00	-13.20	12.92	-0.28
Non-agriculture	0.00	0.00	0.00	-12.90	15.30	2.39

[a] All projections are expressed in percentage changes.

* Figures are deflated using consumer price index.

the official rate relative to the rate of depreciation in the short run. Thus, the appreciation in the secondary market exchange rate is larger than it is in the short run, leading to further contraction in export industries. Jute textiles, the only export industry that experiences expansion in the short run, can no longer maintain its competitiveness as the jute price increases by over three times the official exchange rate depreciation. The contraction of the majority of industries in the economy generates contractionary effects to the remaining industries. The reduced production activity causes a ten times larger decline in real income and real GDP in the long run.

A point to note is that, as discussed in the beginning of this section, the numbers in the exchange rate unification column do not represent the full effects of the experiment. To obtain a comprehensive picture of this experiment, a part of the results of import control elimination should be added to it. As the outcome of import control elimination is markedly positive for most of the variables (discussed in the following section), the actual outcome of exchange rate unification is better than what the model suggests. If, for example, the general foreign exchange scarcity contributes to 50 per cent of total scarcity premia, half of the values for changes in variables in the import premia elimination column should be added to corresponding variables in the exchange rate unification column to give the full effect of exchange rate unification. The consequent changes would be positive for most of the variables. At the same time, the changes in import control elimination, though still in the same direction, would be less pronounced than the figures suggest.

Elimination of import controls

With the elimination of import control, both exchange rates depreciate in the short and long run. The official rate depreciates as an outcome of increased demand for imports as they become cheaper with the removal of scarcity premia. The constant exchange rate ratio generates a depreciation of a similar value for the secondary market rate. Although production cost increases as imports and their domestic substitutes become dearer because of the depreciation, the depreciation of both exchange rates results in an increased competitiveness of domestic trade-exposed industries. Consequently, export volumes rise at a spectacular rate, leading to a marked improvement in the current account balance. Part of this improvement is because Bangladesh is a small country in the world market for many of its exportables. The model assumes high export demand elasticities for 37 per cent of its exports. Pagan and Shannon (1987) argued that, for tariff reductions, expansion in the export sector depended more on export supply elasticities than export demand elasticities in the short run. As demonstrated in Chapter 6 (Table 6.1), short-run supply elasticities for all export goods are quite low except for the clothing industry. The relatively high supply elasticity for the labour-intensive clothing industry is justified, given the low wage availability of labour in Bangladesh. The spectacular increase in exports is therefore an indication of the impeding effects of macro and trade policies in the development of a highly competitive agro-based export sector.

Competitiveness also increases in import-competing industries, as depreciation gives them an edge over foreign products. As a result, these industries expand along with service industries which usually follow the trend in GDP.

Along with the current account, the budgetary situation also improves, the two important contributors being tax receipts from foreign trade and the local currency value of foreign aid. Elimination of import controls raises import demand as imports become cheaper, thereby raising tariff revenue. Increased exports, on the other hand, generate higher revenue receipts from export tax. The increased local currency value of foreign aid is due to the depreciation of the exchange rate.

The expansion in export activities in the long run is markedly larger than it is in the short run, as a result of increased capital accumulation in these industries.

Although aggregate real disposable income and its components show a highly positive trend in the long run, in the short run, real disposable income falls. The decline is due to reduced real income accrued to non-farm households as real farm income exhibits a positive change. Among the sources of non-farm income, value added components and remittance receipts improve. The latter is a result of secondary market exchange rate depreciation. Food subsidies not being affected significantly with this policy reform, the fall in non-farm income is due to a 100 per cent fall in premia income, which accounts for 6.5 per cent of non-farm income. In the long run, the substantial increase in value added income outweighs the negative effect due to the fall in premia income.

Combined effects of the elimination of import controls and the unification of exchange rates

Given the data limitations that make it impossible to show separately the exclusive effects of the elimination of import control and unification of exchange rates, the combined results are interesting in providing the full effects of the two experiments taken together. From the perspective of policy reforms, the combination is important. Among the group of more general policy reforms, these two experiments are crucial to affecting an open-development strategy.

As appears from Table 7.6, all macro aggregates except for real absorption and real disposable income exhibit an improvement in both the short and long run. Elimination of import controls initially raises import demand and shifts the import demand curve to the right. A rise in import demand raises the price of both rates of foreign exchange, and unification of exchange rates brings about a larger depreciation of the official rate. The result is increased competitiveness of domestic trade-exposed industries causing an expansion of export- and import-competing industries. Although the trade liberalization initially raises import demand, the depreciation of the exchange rates discourages imports. Reduced imports and increased exports lead to an improvement in the current account balance. Also, government borrowing requirements decrease, mainly because of increases in the local currency value of foreign receipts following from exchange rate depreciation and because of increases in taxes from export revenue.

The expansion of trade-exposed domestic manufacturing industries is evident from Table 7.7. In the case of agriculture, the overall contraction is due to reduced rice production resulting from acreage reallocation in favour of export-oriented jute whose profitability has increased.

Although aggregate real disposable income and real absorption decline, a disaggregation of aggregate disposable income in Table 7.8 indicates that in both time horizons, real returns to all factors remain positive in agriculture and non-agriculture, except for real returns to agricultural labour in the short run and real returns to agricultural land and capital in the long run. In the short run, although overall agricultural production declines because of decreased rice production, agricultural employment increases because of increased jute acreage. However, the increase in employment is more than offset by the increase in the consumer price index resulting in a fall in real labour income in agriculture. The real non-labour factor income component of agricultural value added is positive and this almost makes up for the loss in agricultural value added caused by real labour income. In the long run, the returns to non-labour factors in agriculture is brought about by reduced capital stock. However, positive real value added to labour dominates and causes an improvement in aggregate real value added to agriculture. In non-agricultural sectors, real returns to all the production factors are positive in both the short and long run. Thus, the fall in the real disposable income accrued to non-farm households as well as aggregate real disposable income is entirely due to the non-value added component of the non-farm income, the premia income, which disappears in this combined case of premia removal and exchange rate unification.

Policy shocks which have direct effects on relative price structure in agriculture: partial reforms with fertilizer, irrigation, and food subsidy policies

The effects of microeconomic policy reforms which directly affect agriculture are presented in Tables 7.10 to 7.12.

Effects on key macro variables

Table 7.9 **Short- and long-run effects on macro aggregates of removal of agriculture specific subsidies[a]**

	Short-run			Long-run		
	Fertilizer	Irrigation	Food	Fertilizer	Irrigation	Food
Real GDP	0.25	0.07	0.08	-0.42	-0.33	-1.69
Real disposable income	-0.11	-0.07	-0.79	-0.78	-0.46	-2.43
Real import	-0.99	-0.41	-1.37	-2.01	-0.67	-2.11
Real export	1.77	0.61	5.93	-1.30	-0.34	1.88
Government borrowing	-0.27	-0.11	-0.65	-0.25	-0.08	-0.50
Current account	0.34	0.13	0.75	0.32	0.11	0.59
Consumer price index	0.05	-0.01	0.02	0.00	0.00	-0.04
Official exchange rate	0.25	0.11	1.83	-0.22	-0.03	0.71
Secondary market exchange rate	0.25	0.11	1.83	-0.22	-0.03	0.71
Aggregate employment	0.25	0.06	0.43	-0.55	-0.28	-1.32
Aggregate capital stock	0.00	0.00	0.00	-0.61	-0.57	-2.27

[a] All projections are expressed in percentage changes except for government borrowing and current account which are percentage points worth of base-period GDP.

In the short run, each of the partial reforms leading to the withdrawal of agricultural input subsidies and food subsidies brings about an improvement in real GDP, government budget position, current account, aggregate employment and export volume. As all of these subsidies are budget financed, the improvement in budget balance is self explanatory. The improvement in trade balance is an outcome of reduced demand for imports and an increase in exports. In the model data the subsidies on fertilizer and irrigation equipment apply to imported commodities alone. A withdrawal of these subsidies raises the purchaser prices, resulting in reduced demand. In order to keep the per foreign currency unit premium rate and exchange rate ratio constant, a depreciation of both exchange rates is necessary. The depreciation raising competitiveness of domestic industries brings in an improvement in the current account.

The long-run effects are negative in each experiment for all macro aggregates except the budget position and trade account and its components. In the short run, while the fall in the import demand is a movement upward along the demand curve, in the long run, the demand curve itself shifts to the left because of a decline in real disposable income. Real disposable income falls as food subsidies, which are infra-marginal, are withdrawn. It also falls as increased input prices reduce the profitability in agricultural production, reducing employment of factors of production. To keep the premium rate constant the official rate must appreciate, and for a constant exchange rate ratio, the secondary market rate has to appreciate simultaneously. The outcome is a loss of competitiveness of domestic trade-exposed industries, reflected in negative real GDP growth.

The effects on sectoral output levels

The reallocation effects of these policies at sectoral levels are reported in Table 7.10. In the short run, agriculture as a whole has contracted, following all of these policy reforms. A disaggregation by commodities, however, shows that in the case of the withdrawal of fertilizer and irrigation subsidies, the fall in production of import-substituting rice causes this contraction. The removal of fertilizer and irrigation subsidies, in each case, exerts upward pressure on agricultural prices by raising their production cost. As rice is the most sensitive in the model to material input prices, the removal of subsidies in these inputs affects the production of rice most. On the other hand, the expansion in the export-oriented jute textiles industry induced by currency depreciation, pushes up the domestic price of jute. As the net supply elasticity is higher for jute (discussed in tariff cut simulation exercise), jute production increases and rice production declines. In the withdrawal of food subsidies, the demand pull effects operate to cause a decline in rice production. As food subsidies are modelled as infra-marginal, their withdrawal has no direct impact on rice and wheat prices, but affect all demands via income effects. A reduced disposable income affects rice consumption which claims 39 per cent of consumers' budget.

Industries that expand in these three partial price reforms in the short run are all the export industries and some of the import-substituting industries such as cotton yarn, cloth, paper, chemicals, cement, steel, machinery, and wood. Livestock, dairy, and poultry contract in all three cases, reflecting the reduced spending effect due to reduced disposable income. As expected, the fertilizer industry expands significantly when subsidies on imported fertilizer are withdrawn. Similarly, the expansion in domestic machinery industry is more pronounced when subsidies on imported machineries are withdrawn.

As the traded sectors expand by gaining competitiveness through currency depreciation, most of the industries in non-traded sectors lose.

Table 7.10 **Short- and long-run effects on industry output levels of removal of agriculture specific subsidies[a]**

	Short-run			Long-run		
	Fertilizer	Irrigation	Food	Fertilizer	Irrigation	Food
All crops	**-0.11**	**-0.03**	**-0.05**	**-0.70**	**-0.37**	**-1.63**
Rice	-0.15	-0.04	-0.15	-0.60	-0.33	-1.44
Jute	0.07	0.05	0.78	-1.39	-0.68	-2.75
Other	-0.06	-0.01	0.06	-0.81	-1.88	-0.42
Wheat	-0.01	0.05	1.07	-1.33	-0.64	-2.38
Coarse grains	-0.01	0.03	0.76	-1.04	-0.50	-1.91
Oils	-0.07	0.02	0.75	-1.67	-0.83	-3.41
Feeds	0.02	0.00	0.09	-0.95	-0.51	-2.34
Sugarcane	-0.13	-0.03	0.04	-1.57	-0.82	-3.69
Vegetables	-0.06	-0.03	-0.24	-0.45	-0.25	-1.23
Fruits	-0.10	-0.04	-0.31	-0.80	-0.43	-2.11
Cotton	0.99	0.38	4.18	-2.01	-0.85	-1.75
Tobacco	-0.15	-0.05	-0.30	-1.36	-0.73	-3.44
Manufacturing for exports	**0.77**	**0.23**	**1.92**	**-1.20**	**-0.52**	**-1.10**
Tea	0.00	0.06	0.48	-0.15	-0.02	0.47
Fishery	0.61	0.17	1.33	-0.97	-0.46	-1.46
Leather	0.98	0.29	2.35	-1.71	-0.67	-0.50
Textiles	1.21	0.35	2.75	-1.20	-0.51	-0.92
Jute textiles	0.34	0.12	1.66	-1.46	-0.65	-1.40
Manufacturing for import substitution	**0.82**	**0.27**	**1.16**	**0.28**	**-0.21**	**-1.29**
Livestock	-0.01	-0.04	-0.69	-0.82	-0.48	-2.62
Poultry	-0.08	-0.07	-0.83	-0.93	-0.54	-2.90
Dairy	-0.04	-0.06	-0.54	-1.30	-0.75	-3.92
Forestry	-0.13	-0.03	0.04	-0.76	-0.52	-1.98
Cotton yarn	1.17	0.34	2.84	-1.24	-0.52	-0.89
Textiles	1.21	0.35	2.75	-1.20	-0.51	-0.92
Paper	0.00	0.00	0.07	-0.68	-0.37	-1.47
Fertilizer	4.48	-0.23	0.08	15.94	-1.24	-1.31
Chemical	0.13	0.02	0.12	-1.00	-0.66	-2.67
Cement	0	0	0	-0.40	-0.29	-0.83
Steel	0.10	0.15	0.38	-0.42	0.44	-0.80
Machinery	0.18	0.92	0.47	-0.44	1.39	-0.90
Wood & other	0.20	0.07	0.40	-0.49	-0.28	-1.19
Services	**-0.48**	**-0.12**	**0.02**	**0.75**	**-0.51**	**-1.51**
Urban housebuilding	-0.01	0	0	-0.60	-0.53	-2.20
Rural housebuilding	0	0	0	-0.61	-0.55	-2.24
Other building	-0.03	-0.01	0	-0.21	-0.18	-0.70
Electricity	0.13	-0.01	0.24	0.39	-0.23	-0.55
Housing	0	0	0	-0.47	-0.29	-1.68
Public administration	-0.05	-0.03	-0.21	-0.27	-0.16	-0.79
Trade & transport	-0.87	-0.21	0.09	-1.15	-0.74	-1.87

[a] All projections are expressed in percentage changes.

In the long run, the small gain in competitiveness achieved through currency depreciation is no longer available when the fertilizer and irrigation subsidies are withdrawn. As explained earlier, the import demand curve shifts to the left following a fall in real income and production, and a constant exchange rate ratio with constant premium rate results in an appreciation in both exchange rates, generating contraction in the traded sector. The only exceptions are, for obvious reasons, the fertilizer industry in the fertilizer subsidies withdrawal case, and machinery and steel industries in the irrigation subsidies withdrawal case. The contraction in these industries is sufficient to bring about a decline in employment and income which explains the contraction in the livestock, poultry and dairy industries. The decline in spending capacity brings a decline in demand for cereals and other food products. Raw jute production declines as the jute textile industry contracts. In the case of the withdrawal of food subsidies, the contraction in overall domestic production activities, despite the depreciation of the exchange rates, is largely a result of reduced disposable income.

As the service industries usually follow the GDP trend, they contract with the fall in real GDP.

Effects on real income and its components

Aggregate real disposable income has unambiguously fallen in these three cases of partial price policy reforms in both time horizons. The fall is due to reduced agricultural production which is not outweighed by increased production activities in the non-agricultural sector. An examination of the effects of these policy reforms on the components of income reveals some interesting features about equity and distribution issues (Table 7.11).

In the short run, agricultural labour employment increases leading to increased labour value-added despite reduced overall economic activities in the sector. Rice production diminishes following reduced profitability in rice production as input subsidies are withdrawn. The acreage is reallocated in favour of labour-intensive jute which is little affected by these price changes. Also, material inputs and labour being assumed substitutes in the model, an increase in the material price leads to further increase in labour employment. The latter factor, however, does not operate when food subsidies are withdrawn, thus causing a less marked increase in labour employment in this case. However, as labour employment increases, a constant money wage generates increased labour value added, and an increase in material input costs following the withdrawal of input subsidies lead to reduced share of non-labour value added.

Non-agricultural labour employment, on the other hand, decreases as service sector, employing 38 per cent of the labour force, contracts when input subsidies are withdrawn. The contraction occurs mostly in the trade and transport sector which is highly linked with the agricultural sector. The increased economic activities in the manufacturing sector, employing only 22 per cent of the labour force, is not enough to counter the employment effects of contraction in the service sector. In case of withdrawal of food subsidies, the employment effect is positive as both manufacturing and service sector expands. With money wage held constant in the short run, the increase in non-labour value added in non-agricultural sector when fertilizer and food subsidies are withdrawn, and a decrease in it when irrigation subsidies are withdrawn, are reflections of the trends in price changes in the relevant cases.

Table 7.11 **Short- and long-run effects[*] on real income and its components of removal of agriculture specific subsidies[a]**

	Short-run			Long-run		
	Fertilizer	Irrigation	Food	Fertilizer	Irrigation	Food
Real disposable income	-0.11	-0.07	-0.79	-0.78	-0.46	-2.43
Farm	-0.38	-0.01	-1.70	-0.82	-0.37	-3.11
Non-farm	0.06	-0.11	-0.22	-0.75	-0.51	-2.01
Real agricultural value added	-0.38	-0.01	-0.73	-0.84	-0.38	-2.15
Labour	1.11	0.29	0.13	0.00	0.06	-1.23
Non-labour	-1.78	-0.29	-1.54	-1.63	-0.79	-3.02
Real non-agr value added	0.09	-0.11	0.52	-0.75	-0.53	-1.36
Labour	-0.42	-0.08	0.60	-0.56	-0.55	-1.35
Non-labour	0.59	-0.13	0.45	-0.93	-0.52	-1.37
Labour employment	0.25	0.06	0.43	-0.55	-0.28	-1.32
Agriculture	1.16	0.28	0.15	0.00	0.06	-1.23
Non-agriculture	-0.37	-0.09	0.62	-0.93	-0.51	-1.38
Capital Stock	0.00	0.00	0.00	-0.61	-0.57	-2.27
Agriculture	0.00	0.00	0.00	-1.44	-0.75	-3.55
Non-agriculture	0.00	0.00	0.00	-0.37	-0.52	-1.90

[a] All projections are expressed in percentage changes·

[*] Figures are deflated using consumer price index.

The long-run effects on factor payments are negative in all cases of subsidy withdrawal. This is a natural outcome of reduced economic activities in almost all sectors.

Experiments with non-price measures of technological growth and increased investment in agriculture

The short- and long-run estimates of the effects of 10 per cent technological growth in agricultural production and the short-run effects only of an exogenous increase in agricultural capital stock of 10 per cent are presented in Tables 7.13 to 7.15. No experiment was undertaken with increasing capital stock in agriculture in the long run because there is no point in exogenously increasing capital stock in agriculture unless the rate of return warrants it. An exogenous increase in capital stock in agriculture may be appropriate in the short run for equity, for most of the poor are unable to leave agriculture. But in the long run, the answer to better equity and poverty reduction lies in boosting agricultural competitiveness to increase employment within the sector as well as boosting non-agricultural competitiveness to draw surplus labour away from agriculture. Results of experiments presented earlier in the chapter show that reforms such as tariff cuts and the elimination of import controls would be effective in both attracting capital into the agricultural sector and increasing competitiveness of the non-agricultural sector.

Table 7.12 **Effects of non-price measures on macro aggregates[a]**

	Technology		Capital stock
	Short-run	Long-run	Short-run
Real GDP	7.75	17.00	3.30
Real absorption	5.98	13.27	2.70
Real disposable income	7.83	16.34	3.35
real import	0.15	7.01	0.65
Real export	11.85	40.91	3.97
Government borrowing	-0.42	-1.19	-0.17
Current account	0.90	1.75	0.18
Consumer price index	-0.38	-0.04	-0.22
Official exchange rate	7.15	8.69	2.49
Secondary market exchange rate	7.15	8.69	2.49
Aggregate employment	5.46	13.93	4.26
Aggregate capital stock	0.00	12.80	2.26

[a] All projections are expressed in percentage changes except government borrowing and current account which are percentage points worth of base-period GDP.

The short- and long-run results of technological growth in agriculture on each of the macro aggregates are very impressive. The advancement is especially spectacular for real GDP, real disposable income, and employment. In fact, the technological growth shock reemphasizes the fact that agricultural growth is complementary to non-agricultural development. As Table 7.13 demonstrates, a 9.6 per cent growth in overall agriculture brings about a 10 per cent growth in manufactured exports, 6.8 per cent growth in manufactured imports, and 2.4 per cent growth in service industries.

An increase in capital stock in agriculture produces a result similar in direction to that achieved by technological growth in agriculture. A 10 per cent increase in agricultural capital brings about a growth rate of 4 per cent in agriculture, 4 per cent in manufactured exports, 2 per cent in manufactured imports, and 2 per cent in service industries.

A disaggregation of aggregate income in Table 7.14 exhibits a high growth rate of farm and non-farm income with both technological growth and increased investment in agriculture. Income distribution between different functional groups, however, is not of the same direction or magnitude in the two simulations.

In the case of technological growth, income accrued to non-farm households was twice as large the income accrued to farm households. The short-run widening of income disparity seems to narrow down in the long run, with real farm income growing at more than three times the growth rate achieved in the short run. By comparison, non-farm income growth was a little less than double the short-run performance.

Table 7.13 **Effects of non-price measures on industry output levels[a]**

	Technology		Capital stock
	Short-run	Long-run	Short-run
All crops	**9.64**	**15.93**	**4.33**
Rice	9.49	14.72	3.46
Jute	11.69	25.62	9.73
Other	9.66	17.11	5.42
Wheat	17.99	29.07	10.47
Coarse grains	13.85	22.56	8.04
Oils	21.29	35.80	12.22
Feeds	10.87	20.39	5.60
Sugarcane	18.66	33.00	10.50
Vegetables	4.78	9.12	2.61
Fruits	8.84	16.47	4.86
Cotton	27.30	50.62	13.59
Tobacco	15.52	28.31	8.62
Manufacturing for exports	**10.11**	**32.12**	**3.52**
Tea	1.51	6.11	0.37
Fishery	8.97	25.06	2.95
Leather	10.14	50.75	3.01
Textiles	13.42	33.33	4.23
Jute textile	8.47	34.24	4.51
Manufacturing for import substitution	**6.81**	**19.92**	**2.34**
Livestock	7.53	16.91	3.31
Poultry	9.18	19.54	3.93
Dairy	11.13	27.85	4.65
Forestry	2.54	13.15	1.77
Cotton yarn	13.72	34.45	4.47
Textiles	13.42	33.33	4.23
Paper	3.50	12.38	1.34
Fertilizer	-0.53	2.02	0.47
Chemical	5.43	21.39	2.11
Cement	0.00	9.82	0.00
Steel	1.41	9.87	0.63
Machineries	2.38	10.05	0.98
Wood & other	3.55	11.03	1.28
Services	**2.43**	**10.91**	**1.61**
Urban housebuilding	0.04	12.38	1.99
Rural housebuilding	0.00	12.63	2.16
Other building	0.11	4.04	0.71
Electricity	1.73	6.45	0.87
Housing	0.00	9.14	0.00
Public administration	2.39	5.26	1.05
Trade & transport	3.52	14.43	2.18

[a] All projections are expressed in percentage changes.

The short-run regressive effects of technological growth on income distribution was also observed by Hossain (1988) in regard to the impact of the green revolution in Bangladesh. His work, based on micro data of two villages, found that the diffusion of new technology increases the income of all groups of farmers, but also increases agricultural income inequality. As found here, the income increase of the poorest group in Hossain's villages arose from increased labour demand.

Table 7.14 **Effects* of non-price measures on real income and its components[a]**

	Technology		Capital stock
	Short-run	Long-run	Short-run
Real disposable income	7.83	16.34	3.35
Farm	4.92	13.57	1.06
Non-farm	9.66	18.08	4.80
Real agricultural value added	5.00	13.77	1.09
Labour	1.10	6.39	4.54
Non-labour	8.67	20.72	-2.16
Real non-agricultural value added	10.04	19.28	5.07
Labour	11.01	19.43	5.72
Non-labour	9.10	19.13	4.44
Labour employment	5.46	13.93	4.26
Agriculture	0.72	6.39	4.00
Non-agriculture	8.72	19.13	4.22
Capital Stock	0.00	12.80	2.26
Agriculture	0.00	13.92	10.00
Non-agriculture	0.00	12.47	0.00

[a] All projections are expressed in percentage changes.

* Figures are deflated using consumer price index.

The income distribution pattern following from an increase in agricultural capital stock exhibits more regressivity between farm and non-farm income. However, the inequality between aggregate labour and non-labour income appears to improve. Agricultural employment and real returns to agricultural labour improve markedly when capital in agriculture rises. The returns to non-labour factors in agriculture decline as increased capital stock drives down the rate of return to capital.

Comparison of experiments

In the short run, reforms involving full import flexibility and exchange rate unification perform better than each of the partial price reforms in terms of most of the macro aggregates. Growth in real GDP, employment, and exports, and improvement in the government budget position and trade balance are significantly larger when full import flexibility with a unified exchange rate is introduced. The five-fold greater increase in aggregate employment associated with these two policy reforms is strikingly important when a huge labour force is sitting idle, and increasing employment opportunities are a proclaimed objective of the government.

In the long run, the supremacy of full import flexibility with unified exchange rates falters. Most of the gains are smaller than those achieved by a tariff reform. The two exceptions are the government budget position and current account balance. Both the short- and long-run performance of these two variables are significantly better when full import flexibility with unified exchange rates is introduced than in any partial price reform. Given the problem of chronic debt burden of Bangladesh, the government budget position and current account balances demand larger weights when the relative performance of different policies are assessed.

The above comparison suggests the need for a policy package rather than separate partial reforms. For example, elimination of import controls with unified exchange rates may assist in budgetary sustainability of a tariff reform. Table 7.15 presents estimates of two different combinations of policy reforms in terms of a few selected variables. The first set are direct policy reforms, which group agriculture specific policies such as withdrawal of agricultural input subsidies and food subsidies. The second set are indirect policy reforms, which cover tariff reform, exchange rate unification, and elimination of the import scarcity-premium via full import flexibility.

Table 7.15 **Short- and long-run effects of direct and indirect policies on key macro variables[a]**

	Short-run			Long-run		
	Direct	Indirect	All	Direct	Indirect	All
Real GDP	0.40	1.43	1.83	-2.44	10.02	7.58
Agriculture	-0.19	-0.09	-0.28	-2.70	6.12	3.38
Export industries	2.92	12.27	15.19	-2.82	33.20	30.38
Import industries	2.25	4.83	7.08	-1.22	14.70	13.48
Service industries	-0.58	0.88	0.30	-2.77	8.83	6.06
Real absorption	-0.74	-1.05	-1.79	-3.01	5.98	2.97
Real disposable income	-0.97	-1.38	-2.35	-3.67	6.71	3.04
Government borrowing	-1.04	-0.55	-1.59	-0.83	-1.23	-2.07
Current account	1.23	2.51	3.74	1.01	3.00	4.02
Aggregate employment	0.74	3.44	4.18	-2.15	9.37	7.22
Aggregate capital stock	0	0	0	-3.45	14.02	10.57

[a] All projections are expressed in percentage changes except government borrowing and current account which are percentage points worth of base-period GDP.

A comparison of the estimates of direct and indirect reforms shows that assistance to agriculture, granted through sector specific policies, was relatively less effective than negative taxes granted through explicit and implicit assistance extended to import-substituting manufacturing. As the short- and long-run results demonstrate, removal of direct assistance to agriculture causes a decline in agricultural production, 0.2 per cent in the short run and 2.7 per cent in the long run. Agriculture also declines in the short run when assistance to manufacturing is withdrawn. While it is expected that agriculture will decline as the removal of direct assistance reduces profitability of the sector, the short-run negative performance of agriculture as a result of withdrawal of assistance to manufacturing requires an explanation. As import licensing system is abolished and tariffs are reduced, export sector experiences a vigorous growth in the short run, along with an even higher growth in the long run. The largest export item being jute textiles (41 per cent of total export), the growth in exporting sector induces jute acreage to grow at the expense of rice. As rice dominates agricultural production (67 per cent), a decline in rice production translates into a decline in overall agricultural production. In the long run, the competition between rice and jute is absent as increased capital movement into the sector, following indirect policy reforms, makes it possible to have simultaneous expansion of both rice and jute output. The rest of the sectors shows positive improvement in both the time horizons when the indirect policies are reformed, while they all perform negatively except for a short-run improvement in export and import industries when the direct policies are reformed.

If distortions created by macro and trade policies are compared with those created by direct policies, it appears that the former was more influential. A look at the macro variables suggest that indirect policy reforms produce the most desired outcome for both the short and long runs, for the majority of the variables. For example, real GDP increases by 0.25 per cent if the subsidy on fertilizer is completely withdrawn, and there is hardly any improvement if irrigation or food subsidies are removed (Table 7.9). On the other hand, a tariff cut of only 25 per cent brings about a GDP growth of 0.50 per cent (Table 7.1) and a complete removal of import controls with unified exchange rates increases GDP by about 1 per cent. In the long run, all the macro aggregates record significantly high growth in contrast to negative performance with direct policy reforms. The only exceptions are government budget position and current account balance. In the short run, government budget position performs better with direct policy reforms, and the positive change continues in the long run. The short-run positive performance of current account balance also continues in the long run. Hence, a combination of direct and indirect policy reforms may be justified when budget and current account deficits are of serious concern.

In the absence of an explicit treatment of a welfare function in the model, changes in employment and real value added to the factors may provide some insights about welfare implications of these policy reforms. As Table 7.15 suggests, aggregate employment increases in both sets of policy reforms in the short run, but real income and real returns to factors exhibit varied outcome which has important income distribution considerations. Indirect policy reforms have the potential to improve the condition of the poorer people, while direct policy reforms erode the purchasing power of the farmers more drastically. Of course the rise in agricultural value added with indirect policy reforms are at the expense of labour value added which, in contrast, rises with direct policy reforms (Table 7.16). Unlike in the non-farm sector, where poorer sections of the population are more clearly identified with unskilled or blue collar workers, and a relatively larger increase in labour employment and labour value added suggests better equity, such a conclusion is not recommended in the case of the farm sector. Family labour is an important element in farming and an increase in labour employment (defined as person hours in the data) does not necessarily mean more employment to wage workers. Also, a part of the increase in non-labour value added accrues to the small farms who dominate farming activities[1]. Thus in the absence of data on disaggregation of farmers according to income groups, it is not possible to draw conclusions on the short-run income distributional impact of both the direct and indirect policy reforms on the farm households.

Table 7.16 **Short- and long-run effects* of direct and indirect policies on income and its components[a]**

	Short-run			Long-run		
	Direct	Indirect	All	Direct	Indirect	All
Real disposable income	-0.97	-1.38	-2.35	-3.67	6.71	3.04
Farm	-2.09	1.26	-0.83	-4.30	8.36	4.06
Non-farm	-0.27	-3.02	-3.29	-3.27	5.66	2.39
Real agricultural value added	-1.12	1.21	0.09	-3.37	8.44	5.07
Labour	1.53	-1.43	0.10	-1.17	6.00	4.83
Non-labour	-3.62	3.70	0.08	-5.44	10.74	5.30
Real non-agricultural value added	0.51	1.75	2.26	-3.87	16.51	12.64
Labour	0.10	1.92	2.02	-2.82	11.70	8.88
Non-labour	0.91	1.58	2.49	-2.46	11.10	8.64
Labour employment	0.74	3.44	4.18	-2.15	9.37	7.22
Agriculture	1.59	1.45	3.04	-1.17	6.00	4.83
Non-agriculture	0.16	4.80	4.96	-2.83	11.69	8.87
Capital stock	0.00	0.00	0.00	-3.45	14.02	10.57
Agriculture	0.00	0.00	0.00	-5.74	13.88	8.14
Non-agriculture	0.00	0.00	0.00	-2.78	14.06	11.28

[a] All projections are expressed in percentage changes.

* Figures are deflated using consumer price index.

For non-farm sectors, clearly the poorer section has benefited more with indirect policy reforms as both labour employment and labour value added have increased. In fact, non-farm labour employment has increased by around 5 per cent with indirect policy reforms against an increase of 0.2 per cent with direct policy reforms. The industries which have expanded most are export oriented, and export-oriented industries employ a higher

[1] Small farms, defined as farms of size less than 2.5 acres, account for approximately 70 per cent of total farm holdings, and they operate on 30 per cent of total agricultural land (Bangladesh, Bureau of Statistics 1986c)

percentage of blue collar workers (Bangladesh, Bureau of Statistics 1987). Urban-based export manufacturing industries, such as jute textiles and clothing, are intensive in labour use. A bigger expansion in these industries with the indirect reforms generates a larger increase in labour demand, the beneficiaries of which are largely the urban poor.

The welfare implications of increased non-farm employment, brought about by indirect policy reforms, is not confined to urban areas only. Most export industries are located in rural areas. For example, more than 90 per cent of cotton textile employment is in the handloom sector which is traditionally a rural industry. Labourers employed in the fisheries, leather, and tea industries are mostly from rural areas and are in the poorest groups in the community. Studies have shown that landless agricultural workers supplement their income from employment in rural industries (see Hossain 1984a). Hence the welfare of agricultural workers is to a large extent linked with the expansion of employment opportunities in these industries. Hence, it appears that indirect policy reforms would improve the welfare of the people in the lower strata, especially in the long run, when real returns to all factors in both farm and non-farm sectors rise with a higher increase in non-farm labour value added.

While equity is an important issue, the distributional impact of policy reforms is critical for reasons other than equity considerations. The potential losers from a particular reform would be likely to exert considerable pressure to obstruct changes that act against their immediate interest. A further look into real income and its components indicates some possible areas where such pressures may be forthcoming.

In the short run, in contrast to a rise in real returns to all factors, real disposable income falls for the non-farm group with both types of policy reforms. In the case of direct policy reforms, the factor responsible for the fall in disposable income is withdrawal of food subsidies. However, the effect of withdrawal of food subsidies on non-farm income is relatively marginal, only a 0.3 per cent erosion of the purchasing power. A further disaggregation of value added by individual agriculture-specific policy reforms (Table 7.11) indicates that non-farm disposable income in fact rises as fertilizer subsidies are withdrawn, and they fall slightly in each case of withdrawal of irrigation and food subsidies. With indirect policy reforms, as remittance receipts rise with the depreciation of the secondary market exchange rate, the 3 per cent fall in real disposable income is explained exclusively by the loss of premia income from the non-farm income.

The history of indirect policy reforms shows that although periodic tariff reforms were undertaken and there were steps to simplify the import licensing system, there has never been a wide reaching attempt to decontrol the foreign trade regime. Pressure from special interest groups like import license holders who face reduced income following the removal of import controls, would be a factor which explains hesitancy to undertake wide-reaching reforms. Similar, although less significant, is the pressure from the non-farm households if food or irrigation subsidies are withdrawn. A wider-ranging program of reforms, however, has the scope of at least partially compensating many of those who lose. Thus, the increase in non-farm non-labour value added by withdrawal of fertilizer subsidies (Table 7.11) may partially compensate the non-farm capital-owning group for their losses due to import liberalization and may reduce the opposition from the pressure groups.

However, the greatest scope for compensating the losers from price policy reforms as well as raising the purchasing power of the farmers lies in adopting non-price measures of increasing investment and bringing in technological growth in agriculture. In fact, the achievements brought about by the non-price measures far surpasses that attained by the price policy measures for all the variables, except for government budget and current account balance. The growth in terms of real GDP, real income and employment are impressive. Although income inequality increases between farm and non-farm households as a result of increased investment and technological growth in agriculture, the improvement in the absolute poverty situation that follows, deserves special attention.

Technological growth and increased agricultural investment deserve special attention for other reasons. The question of a trade-off between rice and jute production is resolved when either technological growth or an increase in agricultural capital occurs. In all cases of price measures covered under direct and indirect policy reforms, the short-run expansion in aggregate agricultural production is very small, and often negative, reflecting the net result of competition between rice and jute for acreage reallocation. In the long run, when policy shocks such as the reduction of tariffs and the removal of premia create conditions that attract new capital in agriculture, both rice and jute production expands. The same also happens in the short run when capital stock in agriculture improves. The competition between rice and jute is also by-passed when new technology makes it possible to grow more rice and jute on the same land. As discussed in Chapter 2, only about a third of the rice and wheat area suitable for high-yielding varieties is sown with these varieties and the consumption of fertilizer in mid-1980s was only 36 nutrient pounds per acre of land (Osmani and Quasem 1985) against an average of 300 nutrient pounds for neighbouring Asian countries (FAO 1988). The potential for technological diffusion in the country is, therefore, vast.

The discussion in Chapter 2 indicates that the technological development in agriculture requires further development of new technology as well as diffusion of existing modern technology. While development of new technology is largely dependent on agricultural research, the diffusion of modern technology is mainly constrained by the lack of infrastructure such as water management and road transport. The non-availability of irrigation facilities limits the use of modern varieties in the dry season. Continuous deep flooding of a large area in the monsoon season requires flood control simultaneously with research to develop high-yielding seed varieties that can survive in this unfavourable agroclimate. Taking a survey of 1609 villages, Ahmed and Hossain (1990) found that rural infrastructure, namely road transportation and rural electrification, played a strong positive role in the diffusion of small-scale irrigation technology. The `diffusion model' of Ruttan (1984) and Mellor's (1976) perception of the process of economic development are crucially dependent on the development of rural physical and institutional infrastructure.

In conclusion, it can be said that there is hardly any scope for bringing long-run improvement in the economy through direct policy reforms; the achievements are rather negative. There is a much greater scope for indirect policy reforms. If an improvement in the budget position and current account balance is weighted heavily in the evaluation of reforms, a combination of direct and indirect policy reforms would be preferable. Gains could outweigh the potential loss from direct policy reforms if the government were to divert the budgetary savings gained from removing subsidies to investment in agriculture, at least in the short run. In fact, simulation experiments with technological growth and increased investment in agriculture more than justify such a step. If Bangladesh is to achieve technological growth in agriculture, a large investment in water control, agricultural research, and rural infrastructure such as transportation is needed. Although technological growth is not directly an outcome of policy reform, the government can create opportunities for investment to occur in agriculture and thus initiate and expedite the pace of technological development. Simulation experiments with price policy reforms, for example a tariff cut, shows that capital will move into agriculture in the long run as profitability increases. Meanwhile, in the short run, government has a role to play in financing agricultural infrastructure to stimulate private investment by lowering costs and hence improving profitability.

CHAPTER 8

CONCLUSIONS

The main purpose of the study was to estimate the growth and distributional effects of agricultural price policy reforms in Bangladesh. The term agricultural price policy was used to include exchange rate and trade policies that indirectly affect relative agricultural price structures, and sector-specific policies that directly affect it.

A model was developed and used to simulate these effects. The model is essentially a neo-classical general equilibrium model with some adaptations to suit the institutional aspects of the Bangladesh economy. These were import and export premia, a two-tier foreign exchange rate system, and a slack labour market with constant nominal wages in the short run and constant real wages in the long run.

The model simulations experimented with dismantling the incentive structure resulting from existing price policy, so as to uncover the direction the economy would have taken in the absence of these policies. The incentive structure prevalent in 1984-85 was considered because the data were available for this period. The data suggested less distortions in the economy than studies of protection suggest. But the incentive structure was uneven, with rates of assistance highest in import-substituting production, and no assistance in some export activities. Agriculture, which is dominated by import-substituting rice and wheat, enjoyed some degree of assistance in the form of fertilizer and irrigation subsidies. The subsidies directly relevant to agriculture are budgetary subsidies, while assistance to manufacturing mostly takes the form of consumer transfers. In line with government emphasis to phase out agricultural input subsidies gradually, the rate of assistance in agriculture has decreased over time.

An analysis of the effects of agricultural price policy reforms on gross domestic production and industry output indicates that growth in GDP requires increased competitiveness of the domestic economy. An open-development strategy is necessary to exploit the gains from increased competitiveness. The model starts with some degree of openness when it allows a free float of the exchange rates and partial import liberalization. The economy is completely open when, in the long run, capital is assumed to be perfectly mobile with complete liberalization of imports. A comparison of different price policy reforms demonstrates that performance is best when macro and trade policies are reformed, revealing the constraints to growth that have been generated by these policies. Compensation paid to agriculture through budgetary subsidies was not sufficient to offset the negative effects of the indirect policies. The experiments with direct policy reforms alone add to the argument that removing some assistance while maintaining some ultimately leads to more dispersion in the incentive structure generating further inefficiency. The overall higher rate of decline in the long-run economic performance when assistance to agricultural production and food subsidies are withdrawn and assistance to manufacturing is kept constant, indicate the severity of the problem.

Thus, the general policy conclusion argues for an open-development strategy, with agriculture as the focus of development. An agricultural-demand-led-industrialization strategy, advocated by Singer (1979) and later by Adelman (1984), stresses that increased agricultural production leading to increased agricultural income raises the demand for domestic intermediate and consumer goods, thereby moving towards the goal of industrialization. The prerequisite of increased agricultural production is increased capital investment which will be spent on the development of such rural infrastructure as water control, transportation, and agricultural research. In the short run, the required investment could come from reallocation of government development funds. The small size of land holdings and the indivisible nature of much infrastructural investment make government participation in investment inevitable. In the long run, policies should make investment in agriculture profitable to private investors. The results of the model simulation identify the policy environment that attracts private investment in agriculture: reduced tariffs with at least some degree of import liberalization. Complete liberalization would lead to even better performance.

While substantial benefits are to be derived from such macro and trade policy reforms, the model provides a plausible explanation of why they are usually not carried out fully. Partial reforms of tariff and a managed float of exchange rates became frequent in the 1980s in the name of `structural adjustment'. Full import liberalization with a freely floating exchange rate have only rarely been adopted. Income derived from import scarcity premia accrues to non-farm households, creating a vested interest group which lobbies for import controls and tariffs to continue. Reductions of particular agricultural subsidies benefits the non-farm sector, reducing losses of groups that are hurt in the short run by macro and trade policy reforms. The erosion of farmers' purchasing power caused by direct policy reforms cannot however be ignored. If the budgetary savings from withdrawing agricultural subsidies are used to finance increased public investment in agriculture, the farmers' incomes will rise, even in the short run.

The importance of increased investment in agriculture is further emphasized by the limits set by rice-jute trade-offs. Post-independence agricultural growth has been a cereal based development at the expense of non-cereal crops. Jute is the most important of these. Given the continuing dependence of the country's exports on jute, the gains derived from increased food production at the cost of reduced jute production might not be all that rewarding. Finding optimal trade-offs between rice and jute will be easier when technological growth and/or increased agricultural capital investment causes a shift in the aggregate agricultural supply curve.

In conclusion, Bangladesh has a large potential for gains from reforms of macro and trade policies that have indirectly affected relative agricultural prices. However, unless increased investment in agriculture takes place simultaneously, many of the gains will be lost. In the short run, the government will have to assume the responsibility for channelling resources into agriculture. In the long run private investment is likely to follow on a substantial scale, transforming agricultural productivity and the pace of national growth.

Appendix A Price and quantity data used for estimation of output supply and input demand elasticities in agriculture

Year	Rice quantity	Jute quantity	Land quantity	Fertilizer rate	Wage rate	Jute price	Fertilizer price	Rice price	Labour	`Other' crop price	`Other' crop quantity
1970	100	100	100	100	100	100	100	100	100	100	100
1971	92.83	92.98	92.44	108.88	116.16	125.1	100	96.2	102.14	105.56	102
1972	82.73	58.42	86.06	88.19	104.46	133.33	100	126.46	104.28	124.07	75.46
1973	84.06	90.72	88.72	138.38	133.43	170.22	182.14	193.95	106.51	185.19	71.33
1974	99.2	83.54	89.88	136.91	181.89	192.46	272.15	262.8	108.64	363.15	73.2
1975	94.02	76.52	87.5	101.08	244.29	305.28	459.89	528.83	110.78	299.44	86.79
1976	106.31	54.84	90.7	162.7	245.68	328.15	473.91	327.37	112.92	151.11	74.26
1977	97.89	66.93	88.53	181.31	248.75	365.5	567.78	291.4	112.45	161.54	70.78
1978	108.02	74.65	90.73	258.46	262.95	522.24	558.49	369.78	118.96	249.22	75.31
1979	107.04	89.7	97.3	252.74	303.06	440.21	652.36	396.57	119.89	217.3	69.24
1980	106.13	83.07	97.67	283.17	347.08	332.37	835.38	533.4	120.82	206.87	76.53
1981	115.63	68.88	99.35	296.99	389.14	404.81	971.45	461.5	123.61	207.11	74.3
1982	113.54	64.66	99.72	278.76	431.2	440.57	1163.75	577.46	130.11	182.13	73.53
1983	118.42	68.02	101.21	314.9	474.93	641.07	1458.14	630.8	127.32	187.41	74.86
1984	120.85	72.62	100.85	373.67	545.4	686.69	1454.82	688.78	130.11	269.04	79.17
1985	121.8	71.22	99.29	450.42	681.06	1439.61	1677.59	797.77	130.11	193.65	73.54

Appendix A1 Equations of the Bangladesh model

Identifier	Equation	Subscript	Range	Description
I. ***Input and Primary Factor Demand***				
a. Non-agricultural Sectors				
(M.1)	$x^1_{isj} = z_j - \sigma^1_{ij}(p^1_{isj} - \sum_{s=1}^{2} S^1_{isj}p^1_{isj})$	i=1,..,g s = 1,2 j=2,...,h	2g(h - 1)	Demand for intermediate inputs in non-agricultural sector, by source
(M.2)	$x_{vj} = z_j - \sigma_{vj}(p_{vj} - \sum_{v=1}^{3} S_{vj}p_{vj})$	v=1,2,3 j=2,...,h	3(h − 1)	Primary factor demand in non-agricultural production
b. Agricultural Sector				
(M.3)	$q_2 = \sum_{k} \eta_{q2k}p^0_{k1} + \eta_{q2q1}p_1 + \eta_{q2q2}p_2 + \eta_{q2v}p_{vj} + \eta_{q2w}w + \eta_{q2t}t$	k ∈ agriculture v=1, j=1	1	Demand for composite intermediate input for crop production
(M.4)	$x^1_{ij} = q_2$	i=1,..,g j=1	g	Demand for individual intermediate input in crop production, undifferentiated by source
(M.5)	$x^1_{isj} = x^1_{ij} - \sigma^1_{ij}(p^1_{isj} - \sum_{s=1}^{2} S^1_{isj}p^1_{isj})$	i=1,..,g s=1,2 j=1	2g	Demand for individual intermediate input i by source

Appendix A1 **Equations of the Bangladesh model (continued)**

Identifier	Equation	Subscript	Range	Description
(M.6)	$x_{vj} = \sum_{k} \eta_{vk} p^0_{k1} + \eta_{vq1} p1 + \eta_{vq2} p2 + \eta_{vv} p_{vj} + \eta_{vw} w + \eta_{vt} t$	$k \in$ agriculture v=1 j=1	1	Demand for labour in agricultural production
(M.7)	$x_{vj} = w - \sigma_{vj}(p_{vj} - \sum_{v=2}^{3} S_{vj} p_{vj})$	j=1 v=2,3	2	Demand for land and capital in agricultural production
(M.8)	$p_1 = \sum SQ^1_{ij} p^0_{i1}$	i=1,4..,11 j=1	1	Price of composite agricultural commodity `other'
(M.9)	$p_2 = \sum_{i=1}^{g} SQ^2_{ij} p^1_{ij}$	j=1	1	Price of aggregate intermediate input in agricultural production
(M.10)	$p^* = \sum_{v=2}^{3} SQ^3_{vj} p_{vj}$	j=1	1	Price of composite of capital and land used in agricultural production
(M.11)	$p^1_{ij} = \sum_{s=1}^{2} S^1_{isj} p^1_{isj}$	i=1,...,g j=1	g	Aggregate price of intermediate inputs in agricultural production

II. ***Supply of Output***

Identifier	Equation	Subscript	Range	Description
(M.12)	$x_{i1j} = z_j$	i=1,...,g j=2,...,h	g(h − 1)	Supply of commodities in non-agricultural sectors

Appendix A1 **Equations of the Bangladesh model (continued)**

Identifier	Equation	Subscript	Range	Description
(M.13)	$x_{i1j} = \sum_{k}^{g} \eta_{ik} p^0_{k1} + \eta_{iq1} p1 + \eta_{iq2} p_2$ $+ \eta_{iv} p_{vj} + \eta_{iw} w + \eta_{it} t$	$k \in$ agriculture i=2,3 j=1	2	Supply of major crops from agricultural sector
M.14)	$q_1 = \sum_{k=1} \eta_{q1k} p^0_{k1} + \eta_{q1q1} p_1 +$ $\eta_{q1q2} p_2 + \eta_{q1v} p_{vj} + \eta_{q1w} w + \eta_{q1t} t$	j=1, v=1	1	Supply of composite crop `other' from agricultural sector
(M.15)	$x_{i1j} = q_1 + \sigma_q (p^0_{i1} - p_1)$	i=1,4,...,11 j=1	9	Supply of individual commodities in `other' agricultural category
III. *Final Demand*				
(M.16)	$x^3_i = \varepsilon_i c + \sum_{k=1}^{g} \mu_{ik} p^3_k$	i=1,..,g	g	Household demand for commodities undifferentiated by source
(M.17)	$p^3_i = \sum_{s=1}^{2} Q^3_{is} p^3_{is}$	i=1,...,g	g	Consumers' price undifferentiated by source
(M.18)	$x^3_{is} = x^3_i - \sigma^3_i (p^3_{is} - \sum_{s=1}^{2} Q^3_{is} p^3_{is})$	i=1,..,g s=1,2	2g	Household demand for commodities by source
(M.19)	$x2_{iH} = k$	i=1,..,g	g	Private demand for investment goods undifferentiated by source
(M.20)	$x^2_{isH} = x^2_{iH} - \sigma^2_{iH} (p^2_{is} - \sum_{s=1}^{2} Q^2_{isH} p^2_{is})$	i=1,...,g s=1,2	2g	Private demand for investment goods by source

Appendix A1 **Equations of the Bangladesh model (continued)**

Identifier	Equation	Subscript	Range	Description
(M.21)	$x^5_i = c^r h^5_i + f^5_i$	i=1,...,g	g	Government demand for consumption goods undifferentiated by source
(M.22)	$x^5_{is} = x^5_i - \sigma^5_i (p^3_{is} - \sum_{s=1}^{2} Q^5_{is} p^3_{is})$	i=1,...,g s=1,2	2g	Government demand for consumption goods by source
(M.23)	$x^2_{iG} = k.h^2_i + f^2_i$	i=1,...,g	g	Government demand for investment goods undifferentiated by source
(M.24)	$x^2_{isG} = x^2_{iG} - \sigma^2_{iG}(p^2_{is} - \sum_{s=1}^{2} Q^2_{isG} p^2_{is})$	i=1,...,g s=1,2	2g	Government demand for investment goods by source
(M.25)	$p^e_{i1} = -\gamma_i x^4_{i1} + f^4_{i1}$	i=1,...,g	g	Export demands
IV. *Market Clearing*				
(M.26)	$x_{i1} = \sum_{j=1}^{h} B^1_{i1j} x^1_{i1j} + B^2_{i1H} x^2_{i1H} + B^2_{i1G} x^2_{i1G} + B^3_{i1} x^3_{i1} + B^4_{i1} x^4_{i1} + B^5_{i1} x^5_{i1}$	i=1,...,g	g	Total demand for domestically produced good i
(M.27)	$x_{i1} = \sum_{j=1}^{h} D_{i1j} x_{i1j}$	i=1,...,g	g	Total supply of good i from domestic sources
(M.28)	$l = \sum_{j=1}^{h} B_{vj} x_{vj}$	v=1	1	Aggregate employment
(M.29)	$k = \sum_{j=1}^{h} B_{vj} k_j$		1	Aggregate capital stock
(M.30)	$k_j = x_{vj}$	v=2 j=1,...,h	h	Equilibrium in capital market

Appendix A1 **Equations of the Bangladesh model (continued)**

Identifier	Equation	Subscript	Range	Description
(M.31)	$n_j = x_{vj}$	v=3 j=1,...,h	h	Equilibrium in land market
V. *The Price System*				
(M.32)	$\sum_{i=1}^{g} H^0_{i1j} p^0_{i1} = \sum_{i=1}^{g} \sum_{s=1}^{2} H^1_{isj} p^1_{isj} + \sum_{v=1}^{3} H_{vj} p_{vj}$	j=2,...,h	h-1	Zero pure profits in non-agricultural production
(M.33)	$\sum_{i=1}^{g} H^0_{i1j}(p^0_{i1} + x_{i1j})$ $= \sum_{i=1}^{g}\sum_{s=1}^{2} H^1_{isj}(p^1_{isj} + x^1_{isj}) + \sum_{v=1}^{3} H_{vj}(p_{vj} + x_{vj})$	j=1	1	Zero pure profits in agricultural production
(M.34)	$\pi = \sum_{i=1}^{g}\sum_{s=1}^{2} H^2_{isH} p^2_{is} + \sum_{i=1}^{g}\sum_{s=1}^{2} H^2_{isG} p^2_{is}$		1	Zero pure profits in capital creation
(M.35)	$p^0_{i2} = p^m_{i2} + \phi_1 + T1_i . t_i + T2_i . sp_i$	i=1,...,g	g	Zero pure profits in importing
(M.36)	$p^e_{i1} + S^1_i \phi_2 + (1 - S^1_i)\phi_1 +$ $(S^1_i - SAL_i(1 - S^1_i))a_i = p^0_{i1} + es_i$	i=1,...,g	g	Zero pure profits in exporting
(M.37)	$p^3_{is} = p^0_{is} + g^3_{is}$	i=1,...,g s=1,2	2g	Price of consumption goods by source
(M.38)	$p^2_{is} = p^0_{is} + g^2_{is}$	i=1,...,g s=1,2	2g	Price of investment goods by source

Appendix A1 **Equations of the Bangladesh model (continued)**

Identifier	Equation	Subscript	Range	Description
(M.39)	$p^1_{isj} = p^0_{is} + g^1_{isj}$	i=1,...,g s=1,2 j=1,..,h	2gh	Price of intermediate inputs by source
(M.40)	$ry = S_f(y_{ft} + t_{fy}) + (1 - S_f)(y_{nft} + t_{nfy})$		1	Revenue from income tax
(M.41)	$rt = \sum_{i=1}^{g} ST_i(x_{i2} + p^m_{i2} + \phi_1 + \sum_{i=1}^{g} S_i t_i)$		1	Tariff revenue
(M.42)	$rs1 = \sum_{j=1}^{h}\sum_{i=1}^{g}\sum_{s=1}^{2} RR^1_{isj}\{(x^1_{isj} + p^0_{is}) + R^1_{isj}g^1_{isj}\}$		1	Revenue from tax on intermediate goods
(M.43)	$rs2 = \sum_{i=1}^{g}\sum_{s=1}^{2} RR2_{is}\{(p^0_{is} + R2_{isH}x^2_{isH} + R2_{isG}x^2_{isG} + R2_{is}g^2_{is}\}$		1	Revenue from tax on investment goods
(M.44)	$rs3 = \sum_{i=1}^{g}\sum_{s=1}^{2} SSEX_{is}\{(EX^3_{is}x^3_{is} + EX^5_{is}x5_{is} + p^0_{is} + SEX_{is}g^3_{is}\}$		1	Revenue from tax on consumption goods
(M.45)	$rexp = \sum_{i=1}^{g} SET_i(x^4_{i1} + p^0_{i1} + SE_i es_i)$		1	Revenue from export tax

Appendix A1Equations of the Bangladesh model (continued)

Identifier	Equation	Subscript	Range	Description
(M.46)	$ps = \sum_{i=1}^{g} SH\{x_{i2} + p^m_{i2} + r_i + PRS_2\phi_2 - (PRS_2 - 1)\phi_1\}$		1	Procceds from sale of foreign exchange at secondary market scheme rate
(M.47)	$rem = rm + \phi_1$		1	Remittances receipts by government
(M.48)	$ro = gdp$		1	Other tax revenue
(M.49)	$gr = R1.ry + R2.rt + R3.rs1 + R4.rs2 + R5.rs3 + R6.rexp + R7.ps + R8.ro + R9(fa + \phi_1) + R10(rm + \phi_1)$		1	Total revenue earnings
(M.50)	$gc = \sum_{i=1}^{g}\sum_{s=1}^{2} S5_{is}(x^5_{is} + p^3_{is})$		1	Government current expenditure
(M.51)	$gi = \sum_{i=1}^{g}\sum_{s=1}^{2} S2_{isG}(x^2_{isG} + p^2_{is})$		1	Government capital expenditure
(M.52)	$fs = \sum_{i=1}^{2} SFS_i(p^3_i + x^q_i - RRP_i e^q_i)$		1	Food subsidy
(M.53)	$rs = \sum_{i=1}^{g} SRS_i\{x^4_{i1} + p^e_{i1} + a_i + PRS_2\phi_2 - (PRS_2 - 1)\phi_1\}$		1	Subsidy to exportes under export performance licensing scheme
(M.54)	$er = rm + \phi_2$		1	Expenditure on remittances payment

Appendix A1 **Equations of the Bangladesh model (continued)**

Identifier	Equation	Subscript	Range	Description
(M.55)	$oe = h1g.gdp + fg$		1	Other expenditure
(M.56)	$ge = R11.gc + R12.gi + R13.fs + R14.rs + R15.er + R16.oe$		1	Total expenditure
(M.57)	$100\,\Delta GB = GE.ge - GR.gr$		1	Government borrowing requirement
VII. ***Foreign Trade***				
(M.58)	$x_{i2} = \sum_{j=1}^{h} B^1_{i2j}x^1_{i2j} + B^2_{i2H}x^2_{i2H} + B^2_{i2G}x^2_{i2G} + B^3_{i2}x^3_{i2} + B^5_{i2}x^5_{i2}$	i=1,..,g	g	Import volume
(M.59)	$m = \sum_{i=1}^{g} M_{i2}(p^m_{i2} + x_{i2})$		1	Foreign currency value of imports
(M.60)	$e = \sum_{i=1}^{g} E_{i2}(p^e_{i1} + x^4_{i1})$		1	Foreign currency value of exports
(M.61)	$100\,\Delta CA = A1.e + A2.fa + A3.rm - A4.m$		1	Current acount balance

Appendix A1 **Equations of the Bangladesh model (continued)**

Identifier	Equation	Subscript	Range	Description
VIII. *GDP and Miscellaneous*				
(M.62)	$a^r = SA1\sum_{i=1}^{g}\sum_{s=1}^{2} S^3_{is}x^3_{is} + SA2_H\sum_{i=1}^{g}\sum_{s=1}^{2} S^2_{isH}x^2_{isH} + SA2_G\sum_{i=1}^{g}\sum_{s=1}^{2} S^2_{isG}x^2_{isG} + SA5\sum_{i=1}^{g}\sum_{s=1}^{2} S^5_{is}x^5_{is}$		1	Aggregate real absorption
(M.63)	$gdp^r = SG1\sum_{i=1}^{g}\sum_{s=1}^{2} S^3_{is}x^3_{is} + SG2_H\sum_{i=1}^{g}\sum_{s=1}^{2} S^2_{isH}x^2_{isH} + SG2_G\sum_{i=1}^{g}\sum_{s=1}^{2} S^2_{isG}x^2_{isG} + SG3\sum_{i=1}^{g}\sum_{s=1}^{2} S^5_{is}x^5_{is} + SG4\sum_{i=1}^{g} S^4_{i1}x^4_{i1} - SG5\sum_{i=1}^{g} M_{i2}x_{i2}$		1	Real GDP
(M.64)	$pgdp = SG1\sum_{i=1}^{g}\sum_{s=1}^{2} S^3_{is}p^3_{is} + SG2_H\sum_{i=1}^{g}\sum_{s=1}^{2} S^2_{isH}p^2_{is} + SG2_G\sum_{i=1}^{g}\sum_{s=1}^{2} S^2_{isG}p^2_{is} + SG3\sum_{i=1}^{g}\sum_{s=1}^{2} S^5_{is}p^3_{is} + SG4\sum_{i=1}^{g} E_{i2}(p^e_{i1} + \phi_1) - SG5\sum_{i=1}^{g} M_{i2}(p^m_{i2} + \phi_1)$		1	GDP deflator

Appendix A1 **Equations of the Bangladesh model (continued)**

Identifier	Equation	Subscript	Range	Description
(M.65)	$gdp = gdp^r + pgdp$		1	Nominal GDP
(M.66)	$y_{ft} = V_f \sum_{v=1}^{3} y_{fj}(x_{vj} + p_{vj}) + V_{ef}(oe + v)$		1	Aggregate taxable farm income
(M.67)	$y_{fd} = VY_{ft}(y_{ft} - ST_{fy}.t_{fy}) + + V_{fs}(fs + b) - V_{rf}(ro + u)$		1	Aggregate disposable farm income
(M.68)	$y_{nft} = V_{nf} \sum_{j=1}^{h} \sum_{v=1}^{3} y_{nfj}(x_{vj} + p_{vj}) + V_{enf}(oe - S_e.v) + S_{ysp}.ysp$		1	Aggregate taxable non-farm income
(M.69)	$SY1.ysp + SY2.ps = \sum_{i=1}^{g} SSP_i(x_{i2} + p^m_{i2} + \phi_1 + SP1_i.sp_i)$		1	Distribution of Scarcity premia
(M.70)	$y_{nfd} = VY_{nft}(y_{nft} - ST_{nfy}.t_{nfy}) + V_{nfs}(fs - S_f.b) - V_{rnf}(ro + S_r.u) + V_r.er$		1	Aggregate disposable non-farm income
(M.71)	$y_d = SHf.y_{fd} + (1 - SHf)y_{nfd}$		1	Aggregate income
(M.72)	$c = y_d + f_c$		1	Aggregate consumption function

Appendix A1 **Equations of the Bangladesh model (continued)**

Identifier	Equation	Subscript	Range	Description
(M.73)	$c^r = c - \varepsilon^3$		1	Real consumptiopn
(M.74)	$\varepsilon^3 = \sum_{i=1}^{g}\sum_{s=1}^{2} S^3_{is} p^3_{is}$		1	Consumers' price index
(M.75)	$r_j = Q_j(p_{vj} - \pi)$	j=1,...,h v=2	h	Industry rate of return
(M.76)	$p_{vj} = h^1_j \varepsilon^3 + f^1 + f^1_j$	v=1 j=1,...,h	h	Wage setting
(M.77)	$d = \phi_2 - \phi_1$		1	Extent of currency overvaluation
TOTAL			**5gh + 24g + 8h + 54**	

Appendix A2 **The model variables**

Variables	Subscript range	Number	Description
x^1_{isj}	$i = 1,...,g$ $j = 1,...,h$ $s = 1,2$	2gh	Intermediate input demand in industry j by source
p^1_{isj}	$i = 1,...,g$ $j = 1,...,h$ $s = 1,2$	2gh	Purchasers' price of intermediate input for current production, by source
z_j	$j = 2,...,h$	h-1	Industry activity level in non-agriculture
x_{vj}	$v = 1,2,3$ $j = 1,...,h$	3h	Primary factor demand in industry j
p_{vj}	$v = 1,2,3$ $j = 1,...,h$	3h	Price of primary factors to industry j
x_{i1j}	$i = 1,..,g$ $j = 2,...,h$ $i = 1,4,...11$ if $j = 1$	g(h-1)+11	Supply of individual commodity i by industry j
q_1		1	Supply of composite crop `other'
q_2		1	Demand of composite input
x^1_{ij}	$i = 1,...,g$ $j = 1$	g	Intermediate input demand in crop production
p^0_{is}	$i = 1,...,g$ $s = 1,2$	2g	Producer price of output
p_1		1	Producer price of composite output

Appendix A2 **The Model Variables (continued)**

Variables	Subscript range	Number	Description
p_2		1	Purchasers' price of composite input
p^*		1	Price of composite of land and capital
w		1	Composite of capital and land
t		1	Technology
p^1_{ij}	$i = 1,...,g$ $j = 1$	g	Price of inputs to farmers, undifferentiated by source
x^3_i	$i = 1,...,g$	g	Household demands for commodities by type, undifferentiated by source
p^3_i	$i = 1,...,g$	g	Purchasers' price for consumer goods by type, undifferentiated by source
c		1	Aggregate household consumption expenditure
x^3_{is}	$i = 1,...,g$ $s = 1,2$	2g	Household demands for commodities by type and by source
p^3_{is}	$i = 1,...,g$ $s = 1,2$	2g	Purchasers' price for consumer goods by type and source
x^2_{iH}	$i = 1,...,g$	g	Private investment demands by type, undifferentiated by source
x^2_{isH}	$i = 1,...,g$ $s = 1,2$	2g	Private investment demands by type and source

Appendix A2 **The Model Variables (continued)**

Variables	Subscript range	Number	Description
p^2_{is}	$i = 1,...,g$ $s = 1,2$	2g	Purchasers' price of investment goods by type and source
x^2_{iG}	$i = 1,...,g$	g	Government investment demands by type undifferentiated by source
x^2_{isG}	$i = 1,...,g$ $s = 1,2$	2g	Government investment demands by type and source
x^5_i	$i = 1,...,g$	g	Government current expenditure on good i, undifferentiated by source
x^5_{is}	$i = 1,...,g$ $s = 1,2$	2g	Government current expenditure on good i, by source
f^5_i	$i = 1,...,g$	g	Shift term in government current expenditure
f^2_i	$i = 1,...,g$	g	Shift term in government capital expenditure
p^e_{i1}	$i = 1,...,g$	g	Foreign currency price of export
x^4_{i1}	$i = 1,...,g$	g	Export demand
f^4_{i1}	$i = 1,...,g$	g	Shift term in export demand
x_{i1}	$i = 1,...,g$	g	Aggregate supply of ith commodity
k_j	$j = 1,...,h$	h	Industry capital stock

Appendix A2 **The Model Variables (continued)**

Variables	Subscript range	Number	Description
n_j	j = 1,...,h	h	Use of land in each industry
l		1	Aggregate employment
k		1	Aggregate capital stock
π		1	Unit cost of capital creation
$p^m{}_{i2}$	i = 1,...,g	g	Foreign currency price of import
Φ_1		1	Official exchange rate
Φ_2		1	Secondary market exchanmge rarte
t_i	i = 1,...,g	g	One plus ad valorem tariff rate
sp_i	i = 1,...,g	g	One plus rate of scarcity premium
a_i	i = 1,...,g	g	Foreign exchange retention partameter
es_i	i = 1,...,g	g	One plus ad valorem export tax rate or one minus ad valorem export subsidy rate
$g^3{}_{is}$	i = 1,...,g s = 1,2	2g	One plus (minus if subsidy) ad valorem tax rate on sale of consumption goods
$g^2{}_{is}$	i = 1,...,g s = 1,2	2g	One plus (minus if subsidy) ad valorem tax rate on sale of investment goods

Appendix A2 **The Model Variables (continued)**

Variables	Subscript range	Number	Description
g^1_{isj}	$i = 1,...,g$ $s = 1,2$ $j = 1,...,h$	2gh	One plus (minus if subsidy) ad valorem tax rate on sale of intermediate goods
ry		1	Revenue from income tax
t_{fy}		1	Income tax rate on farm income
t_{nfy}		1	Income tax rate on non-farm income
rt		1	Tariff revenue
rs1		1	Revenue from tax on intermediate goods
rs2		1	Revenue from tax on investment goods
rs3		1	Revenue from tax on consumption goods
rexp		1	Revenue from export tax
ps		1	Procceds from sale of foreign exchange at secondary rate
r_i		g	Proportion of imports of i purchased at secondary rate of foreign exchange
rem		1	Remittances received by government, evaluated at official exchange rate
rm		1	Foreign currency value of remittances received
ro		1	Other tax revenue

Appendix A2 **The Model Variables (continued)**

Variables	Subscript range	Number	Description
gr		1	Total government earnings
fa		1	Foreign currency value of foreign aid
gc		1	Government current expenditure
gi		1	Government capital expenditure
fs		1	Food subsidy
x^{q}_{i}	i = 1,2	2	Ration quota
e^{q}_{i}	i = 1,2	2	One minus subsidsy rate on food
rs		1	Subsidy under export performance licensing scheme
er		1	Remittance payments, evaluated at secondary market exchange rate
oe		1	Other government expenditure
ge		1	Aggregate government expenditure
f_g		1	Shift term in other expenditure
ΔGB		1	Government borrowing requirement
x_{i2}	i = 1,...,g	g	Import volume
m		1	Foreign currency value of total import
e		1	Foreign currency value of total export

Appendix A2 **The Model Variables (continued)**

Variables	Subscript range	Number	Description
ΔCA		1	Current account balance
a^r		1	Real absorption
gdp^r		1	Real GDP
gdp		1	Nominal GDP
pgdp		1	GDP deflator
y_{ft}		1	Aggregate taxable farm income
y_{fd}		1	Aggregate disposable farm income
v		1	Share of farm households in government's other expenditure
u		1	Share of farm households' spending in generating government's other revenue
b		1	Ratio of food subsidy going to farm people
ysp		1	Income from import premia
y_{nft}		1	Aggregate taxable non-farm income
y_{nfd}		1	Aggregate disposable non-farm income
y_d		1	Aggregate disposable income

Appendix A2 **The Model Variables (continued)**

Variables	Subscript range	Number	Description
c^r		1	Aggregate real household expenditure
f_c		1	Shift term in consumption function
ε^3		1	Consumer price index
r_j	j = 1,...,h	h	Industry rate of return
f^1		1	General wage shifter
f^1_j	j = 1,...,h	h	Industry wage shifter
d		1	Exchange rate ratio
TOTAL		**7gh + 37g + 11h + 71**	

Appendix A3 **Parameters and Coefficients of Bangladesh Model**

Equation	Coefficient	Range	Description	Source
(M.1)	S^1_{isj}	i = 1,...,g j = 1,...,h s = 1,2	Share of purchaser-price value of good i from source s in industry j's total use of i as current input.	Input-output data files. Total value is arrived at by summing the ijth elements of matrices A, G, Kt, Qt. Next we sum ijth element of A and Kt. S^1_{i1j} is the ratio of second sum to the first. S^1_{i2j} is 1 - S^1_{i1j}.
(M.1)	σ^1_{ij}	i = 1,...,g j = 1,...,h	Elasticity of substitution between domestic and foreign sources of good i for use in current production.	Elasticity file.
(M.2)	σ_{vj}	j = 1,...,h v = 1,2,3	CES parameter reflecting degree of substitutability between primary factors.	Elasticity file.
(M.2)	S_{vj}	j = 1,...,h	Share of factor v in total factor payment in industry j.	Input-output data files. S_{vj} is the ratio of jth element in V and sum of all the jth elements in V, W, and X.
(M.3)	η_{ik}	i ∈ agriculture, q1, q2 i ∈ agriculture, q1, q2	Own and cross price elasticities in input demand and output supply equations.	Econometric estimation.
(M.3)	η_{iv}	i ∈ agriculture, q1, q2	Price elasticities of input demand and output supply with respect to wage rate.	Econometric estimation.
(M.3)	η_{iw}	i ∈ agriculture, q1, q2	Elasticities of input demand and output supply with respect to the quantity of the composite of fixed factors.	Econometric estimation.
(M.3)	η_{it}	i ∈ agriculture, q1, q2	Elasticities of input demand and output supply with respect to technology.	Econometric estimation.
(M.6)	η_{vk}	k ∈ agriculture, q1, q2 v = 1	Elasticities of input demand and output supply labour demand with respect to input and output prices.	Econometric estimation.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.6)	η_{vv}	v = 1	Elasticities of labour demand with respect to wage rate.	Econometric estimation.
(M.6)	η_{vk}	k = w, t	Elasticities of labour demand with respect to composite of fixed factors and technology.	Econometric estimation.
(M.8)	SQ^1_{ij}	i = 1,4,...,11 j = 1	Share of aggregate revenue from composite crop `other' accounted for by individual crop i.	Input-output data files. ijth element in Y divided by the sum of elements in Y for i = 1,4 to 11 and j = 1.
(M.9)	SQ^2_{ij}	i = 1,...,g j = 1	Share of aggregate input cost accounted for by input i.	Input-output data files. ijth element in A + G + K_t + Q_t divided by the sum of all elements in jth columns of A + G + K_t + Q_t.
(M.10)	SQ^3_{vj}	v = 2,3 j = 1	Share of aggregate value added to land and capital in industry j accounted for by land when v = 3, and by capital when v = 2.	Input-output data files. jth element in W divided by jth elements in W + X if v = 2, and jth element in X divided by jth elements in W + X if v = 3.
(M.15)	σ_q		Elasticity of transformation between the commodities in `other'.	Assigned value is 0.50.
(M.16)	ε_i	i = 1,...,g	Expenditure elasticities	Elasticity files.
(M.16)	μ_{ik}	i,k = 1,...,g	Own and cross price elasticities in consumer demand.	Elasticity files.
(M.17)	Q^3_{is}	i = 1,...,g s = 1,2	Share of purchaser-price value of good i from source s in total household consumption of good i.	Input-output data files. First, the ith elements B, H, L_t, and R_t are added. Next the ith elements of only B, and L_t are summed. Q^3_{i1} is the ratio of the second sum to the first. Q^3_{i2} is equal to 1 - Q^3_{i1}.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.18)	$\sigma^3{}_i$	i = 1,...,g	Elasticity of substitution between domestic and foreign sources of good i for use by households for consumption.	Elasticity file.
(M.20)	$Q^2{}_{isH}$	i = 1,...,g s = 1,2	Share of purchaser-price value of good i from source s in total household purchase of i for investment.	Input-output data files. First, the ith elements in C, I, M_t, and S_t are added. Next the ith elements of only C and Mt are summed. $Q^2{}_{i1H}$ is the ratio of the second sum to the first. $Q^2{}_{i2H}$ is equal to 1 - $Q^2{}_{i1H}$.
(M.20)	σ_{2iH}	i = 1,...,g	Elasticity of substitution between domestic and foreign sources of good i for use by households for investment.	Elasticity file.
(M.21)	$h^5{}_i$	i = 1,...,g	Indexing parameter.	Default value is 0.00.
(M.22)	$Q^5{}_{is}$	i = 1,...,g s = 1,2	Share of purchaser-price value of good i from source s in total government consumption of i.	Input-output data files. First, the ith elements in E, J, O_t, and T_t are added. Next the ith elements of only E, and O_t are summed. $Q^5{}_{i1}$ is the ratio of the second sum to the first. $Q^5{}_{i2}$ is equal to 1 – $Q^5{}_{i1}$.
(M.22)	$\sigma^5{}_i$	i=1,...,g	Elasticity of substitution between domestic and foreign sources of good i for use by government for consumption.	Elasticity file.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.23)	h^2_i	$i = 1,\ldots,g$	Indexing parameter.	Default value is 0.00.
(M.24)	Q^2_{isG}	$i = 1,\ldots,g$ $s = 1,2$	Share of purchaser-price value of good i from source s in total government purchase of i for investment.	Input-output data files. First, the ith elements in F, K, P_t, and U_t are added. Next the ith elements of F and P_t are summed. Q^2_{i1g} is the ratio of the second sum to the first. Q^2_{i2g} is equal to $1 - Q^2_{i1g}$.
(M.24)	σ^2_{iG}	$i = 1,\ldots,g$	Elasticity of substitution between domestic and foreign sources of good i for use by government for investment.	Elasticity file.
(M.25)	γ_i	$i = 1,\ldots,g$	Reciprocal of the foreign elasticity of demand for domestic good i.	Elasticity file.
(M.26)	B^1_{i1j}	$i = 1,\ldots,g$ $j = 1,\ldots,h$	Share of the domestic good i purchased for intermediate use in total sales of domestic good i.	Input-output data files. B^1_{i1j} is the ijth element of A divided by the ith row of A+B+C+D+E+F, the total sale of i.
(M.26)	B^2_{i1H}	$i = 1,\ldots,g$	Share of the total sales of domestic good i purchased by household for investment.	Input-output file. B^2_{i1H} is the ijth element of C divided by the total sales of domestic good i.
(M.26)	B^3_{i1}	$i = 1,\ldots,g$	Share of the total sales of domestic good i purchased by household for consumption.	Input-output file. B^3_{i1} is the ijth element of B divided by the total sales of domestic good i.
(M.26)	B^5_{i1}	$i = 1,\ldots,g$	Share of the total sales of domestic good i purchased by government for consumption.	Input-output file. B^5_{i1} is the ijth element of E divided by the total sale of domestic good i.
(M.26)	B^2_{i1G}	$i = 1,\ldots,g$	Share of the total sales of domestic good i purchased by government for investment.	Input-output file. B^2_{i1G} is the ijth element of F divided by the total sales of domestic good i.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.26)	$B^4{}_{i1}$	i = 1,...,g	Share of the total sales of domestic good i exported.	Input-output file. $B^4{}_{i1}$ is the ijth element of D divided by the total sales of domestic good i.
(M.27)	D_{i1j}	i = 1,...,g	Share of commodity i produced by industry j.	Input-output file. Ratio of ijth element in Y divided by ith row sum.
(M.28)	B_{vj}	j = 1,...,h v = 1,2	Share of industry j's employment of primary factor v in total employment of v.	Input-output file. It is the jth element in V divided by sum of all the elements in V.
(M.32) & (M.33)	$H^0{}_{i1j}$	i = 1,...,g j = 1,...,h	Share of commodity i in total value of production of industry j.	Input-output data file. First the elements in jth column of matrix Y are added. Ratio of ijth element in Y to the sum gives $H^0{}_{i1j}$.
(M.32) & (M.33)	$H^1{}_{isj}$	i = 1,...,g	Share of purchaser-price value of good i from source s for intermediate use in total cost of industry j.	Input-output data file. First all jth elements in A, G, K_t, Q_t, V, W, and X are added to get the total cost of industry j. Next the ijth elements of A and K_t are added. Dividing the second sum by the first gives $H^1{}_{i1j}$. $H^1{}_{i2j}$ is the sum of ijth elements of G and Q_t divided by the total cost of industry j.
(M.32) & (M.33)	H_{vj}	v = 1,2,3 j = 1,...,h	Share of primary factor v in total cost of industry j.	Input-output data file. H_{vj} is the jth element in vector V, when v = 1, divided by the total cost of industry j. Similarly, when v = 2, H_{vj} is the ijth element in W divided by the total cost of industry j. When v = 3, H_{vj} is the ijth element in X divided by the total cost of industry j.
(M.34)	$H^2{}_{isH}$	i = 1,...,g s = 1,2	Share of purchaser-price value of good i from source s bought by household in total cost of capital creation in the economy.	Input-output data file. First the elements in C, I, M_t, S_t, F, K, P_t, and U_t are added to get the total cost of capital creation in the economy. Next the ith elements of C and M_t are added together. Dividing the second sum by the first gives $H^1{}_{i1H}$. $H^1{}_{i2H}$ is the sum of ith elements of I and S_t expressed as a fraction of total cost of capital creation.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.34)	H^2_{isG}	$i = 1,...,2$ $s = 1,2$	Share of purchaser-price value of good i from source s bought by government in total cost of capital creation in the economy.	Input-output data file. The ith elements in F and P_t are added. Dividing the sum by the total cost of capital creation gives H^2_{i1G}. H^2_{i2G} is the sum of ith elements in K and U_t expressed as a fraction of total cost of capital creation.
(M.35)	$T1_i$	$i = 1,...,g$	Share of c.i.f. plus tariff in total value of import of i at importers' prices.	Input-output data file. $T1_i$ is the ratio of ith elements in $(G+H+I+J+K-Z_2)$ divided by the ith elements in (G+H+I+J+K).
(M.35)	$T2_i$	$i = 1,...,g$	Share of c.i.f plus premium in total value of import of i at importers' prices.	Input-output data file. $T2_i$ is the ratio of ith elements in $(G+H+I+J+K-Z_1)$ divided by the ith elements in (G+H+I+J+K).
(M.36)	S^1_i	$i = 1,...,g$	Share of export value that earns premia in aggregate export value.	Miscellaneous data section from government budget file.
(M.36)	SAL_i	$i = 1,...,g$	Ratio of retention parameter to 1 minus the value of the retention parameter	Miscellaneous data section from government budget file.
(M.40)	S_f		Share of income tax from farm income in total income tax.	Government budget file.
(M.41)	ST_i	$i = 1,...,g$	Share of tariff on i in total tariff revenue.	Input-output data files. ST_i is the ratio of ith element in Z_1 and the sum of all the elements in Z_1.
(M.41)	S_i	$i = 1,...,g$	Ratio of tariff inclusive value to tariff on i.	Input-output data files. S_i is the ratio of ith elements in $(G+ H+I+J+K-Z_2)$ and the ith element in Z_1.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.42)	RR^1_{isj}	i = 1,...,g j = 1,...,h s = 1,2	Share of tax on i from source s paid by industry j in aggregate taxes on intermediate inputs.	Input-output data files. ijth element of K_t (or Q_t if s = 2) divided by the sum of all elements in K_t+Q_t.
(M.42)	R^1_{isj}	i = 1,...,g j = 1,...,h s = 1,2	Ratio of tax plus basic value to tax alone on i from source as paid by industry j for intermediate inputs.	Input-output data files. ijth element of A+K_t (or G+Q_t if s = 2) divided by the ijth element in K_t (or Q_t if s = 2).
(M.43)	$RR2_{is}$	i = 1,...,g s = 1,2	Share of tax on i from source s paid by household and government on capital goods in aggregate taxes on capital goods.	Input-output data files. ith element of M_t+P_t (or S_t+U_t if s = 2) divided by the sum of all elements in M_t+S_t+P_t+U_t.
(M.43)	$R2_{isH}$	i = 1,...,g s = 1,2	Household share in total tax on i from source s on capital goods.	Input-output data files. ith element of M_t (or S_t if s = 2) divided by the ith element in M_t+P_t (or S_t+U_t if s = 2).
(M.43)	$R2_{isG}$	i = 1,...,g s = 1,2	Government share in total tax on i from source s on capital goods.	Input-output data files. ith element of P_t (or U_t if s = 2) divided by the ith element in M_t+P_t (or S_t+U_t if s = 2).
(M.43)	R^2_{is}	i = 1,...g s = 1,2	Ratio of tax plus basic value to tax alone on i from source s on capital goods.	Input-output data files. ith element of C+M_t+F+P_t (or I+S_t+K+U_t if s = 2) divided by the ith element in M_t+P_t (or S_t+U_t) if s = 2).
(M.44)	$SSEX_{is}$	i = 1,...,g s = 1,2	Share of consumption tax on i from source s in total consumption tax.	Input-output data files. Sum of all elements in Lt, Rt, Ot, and Tt gives the total of consumption tax. $SSEX_{i1}$ is obtained by the ratio of ith element in Lt+Ot and the total consumption tax. $SSEX_{i2}$ is the ratio of ith element in Rt+Tt and the total consumption tax.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.44)	EX^3_{is}	$i = 1,...,g$ $s = 1,2$	Share of consumption tax on i from source s bought by household in total consumption tax on i from s.	Input-output data files. EX^3_{i1} is ith element in Lt divided by ith element in Lt+Ot. EX^3_{i2} is the ith element in Rt divided by ith element in Rt+Tt.
(M.44)	EX^5_{is}	$i = 1,...,g$ $s = 1,2$	Share of consumption tax on i from source s purchased by government in total consumption tax on i from s.	Input-output data files. EX^5_{i1} is ith element in Ot divided by ith element in Lt+Ot. EX^5_{i2} is the ith element in Tt divided by ith element in Rt+Tt.
(M.44)	SEX_{is}	$i = 1,...,g$ $s = 1,2$	Ratio of duty-paid value of i from source s consumed by both household and government to total duty on i from source s.	Input-output data files. SEX_{i1} is the row sum of B, Lt, E and Ot, divided by row sum of Lt and Ot. Similarly, SEX_{i2} is the row sum of H, Rt, J, and Tt divided by row sum of Rt and Tt.
(M.45)	SET_i	$i = 1,...,g$	Share of tax on exported good i in aggregate tax on export.	Input-output data file. ith element of Nt divided by the sum of all elements in Nt.
(M.45)	SE_i	$i = 1,...,g$	Ratio of tax plus basic value to tax alone on for domestic good i sold for exports.	Input-output data files. ith element of D+Nt divided by the ith element in Nt.
(M.46)	SH_i	$i = 1,...,g$	Ratio of c.i.f. value of i in total c.i.f. import value.	Input-output data files. ith element in $(G+H+I+J+K-Z_1-Z_2)$ divided by the sum of all elements in $(G+H+I+J+K-Z_1-Z_2)$.
(M.46)	PRS_2		Ratio of secondary market exchange rate to difference between secondary market exchange rate and official rate.	Base year value is 8.9.
(M.49)	R1		Share of income tax in aggregate government earnings.	Government budget file. Calculated directly from government revenue and expenditure account.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.49)	R2		Share of tariff revenue in aggregate government earnings.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.49)	R3		Share of commodity taxes on intermediate inputs in aggregate government earnings.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.49)	R4		Share of commodity taxes on capital goods in aggregate government earnings.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.49)	R5		Share of commodity taxes on consumption goods in aggregate government earnings.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.49)	R6		Share of export tax in total government earnings. .	Government budget file. Calculated directly from government revenue and expenditure account.
(M.49)	R7		Share of earnings from sale of foreign exchange at secondary market exchange rate in aggregate government earnings.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.49)	R8		Share of other revenue in aggregate government earnings.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.49)	R9		Share of foreign aid in total government earnings.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.49)	R10		Share of remittances in total government earnings.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.52)	SFS_i	i = 1,...,g	Share of food subsidy on i in aggregate food subsidy.	Government budget file.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.52)	RRP_i	i = 1,2	Ratio of ration value to food subsidy on ith commodity.	Government budget file.
(M.53)	SRS_i	i = 1,...,g	Share of subsidy under foreign exchange retention scheme on export of i in aggregate subsidy under the scheme.	Input-output data files. ith element in N_{t+1} divided by the sum of all elements in N_{t+1}.
(M.55)	h1g		Indexing parameter to link expenditure with nominal GDP.	Default value 0.00.
(M.56)	R11		Share of government current expenditure in total government expenditure.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.56)	R12		Share of government capital expenditure in total government expenditure.	Government budget file. Calculated directly from government revenue and government revenue and expenditure account.
(M.56)	R13		Share of food subsidy in aggregate government expenditure.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.56)	R14		Share of subsidy under retention scheme in aggregate government expenditure.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.56)	R15		Share of remittances payment in aggregate government expenditure.	Government budget file. Calculated directly from government revenue and expenditure account.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.56)	R16		Share of other expenditure in aggregate government expenditure.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.57)	GR		Aggregate government revenue.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.57)	GE		Aggregate government expenditure.	Government budget file. Calculated directly from government revenue and expenditure account.
(M.58)	B^1_{i2j}	i = 1,...,g j = 1,...,h	Share of the total sales of imported good i used by industry j as an input into current production.	Input-output data files. ijth element of G divided by the ith row of G+H+I+J+K, the total import of i.
(M.58)	B^2_{i2H}	i = 1,...,g	Share of the total sales of imported good i purchased by household for investment.	Input-output file. ijth element of I divided by the total import of i.
(M.58)	B^3_{i2}	i = 1,...,g	Share of the total sales of imported good i consumed by household for consumption.	Input-output file. ijth element of H divided by the total sales of imported good i.
(M.58)	B^5_{i2}	i = 1,...,g	Share of the total sales of imported good i purchased by government for consumption.	Input-output file. ijth element of J divided by the total sales of imported good i.
(M.58)	B^2_{i2G}	i = 1,...,g	Share of the total sales of imported good i purchased by government for investment.	Input-output file. ijth element of K divided by the total sales of imported good i.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.59)	M_{i2}	i = 1,...,g	Share in foreign currency cost of total import borne by import of good i.	Input-output data files. The c.i.f. value of total imports is given by the sum of all elements in G, H, I, J, K, $-Z_1$, and $-Z_2$. M_{i2} is the ratio of ith elements in G, H, I, J, K, $-Z_1$ and $-Z_2$ to total c.i.f. value of imports.
(M.60)	E_{i2}	i = 1,...,g	Share of total export earnings accounted for by exports of good i.	Input-output data files. Ei2 is the ratio of ith element in D, N_t and $-N_{t+1}$, divided by all elements in $(D+N_t-N_{t+1})$.
(M.61)	A1		Base period foreign currency value of aggregate exports.	Input-output data files. Sum of all elements in D, Nt and $- N_{t+1}$, divided by the official exchange rate.
(M.61)	A2		Base period foreign currency value of foreign aid.	Budget file.
(M.61)	A3		Base period foreign currency value of remittance receipts.	Budget file.
(M.61)	A4		Base period foreign currency value of aggregate imports.	Input-output data files. The foreign currency value of total imports is given by the sum of all elements in G, H, I, J, K, $-Z_1$, and $-Z_2$, divided by the official exchange rate.
(M.62)	SA_1		Share of aggregate household consumption in total absorption at market prices.	Input-output data files. Sum of all elements in B + H + Lt + Rt divided by total absorption. Total absorption is given by the sum of all elements in B + H + Lt + Rt + C + I + Mt + St + E + J + Ot + Tt + F + K + Pt + Ut.
(M.62)	S^3_{is}	i = 1,..,g s = 1,2	Share of aggregate household consumption accounted for by consumption of good i from source s.	Input-output data files. ith element of B + Lt (H + Rt if s = 2) divided by B + Lt + H + Rt.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.62)	$SA^2{}_H$		Share of private investment in aggregate absorption.	Input-output data files. ith element of C + I + Mt + St divided by total absorption.
(M.62)	$S^2{}_{isH}$	i = 1,...,g s = 1,2	Share of aggregate private investment accounted for by purchase of good i from source s.	Input-output data files. ith element of C + Mt (I + St if s = 2) divided by C + I + Mt + St.
(M.62)	$SA^2{}_G$		Share of public investment in aggregate absorption.	Input-output data files. ith element of F + K + Pt + Ut divided by total absorption.
(M.62)	$S^2{}_{isG}$	i = 1,...,g s = 1,2	Share of aggregate public investment accounted for by investment in good i from source s.	Input-output data files. ith element of F + Pt (K + Ut if s = 2) divided by F + K + Pt + Ut.
(M.62)	SA_5		Share of aggregate government consumption in total absorption.	Input-output data files. sum of all elements in E + J + Ot + Tt divided by total absorption.
(M.62)	$S^5{}_{is}$	i = 1,...,g	Share of aggregate government consumption accounted for by consumption of good i from source s.	Input-output data files. ith element of E + Ot (J + Tt if s = 2) divided by E + J + Ot + Tt.
(M.63)	SG1		Share of aggregate household consumption in nominal GDP at market prices.	Input-output data files. Sum of all elements in B + H + Lt + Rt divided by GDP, where GDP is B + H + Lt + Rt + C + I + Mt + St + E + J + Ot + Tt + F + K + Pt + Ut + D + Nt - (G + H + I + J + K - Z_1 - Z_2).
(M.63)	$SG2_H$		Share of aggregate private investment in nominal GDP market prices.	Input-output data files. Sum of all elements in C + I + Mt + St divided by nominal GDP defined above.
(M.63)	$SG2_G$		Share of aggregate public investment in nominal GDP at market prices.	Input-output data files. Sum of all elements in F + K + Pt + Ut divided by nominal GDP.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.63)	SG3		Share of government total current consumption in nominal GDP at market prices.	Input-output data files. Sum of all elements in E + J + Ot + Tt divided by nominal GDP.
(M.63)	SG4		Share of aggregate export in nominal GDP at market prices.	Input-output data files. Sum of all elements in D + Nt divided by nominal GDP.
(M.63)	SG5		Share of aggregate import in nominal GDP at market prices.	Input-output data files. Sum of all elements in G + H + I + J + K - Z_1 - Z_2 divided by GDP.
(M.66)	V_f		Share of factor income in aggregate taxable farm income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.66)	Y_{fj}		Share of farm income accounted for by factor income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.66)	V_{ef}		Share of other income in farm taxable income received from government's other expenditure.	Elasticity file. Calculated directly from miscellaneous data section.
(M.67)	VY_{ft}		Share of tax-deducted income in aggregate disposable farm income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.67)	ST_{fy}		Share of income tax paid on farm income in taxable farm income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.67)	V_{fs}		Share of food subsidies in aggregate disposable farm income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.67)	V_{rf}		Share of expenditure that forms a part of other income in government account in aggregate disposable farm income.	Elasticity file. Calculated directly from miscellaneous data section.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.68)	V_{nf}		Share of factor income in aggregate taxable non-farm income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.68)	Y_{nfj}		Share of non-farm income accounted for by factor income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.68)	V_{enf}		Share of other income in non-farm taxable income received from government's other expenditure account.	Elasticity file. Calculated directly from miscellaneous data section.
(M.68)	S_{ysp}		Share of premia income in non-farm taxable income.	Elasticity file. Calculated directly from miscellaneous data miscellaneous data section.
(M.69)	SY1		Share of import premia accrued to household in total premia.	Elasticity file and input-output data file.
(M.69)	SY2		Share of import premia accrued to government in total premia.	Elasticity file and input-output data file.
(M.69)	SSP_i	i = 1,...,g	Ratio of import premium from i in total premia value.	Input-output file. Ratio of ith element in Z_2 divided by the sum of all elements in Z_2.
(M.69)	$SP1_i$	i = 1,...,g	Ratio of premia-inclusive value of i to premium on i.	Input-output file. Ratio of the ith element in $(G+H+I+J+K-Z_1)$ divided by ith element in Z_2.
(M.70)	VY_{nft}		Share of tax-deducted income in aggregate disposable non-farm income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.70)	ST_{nfy}		Share of income tax paid on non-farm income in taxable non-farm income.	Elasticity file. Calculated directly from miscellaneous data section.

Appendix A3 **Parameters and Coefficients of Bangladesh Model (continued)**

Equation	Coefficient	Range	Description	Source
(M.70)	V_{nfs}		Share of food subsidies in aggregate disposable non-farm income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.70)	V_{rnf}		Share of expenditure that forms a part of other income in government account in aggregate disposable non-farm income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.70)	V_r		Share of remittance income in aggregate disposable non-farm income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.71)	SH_f		Share of farm income in aggregate disposable income.	Elasticity file. Calculated directly from miscellaneous data section.
(M.69)	Q_j	j = 1,...,h	Ratio of gross (before depreciation) to net (after depreciation) rate of return in industry j.	Elasticity files.
(M.72)	$h^1{}_j$	j = 1,...,h	Indexing parameter.	User specific. Default value is 1.00.

Appendix A4 **List of exogenous variables**

Variables	Subscript Range	Number	Description
t		1	Technology
$f^5{}_i$	i = 1,...,g	g	Shift term in government current expenditure
$f^2{}_i$	i = 1,...,g	g	Shift term in government capital expenditure
$f^4{}_{i1}$	i = 1,...,g	g	Shift term in export demand
k_j	j = 1,...,h	h	Industry capital stock
n_j	j = 1,...,h	h	Use of land in each industry
$p^m{}_{i2}$	i = 1,...,g	g	Foreign currency price of import
t_i	i = 1,...,g	g	One plus ad valorem tariff rate
sp_i	i = 1,...,g	g	One plus import scarcity premium rate
a_i	i = 1,...,g	g	Foreign exchange retention partameter
es_i	i = 1,...,g	g	One plus ad valorem export tax rate or one minus ad valorem export subsidy rate
$g^3{}_{is}$	i = 1,...,g s = 1,2	2g	One plus (minus if subsidy) ad valorem tax rate on sale of consumption goods

Appendix A4 **List of exogenous Variables (continued)**

Variables	Subscript Range	Number	Description
g^2_{is}	i = 1,...,g s = 1,2	2g	One plus (minus if subsidy) ad valorem tax rate on sale of investment goods
g^1_{isj}	i = 1,...,g s = 1,2 j = 1,...,h	2gh	One plus (minus if subsidy) ad valorem tax rate on sale of intermediate goods
t_{fy}		1	Income tax rate on farm income
t_{nfy}		1	Income tax rate on non-farm income
r_i	i = 1,...,g	g	Proportion of imports of i purchased at secondary rate of foreign exchange
fa		1	Foreign aid in foreign currency
rm		1	Foreign currency value of remittance receipts
x^q_i	i = 1,2	2	Ration quota
e^q_i	i = 1,2	2	One minus subsidsy rate on food
fg		1	Shift term in other govt expenditure
pgdp		1	GDP deflator
v		1	Share of farm households in government's other expenditure

Appendix A4 **List of exogenous Variables (continued)**

Variables	Subscript Range	Number	Description
u		1	Share of farm households' spending in generating government's other revenue
b		1	Ratio of food subsidy going to farm people
f_c		1	Shift term in consumption function
f^1		1	Shift term in real wage
$f^1{}_j$	j = 1,...,h	h	Industry wage shifter
d		1	Exchange rate ratio
TOTAL		2gh + 13g + 3h + 17	

Appendix A5

Derivation of percentage change form of output supply and input demand equations for agriculture

The level form of output supply and input demand equations for agriculture, as detailed in Chapter 4, are given as follows:

$$X_i = \alpha_i + \sum_{j=1}^{4} \beta_{ij} P_j + \sum_{k=1}^{2} \gamma_{ik} Z_k \qquad i=1,...3 \qquad (4.8)$$

$$- X_i = \alpha_i + \sum_{j=1}^{4} \beta_{ij} P_j + \sum_{k=1}^{2} \gamma_{ik} Z_k \qquad i=4 \qquad (4.9)$$

where i in (4.8) represents three outputs and i in (4.9) represents fertilizer. P_j is the normalized price of jth input, obtained by dividing the nominal price of j (P'_j) by the price of the numeraire variable (P_l, in this case the wage rate).

Thus, (4.8) and (4.9), expressed in terms of nominal prices, are given by

$$X_i = \alpha_i + \sum_{j=1}^{4} \beta_{ij} P'_j / P_l + \sum_{k=1}^{2} \gamma_{ik} Z_k \qquad i=1,...3 \qquad (4.8a)$$

$$- X_i = \alpha_i + \sum_{j=1}^{4} \beta_{ij} P'_j / P_l + \sum_{k=1}^{2} \gamma_{ik} Z_k \qquad i=4 \qquad (4.9a)$$

Taking total derivatives of (4.8a),

$$dX_i = \sum_{j=1}^{4} \beta_{ij} dP'_j - \sum_{k=1}^{2} \beta_{ij} dP_l + \sum_{k=1}^{2} \gamma_{ik} dZ_k \qquad i=1,...3 \qquad (4.8b)$$

$$\text{or } dX_i/X_i = \sum_{j=1}^{4} \beta_{ij} (dP'_j/P'_j)(P'_j/X_i) - \sum_{j=1}^{4} \beta_{ij} (dP_l/P_l)(P_l/X_i) +$$

$$\sum_{k=1}^{2} \gamma_{ik} (dZ_k/Z_k)(Z_k/X_i) \qquad i=1,...3 \qquad (4.8b)$$

Since $\sum_{j=1}^{2} \beta_{ij} = - \beta_{il}$, (4.8b) becomes

$$dX_i/X_i = \sum_{j=1}^{4} \beta_{ij}(dP'_j/P'_j)(P'_j/X_i) \quad + \beta_{il}(dP_l/P_l)(P_l/X_i) \; +$$

$$\sum_{k=1}^{2} \gamma_{ik}(dZ_k/Z_k)(Z_k/X_i) \qquad i=1,...3 \qquad (4.8b)$$

$$\text{or } x_i = \sum_{j=1}^{4} \eta_{ij}p'_j + \eta_{il}p_l + \eta_{ik}z_k \qquad (4.8c)$$

Similar is the derivation of fertlizer demand function, (4.9). p'_j is same as p^0_{k1} and p_l is same as p_{vj} for v=1 in equation (M.3) in Appendix A1. Similarly, z in (4.9c) is w in (M.3) in Appendix A1.

APPENDIX B COMMODITIES AND SECTORS IN THE BANGLADESH MODEL

Commodities	Sectors
1. Wheat	1. Agriculture
2. Rice	
3. Jute	
4. Grains	
5. Oil	
6. Feed	
7. Sugar	
8. Vegetables	
9. Fruit	
10. Cotton	
11. Tobacco	
12. Tea	2. Tea
13. Livestock	3. Livestock
14. Poultry	4. Poultry
15. Dairy	5. Dairy
16. Fishery	6. Fishery
17. Forestry	7. Forestry
18. Cotton yarn	8. Cotton yarn
19. Textiles	9. Textiles
20. Jute textiles	10. Jute textiles
21. Paper and paper products	11. Paperm and paper products
22. Leather	12. Leather
23. Fertilizer	13. Fertilizer
24. Pharmaceuticals and chemicals	14. Pharmaceuticals and chemicals
25. Cement	15. Cement
26. Steel and basic metals	16. Steel and basic metals
27. Machinery and metal products	17. Machinery and metal products
28. Wood and other industries	18. Wood and other industries
29. Urban housebuilding	19. Urban housebuilding
30. Rural housebuilding	20. Rural housebuilding
31. Other building	21. Other building
32. Electricity and gas	22. Electricity and gas
33. Housing services	23. Housing services
34. Public administration	24. Public administration
35. Trade & transport	25. Trade & transport

Input-output flow matrix at producers' prices, domestic, 1984-85 Appendix C Table 1 (in million Taka)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3597.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	393.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	428.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	547.0	4.3	1.8	3.0	5.7	304.4	0.0	0.0	3.7	0.0	443.1	1.4	0.0	0.0	0.0	0.0	0.0	2342.5	220.2	2842.9	294.7	0.0	0.0	0.0	128.9
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4212.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	0.0	0.0	0.0	0.0	0.0	0.0	10.0
19	0.0	0.0	0.0	0.0	0.0	127.4	0.0	0.0	712.8	0.0	0.0	3.0	0.0	10.9	0.0	0.0	0.2	216.8	0.0	0.0	0.0	0.0	0.0	246.0	34.1
20	97.4	0.9	0.0	0.0	0.0	49.2	0.3	4.8	3.6	0.0	0.8	0.0	71.2	11.3	9.3	0.4	0.0	1.2	0.0	0.0	0.0	0.0	0.0	7.7	138.8
21	139.4	1.5	0.0	0.0	0.0	8.9	0.0	8.6	116.9	13.7	0.0	54.9	0.0	100.4	0.0	0.4	18.0	337.3	0.0	0.0	0.0	0.6	0.0	205.1	100.3
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	4.6	0.0	0.2	2826.7	0.0	9.8	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	4469.2	43.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	830.9	37.2	9.7	15.8	30.2	78.4	0.1	41.5	692.9	136.9	328.6	63.6	86.6	65.9	0.5	24.0	100.0	852.1	7.8	0.0	130.5	698.5	0.0	113.5	1067.2
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.9	0.0	0.2	2.7	0.0	0.0	0.0	11.1	55.7	37.7	267.8	0.0	0.0	0.0	0.0
26	15.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	9.6	0.0	0.0	1257.8	47.6	158.5	202.8	1220.4	0.0	0.0	0.0	0.0
27	212.5	4.6	0.2	0.3	0.7	80.3	1.9	15.1	90.9	81.8	7.4	7.2	7.5	43.2	0.9	12.4	0.0	99.0	14.8	170.8	297.6	81.0	0.0	123.5	100.7
28	342.2	73.1	0.7	1.1	2.2	265.2	0.0	8.6	72.3	13.1	34.7	14.6	48.7	893.5	9.6	78.3	418.5	0.0	384.8	321.1	2075.9	85.9	0.2	701.2	483.9
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	306.7	0.0	27.2
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	303.1	0.0	0.0
31	84.3	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	145.3	0.0	335.8	286.7
32	198.9	2.0	0.7	1.2	2.3	3.5	0.0	163.6	104.1	337.5	67.8	2.1	243.6	111.5	12.8	42.4	81.1	119.1	0.0	0.0	0.0	293.3	0.0	63.5	230.1
33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	75.0	0.9	0.1	0.1	0.2	0.5	0.2	6.7	57.1	34.5	3.2	0.9	0.6	28.6	0.1	2.2	12.9	16.9	0.0	0.0	10.9	18.0	0.0	201.9	699.2
35	30373.5	655.7	1021.4	355.5	433.4	8797.6	349.1	134.8	4787.2	1053.2	681.1	2702.1	1067.4	5740.8	232.9	574.6	2724.6	4080.8	76.9	149.2	598.7	314.2	7.8	1880.3	486.9

Input-output flow matrix at importers' prices, imported, 1984-85 | Appendix C Table 2 | (in million Taka)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	111.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2310.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	11.3	0.1	0.0	0.1	0.1	6.3	0.0	0.0	0.1	0.0	9.2	0.0	0.0	0.0	0.0	0.0	0.0	48.5	4.6	58.8	6.1	0.0	0.0	0.0	2.7
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1533.3	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	3.7
19	0.0	0.0	0.0	0.0	0.0	41.1	0.0	0.0	229.8	0.0	0.0	1.0	0.0	3.5	0.0	0.0	0.1	69.9	0.0	0.0	0.0	0.0	0.0	79.3	11.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	25.9	0.3	0.0	0.0	0.0	1.6	0.0	1.6	21.7	2.5	0.0	10.2	0.0	18.7	0.0	0.1	3.3	62.7	0.0	0.0	0.0	0.1	0.0	38.1	18.6
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	2936.2	28.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	963.2	43.1	11.2	18.3	35.0	90.9	0.2	48.1	803.2	158.7	381.0	73.7	100.4	76.4	0.6	27.9	115.9	987.8	9.1	0.0	151.3	809.7	0.0	131.6	1237.1
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.1	0.0	0.6	8.9	0.0	0.0	0.0	36.1	182.0	123.4	875.7	0.0	0.0	0.0	0.0
26	18.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	11.2	0.0	0.0	1463.8	55.4	184.5	236.0	1420.2	0.0	0.0	0.0	0.0
27	824.9	17.9	0.8	1.3	2.5	311.7	7.4	58.6	352.8	317.6	28.6	28.1	29.1	167.8	3.3	48.0	0.0	384.2	57.6	662.9	1155.0	314.5	0.0	479.5	390.8
28	189.0	40.3	0.4	0.6	1.2	146.5	0.0	4.8	39.9	7.3	19.1	8.0	26.9	493.4	5.3	43.3	231.1	0.0	212.5	177.3	1146.3	47.4	0.1	387.2	267.2
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix C Table 3 Final demand by source, 1984-85 (in million Taka)

	Private cons		Private inv		Public investment		Govt consumption		Total	
Commodities	dom	imp	dom	imp	dom	imp	dom	imp	dom	imp
Wheat	7185	8919	0	0	0	0	0	0	7185	8919
Rice	110090	5406	0	0	0	0	0	0	110090	5406
Jute	0	0	0	0	0	0	0	0	0	0
Grains	241	145	0	0	0	0	0	0	241	145
Oils	3120	4534	0	0	0	0	0	0	3120	4534
Feed	0	0	0	0	0	0	0	0	0	0
sugar	3290	1642	0	0	0	0	0	0	3290	1642
Vegetables	29902	100	0	0	0	0	0	0	29902	100
Fruits	4033	199	0	0	0	0	0	0	4033	199
cotton	0	0	0	0	0	0	0	0	0	0
Tobacco	2360	1183	0	0	0	0	0	0	2360	1183
Tea	479	0	0	0	0	0	0	0	479	0
Beef	3823	22	0	0	0	0	0	0	3823	22
Poultry	3362	0	0	0	0	0	0	0	3362	0
Dairy	5449	1528	0	0	0	0	0	0	5449	1528
Fish	22182	0	0	0	0	0	0	0	22182	0
Forestry	925	19	0	0	0	0	0	0	925	19
Yarn	0	0	0	0	0	0	0	0	0	0
Textiles	14117	4551	0	0	39	0	0	12	14157	4564
Jute text	187	0	0	0	0	0	0	0	187	0
Paper	547	101	0	0	734	0	0	136	1281	238
Leather	4897	0	0	0	0	0	0	0	4897	0
Fertiliser	0	0	0	0	0	0	0	0	0	0
Pharmacy	4861	5635	0	0	59	0	0	68	4920	5704
Cement	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0
Machinery	1014	3937	1994	7742	294	18569	4784	1142	8088	31392
Wood	4388	2423	0	0	1331	0	0	735	5720	3158
Urban hsebldg	0	0	2227	0	0	0	0	0	2227	0
Rural hsebldg	0	0	6163	0	0	0	0	0	6163	0
Other bldg	0	0	4492	0	154	0	10446	0	15093	0
Electricity	217	0	0	0	3120	0	0	0	3337	0
Housing	9612	0	0	0	1137	0	0	0	10749	0
Health	4075	0	0	0	21776	0	0	0	25852	0
Trade & trans	12605	0	920	0	378	0	2208	0	16112	0

Source: Model database

Appendix C Table 4 Industry cost structure (in million Taka)

Commodities	Intermediate use domestic	Intermediate use import	Input Taxes domestic	Input Taxes import	Primary factor cost Labour	Primary factor cost Capital	Primary factor cost Land	Total
Agriculture	7068	2422	186	0	61834	26116	39505	137131
Tea	0	0	0	0	147	332	575	1054
Beef	0	0	0	0	1614	672	0	2286
Poultry	0	0	0	0	2700	262	0	2962
Dairy	0	0	0	0	3467	1463	0	4930
Fish	0	0	0	0	8160	5020	1255	14435
Forestry	7743	148	434	0	1980	4578	1145	16028
Yarn	6117	1553	137	0	634	357	0	8798
Cloth	1881	436	42	0	4095	1325	0	7780
Textiles	546	0	149	0	2737	2770	0	6202
Paper	1354	206	18	0	90	407	0	2074
Leather	2926	0	78	0	2070	1692	0	6766
Fertiliser	7836	2966	0	-870	249	2499	0	12680
Pharmacy	12680	6274	240	0	684	2312	0	22190
Cement	1959	1256	169	0	0	101	0	3485
Steel	7008	3391	295	0	329	1717	0	12739
Machinery	7883	5645	106	-400	846	2419	0	16498
Wood	10458	3495	214	0	1920	172	0	16259
Urban hsebldg	334	0	0	0	612	312	0	1257
Rural hsebldg	303	0	0	0	524	724	0	1552
Other bldg	856	0	0	0	3844	2090	0	6790
Electricity	2446	0	365	0	349	2167	0	5328
Housing	0	0	0	0	0	10132	0	10132
Health	1171	0	0	0	17734	4218	0	23122
Tr & trans	66723	0	503	0	34884	41488	0	143598

Source: Model database

Appendix C Table 5 Sales of domestic good by usage (in million Taka)

Commodities	Intermediate usage	Private cons	Private inv	Govt cons	Public inv	Export	Total
Wheat	0	7186	0	0	0	0	7186
Rice	0	110090	0	0	0	0	110090
Jute	3784	0	0	0	0	3899	7683
Grains	0	241	0	0	0	0	241
Oils	0	3125	0	0	0	3	3128
Feed	504	0	0	0	0	88	592
sugar	0	3446	0	0	0	0	3446
Vegetables	0	30163	0	0	0	120	30283
Fruits	0	4034	0	0	0	32	4066
cotton	2780	0	0	0	0	26	2805
Tobacco	0	4892	0	0	0	1175	5010
Tea	0	480	0	0	0	1613	2093
Beef	0	3823	0	0	0	22	3846
Poultry	0	3363	0	0	0	0	3363
Dairy	0	5449	0	0	0	0	5449
Fish	0	22,191	0	0	0	2,689	24880
Forestry	7,743	982	0	0	0	0	8725
Yarn	6117	0	0	0	0	2	6119
Cloth	1881.35	14557.95	0	41	0	4003	20483
Textiles	546.02	258.24	0	0	0	10952	11757
Paper	1354	556	0	746	0	220	2876
Leather	2925.86	5031.24	0	0	0	2063	10020
Fertiliser	7836	0	0	0	0	0	7836
Pharmacy	12680	5077	0	62	0	579	18398
Cement	1959	0	0	0	0	0	1959
Steel	7008	0	0	0	0	1	7009
Machinery	7883	1088	2140	316	5133.12	332.36	16893
Wood	10458	4537	0	1376	0	123	16494
Urban hsebldg	333	0	2228	0	0	0	2561
Rural hsebldg	303	0	6163	0	0	0	6466
Other bldg	856	0	4493	154	10446	0	15949
Electricity	2446	255	0	3668	0	0	6369
Housing	0	9613	0	1138	0	0	10751
Health	1171	4075	0	21777	0	0	27023
Trade & trans	66723	12702	929	382	2228	0	82965

Source: Model database

Appendix C Table 6 Tariff and premium rates on imports and taxes and subsidies on exports

Commodities	Tariff rate on imports	Premium rate on imports	Retention rate for exports	Export premia rate	Export tax rate
Wheat	0	0.02	0	0	0
Rice	0	0.11	0	0	0
Jute	0	0	0	0	
Coarse grains	0	0	0	0	0
Oilseed & oil	0.24	0.28	0	0	0
Feed	0	0	0.80	0.10	0
Sugarcane	0	0.14	0	0	0
Vegetable	0	0	0.80	0.10	0
Fruit	0	0.88	0.40	0.05	0
Cotton	0.04	0	0.40	0.05	0
Tobacco	0.10	0.29	0.40	0.05	0
Tea	0	0	0.60	0.03	0.05
Beef & sheep	0	0	0	0	0
Poultry & egg	0	0	0	0	0
Dairy products	0.10	0.63	0	0	0
Fish	0	0	0.80	0.10	0.00
Forestry	3.16	1.41	0	0	0
Yarn	0.10	0	0	0	0
Textiles	0.12	0.06	0.60	0.08	0
Jute textile	0	0	0	0	0
Paper & pulp	0.30	0.10	0	0	0
Leather & products	0	0	0.80	0.03	0.07
Fertiliser	0	0.10	0	0	0
Pharm & chemicals	0.21	0.12	0.60	0.08	0
Cement	0.29	0.38	0	0	0
Basic metal	0.29	0.11	0	0	0
Machinery	0.42	0.18	0.60	0.08	0
Wood & other	0.25	0.57	0.60	0.08	0
Urban hsebldg	0	0	0	0	0
Rural hsebldg	0	0	0	0	0
Other construction	0	0	0	0	0
Electricity & gas	0	0	0	0	0
Housing services	0	0	0	0	0
Health & pub ad	0	0	0	0	0
Trade & transport	0	0	0	0	0

Source: Model database

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