AN ATTEMPT AT INTEGRATING MACROECONOMETRIC AND INPUT-OUTPUT MODELS : THE CASE OF BANGLADESH

by

A.S.M. Anisuzzaman Chowdhury

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ABSTRACT

This thesis constructs an econometric model for Bangladesh, integrating an input-output (I-O) system with a standard macroeconomic model. This integration helps determine not only effects of macroeconomic policies on the supply side (sectoral outputs and incomes) of the economy but also feedbacks of sectoral incomes on to the demand side.

A simple Keynesian macroeconometric sub-model is estimated for the demand side of the economy, while the supply side is described by the 1976-77 I-O table of Bangladesh. The integrated model describes the past experience in Bangladesh with reasonably small error. Analysis of the government's macroeconomic policies for 1981-82 on the basis of the integrated model reveals that they are inconsistent with sectoral output projections by the Bureau of Statistics. Such inconsistency may have aggravated 'structural' inflation and 'disguised' unemployment problems.

The main policy conclusion is that macroeconomic policies should be directed at the agricultural sector. Besides raising productivity, policy measures such as more agricultural credit and agricultural public works would give the poor much needed income for the expansion of domestic markets for industrial goods.

Besides contributing to applied econometrics, this thesis provides a framework that may aid better co-ordination between the Planning Commission and the Department of Finance in Bangladesh.

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Chapter I

INTRODUCTION

Models are essential aids to clear thinking.

- Gunnar Myrdal

(Asian Drama, vol.III, p.1962)

1.1 STATEMENT OF THE PROBLEM

Models have increasingly become essential tools for development planners[1] and macroeconomic policy makers.[2] But the analytical framework and the focus of models which development planners use differ from those of economic policy makers. In particular the analytical framework of development planning models involves, explicitly or implicitly, an economy-wide, multisector model. The core around which all

[1] By development planners we refer to those concerned with medium to long-term issues that might be placed under the broad heading of "development strategy". Their focus is chiefly on real variables such as the growth and structure of production, employment and sectoral investment.

[2] By macroeconomic policy makers we refer to those concerned with relatively short-run issues that can be placed under the broad heading of "stabilization policy". They deal primarily with macroeconomic policies such as monetary and fiscal policies as they affect various nominal flow-of-funds balances, e.g., balance of payments, government accounts, savings-investment balance.

such models are built is the input-output (I-O) model, pioneered by Wassily Leontief. A typical planning model will combine either one of Harod-Domar aggregate growth models, static and dynamic linear programming models and Chenery two-gap models or some combinations of all with the Leontief I-O model.[3]

As a general rule, such I-O models provide the sectoral details and consistency checks among sectoral targets in terms of output and exogenously determined final demand (e.g., investment) targets in the various sectors. An I-O model also seeks to provide a consistency check between over-all import requirements and export possibilities arising out of or associated with various sectoral output. If a set of capital and skill coefficients for individual sectors is available, an I-O model can also estimate requirements for capital and skilled labourers.

However, the I-O model does not provide solutions for optimal combinations of sectoral output or of input-mix in each sector. Programming models provide the necessary extensions of the consistency models of the I-O variety to optimization criteria. But optimization is subject to the constraints arising from technological production possibilities and limited resourses, which may be distinguished in terms of foreign exchange and domestic savings, following Chener-

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[3] For a good discussion on this, see Blitzer, Clark and Taylor (eds.), Economy-wide Models and Development Planning, Oxford University Press, 1975.

y's two-gap model. An I-O model and its extensions into planning models does not usually handle the question of inflation, except indirectly by postulating an equality between costs and prices in each sector; it does not deal with questions of fiscal, monetary and balance of payments policies. The standard practice is to deal with macroeconomic policies as a subsequent or subsidiary exercise after inter-sectoral flows have been established.

In short, the principal concern of these models is "what could happen if 'socially optimum' readjustment of the economy occurred in response to policy changes", rather than "what would happen if independent economic units which make up the economy followed their traditional behavioural patterns in response to such changes" (Behrman, 1975, p.461). As a result these models usually include only real phenomena and are characterized by supply bottlenecks due either to foreign exchange or to capital constraints or to both.

On the other hand, the models used for macroeconomic policy analysis are aggregative in nature and do not directly incorporate inter-sectoral transactions (I-O relations). As a result, macroeconomic policies often do not reach to the micro level; even if they do, they handle micro problems such as supply inelasticity in agriculture, very inefficiently. These models deal with behavioural relationships such as consumption, investment, net exports, and money demand functions, and institutional relationships such as those relating to tax yields, money supply, wage-price formation, and the like, which are largely left out of I-O models.

As opposed to long and medium-term concerns of the planning models, this type of model is concerned with short-run issues, broadly categorized as "stabilization" within the framework of national income determination.[4] The concern is focused largely on various nominal flow-of-funds balances, in particular, the government accounts, balance of payments and saving-investment balance. The analytical framework for such models is provided by macroeconometric models in the 'Keynesian' and/or 'monetarist' traditions. The national income and product accounts provide both the data base and the underlying conceptual framework for policy analysis at the macroeconomic level.(Dervis, De Melo, Robinson, 1982, p.5).

In those economies, where development planning and economic policies are ususally conducted by two separate ministries (typically, a Ministry of Planning and a Ministry of Finance), the difference of concerns and of analytical framework in their respective models, often leads to lack of co-ordination.[5] As a result, either macroeconomic policies

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[4] For a good discussion on various 'stabilization' issues, see Cline, W. and Wientraub, S. (eds.), <u>Economic Stabilzation in Developing Countries</u>, Brookings Institution, Washington D.C., 1981.

[5] For good discussion on this issue, see Dervis, De Melo and Robinson (eds.), <u>General Equilibrium Models for Development Planning</u>, Cambridge University Press, 1982; (specially the introduction).

(e.g., liberal credit policy) instead of raising output, may generate structural inflation or sectoral development and investment programmes may fall apart in the face of a rising price level. For example, since economic policies are directed at the macro level without due information about individual production sectors, certain government fiscal and monetary policy combinations may increase in demand for some output whose production cannot be increased, at least in the short-run, because of structural bottlenecks. As a result, the 'Keynesian multiplier' will occur only in nominal terms (Rao, 1952). On the other hand, planners may set some investment target to free a given sector from structural bottlenecks, but fiscal and monetary policies may not accomodate the required private investment. Moreover, since the I-O model does not explain final demands on the basis of economic behaviour but rather treats them as exogenous, it short-circuits the income propagation mechansim. This, then, leads to inconsistency between the forecasts of the Ministry of Planning and the Ministry of Finance regarding changes in gross domestic product (GDP) due to changes in exogenous variables.

Therefore, for the successful harmonization of stabilization policies and development strategies, the analytical framework of both the multisectoral and econometric models need to be bridged, so that impacts of monetary and fiscal policies can be traced to the individual producing sectors.

Such a bridge will ensure the consistency of macro policies at the micro level. The need for such a bridge between macroeconmetric and I-O models has been identified long ago by Klein (1965, p.319) in the context of the Indian economy. To quote him :

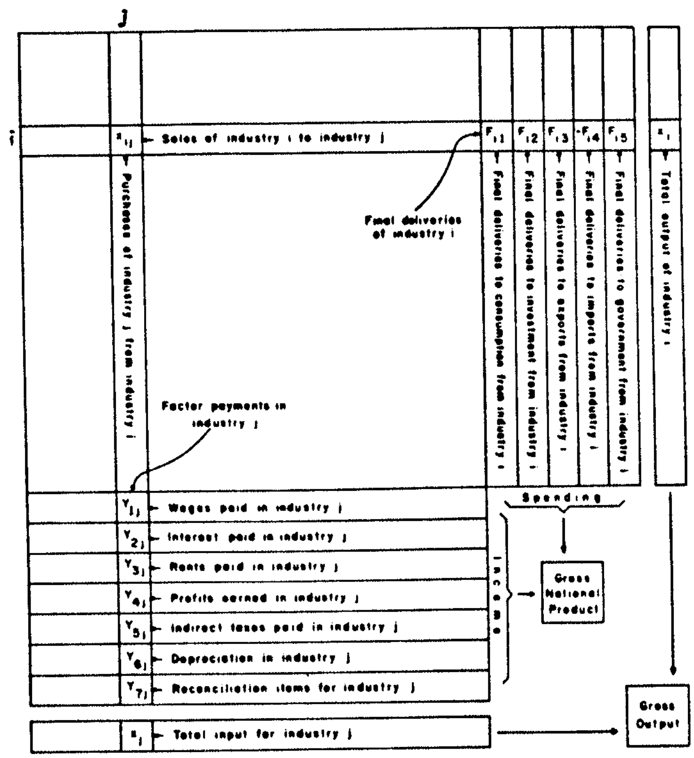
> The two major developments in modelling an economy have been the construction of aggregative econometric models and the construction of input-output models. .... The question becomes one of whether we should concentrate on a detailed analysis of final demand or of intermediate demand, or of whether we ought to try to build a more general system encompassing both the traditional econometric model and the input-output model.

Though the analytical frameworks and data of the macroeconometric and I-O models are apparently different, there exists a relationship between them. Table 1.1 shows this accounting relationship between inter-industry transactions, final demands and factor payments.

Macroeconometric models in general have concentrated on the structural and accounting relationships between the final demand block and the factor payments block, with only cursory treatment of the inter-industry transactions within the economy. On the other hand, the I-O model in general concentrates on the structural and accounting relationships between the inter-industry transactions block and the final demands block, without examining the conditions governing the demands. Thus, the final demands block, being common in both, provides the necessary link between the I-O and macroeconometric models. However, there is a lack of congru-

TABLE 1.1

Relationship Between Interindustry Transactions, Final Demand And Factor Payments



Source : Preston, 1972, p. 2

ence between the usual categorization of final demands (C,I,G,X-M) in the macroeconometric models and the final demand deliveries by sectors in the I-O model. Therefore, if I-O final demand deliveries can be linked to the components of aggregate demand, then the impacts of macro policy variables can be traced to the individual producing sectors and the income propagation mechanism will have a complete loop.

1.2 PURPOSE AND ORGANISATION OF THE PRESENT STUDY

Bangladesh is no exception to the kind of problem stated in the previous section. Shortly after independence in December 1971, the Bangladesh government set up the Bangladesh Planning Commission under the Ministry of Planning to perform three broad sets of functions : (a) to prepare annual and longer term plans, (b) to recommend to the government a range of policies and institutional changes and (c) to act as the central agency for co-ordination of economic policies. Although the Planning Commission constructed two I-O tables in order to prepare two five-year and one two-year plans, it did not attempt to construct a macroeconometric model. Macroeconomic policies (monetary, fiscal and exchange rate policies) are designed largely on the basis of intuitive logic and subjective judgement. The consequence of this is that the Commission's third term of reference remained not only unrealized, but also the First-Five-Year Plan (1973-78) and the Two-Year Plan (1978-80) largely failed to achieve their objectives (Islam, 1977, pp 5-10, 63-81).

The situation is confounded by the Ministry of Finance which conducts macroeconomic policies also on the basis of intuition and judgement. Had they attempted to estimate the parameters of economic behaviour and institutional functions, there would have been a basis for dialogue between the stabilization policy makers and development strategists so that a better co-ordination could have been achieved. Instead, what has emerged is a lack of consistency between sectoral programmes and macroeconomic policies. In fact, inflation due to expansionary fiscal and monetary policies is said to be one of the major causes of failure of the two previous plans (Islam, 1977, pp 51, 150-51, 258; The Second-Five-Year Plan, p I-3).

Thus the purpose of the present study is to construct a macroeconometric model and then to integrate it with the most recent (1976-77) I-O table of Bangladesh with a view to laying the ground for dialogue between the macroeconomic policy makers and the development strategists. The study is organised as follows : Chapter II reviews the I-O and the macro models for Bangladesh. It is found that the 1976-77 I-O model of Bangladesh does not have a proper demand dimension as it does not explain the final demands from equations of economic behaviour. On the other hand, the two available econometric models for Bangladesh are seen to be inadequate in providing a demand dimension to the I-O model. Alternative methodologies of providing such a demand dimension to an I-O table by integrating it with a macroeconometric model are discussed in Chapter III. It is found that the methodology developed by Preston (1972) is more satisfactory in terms of applicability. After examining different multiplier properties of an integrated system , its application to developing countries is reviewed to determine how useful an integrated I-O macro model is in conducting and analysing economic policies. A macroeconometric model for Bangladesh is constructed in Chapter IV. This aggregate model is integrated with the 1976-77 I-O table of Bangladesh in Chapter V. The statistical fit of the integrated I-O macro model in terms of root mean square percentage errors is found quite satisfactory. Moreover, the sign and size of the multipliers conform with economic theory. The integrated I-O macro model is used to test the consistency of the 1981-82 budget of the Bangladesh Government and it is concluded that the over-all monetary and expenditure programmes for 1981-82 are inconsistent with the projection of the Planning Commission. Finally Chapter VI summarizes the study's conclusions and suggests possible extensions of the model.

Chapter II

A REVIEW OF MACRO MODELS AND THE 1976-77 INPUT-OUTPUT MODEL FOR BANGLADESH

> To my mind, the business of economics is the accumulation of tested empirical generalization about relationships that prevail in the current 'real-world' economy.
>
> \- Gardner Ackley
>
> (Macroeconomics, 1978, p.IX)

Bangladesh is probably the poorest country in the world. In the World Bank Atlas (1974) only Rwanda was tentatively estimated to have a smaller per capita income than Bangladesh. On that criterion, two other countries are equally poor, but none of these three has anything like the population of Bangladesh. It is no wonder that growth is the chief concern of economists and policy makers interested in Bangladesh. Deficiency of demand of a Keynesian type has not generally been thought to be relevant for dealing with the problems of economic development. Availability of capital treated as a limiting factor in production is seen to be central to the understanding of the problems facing Bangladesh. The conventional wisdom is that if required capital is available then the vicious circle of poverty can be broken and the country can be freed from structural bottlenecks of all sorts.

Therefore, the emphasis of both partial and economy-wide studies is placed on the supply side of the economy. To the extent the Keynesian consumption function provides some clue to domestic saving mobilization for capital formation, it has served as an analytical tool. The capacity-creating role of investment is emphasised over its demand creating role. The role of net exports as a foreign exchange earning source is emphasised over its role as an injection into the circular flow. In short, the dominant framework for macroeconomic policy analyses and policy recommendations has been provided by some variants (e.g., the Mahalanobis model) of the Harrod-Domar growth model, the Chenery two-gap model and the Leontief input-output model. This is evident from the fact that the two five-year plans and the one two-year plan of the Bangladesh Planning Commission were based on an input-output system combined with a variant of the Harrod-Domar growth model and the Chenery two-gap model. As of today the Planning Commission does not have an economy-wide macroeconometric model of the Keynesian aggregate demand type.

Since its inception in 1972, the Bangladesh Planning Commission has compiled two input-output tables, one for 1972-73 and another for 1976-77.[4] The 33-sector incremental input-output matrix at 1972-73 constant prices was used in

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[4] The fiscal year in Bangladesh is from July to June.

preparing the First Five Year Plan (1973-78) of Bangladesh. Since this incremental input-output (I-O) table was adapted from an earlier work[7] on the then East Pakistan, it was found inadequate to describe the structure of the Bangladesh economy (Government of Bangladesh, 1980b, p 1). Consequently, the Planning Commission made an attempt to compile an I-O table for Bangladesh directly from primary data. The result is the 47- sector[8] I-O table at 1976-77 prices.

2.1 BASIC FEATURES OF 1976-77 INPUT-OUTPUT TABLE

The basic features of the 1976-77 input-output table may be summarised as follows :

a) The Balance Equations: Total supply of the ith product consists of gross domestic production (Xi) and imports (Mi). Deliveries of the ith product are composed of six categories : Private consumption (Ci), public consumption (Gi), gross fixed capital formation (Ki), stocks changes (STi), exports (Ei) and intermediate deliveries (Zij). If we define Vj and Yj as gross value-added in sector j at market price and at factor cost respectively, and Tj as indirect taxes less subsidies on jth sectoral output then we may write :

$$Xi + Mi = \sum_j Zij + Ci + Gi + Ki + STi + Ei \quad ..2.1.1$$

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[7] A.R. Khan and A. McEwan, Regional Current Input-Output Tables for East and West Pakistan, Research Report # 63, Pakistan Institute of Development Economics, Karachi, 1967.

[8] For details, see Government of Bangladesh, 1980b.

$$Xj = \sum_i Zij + Vj \qquad .... \ 2.1.2$$

$$Vj = Tj + Yj \qquad .... \ 2.1.3$$

$$(i=1,2, ... 47)$$

$$(j=1,2, ... 47)$$

b) Intermediate Demand Equations: Following the conventional assumption of input-output analysis,' it has been assumed that the intersectoral current input deliveries (Zij) are proportional to the output levels (Xj) of the using sectors. Therefore,

$$Zij = a_{ij} Xj \qquad .... \ 2.1.4$$

where a_{ij} is the current input coefficient or 'technical coefficient' of production.

c) Treatment of Imports: This is a thorny issue in the construction of an I-O table. Imports may be classified into two types : competitive and non-competitive. The former constitute part of total supply of goods and services and compete with domestic supply. Non-competitive imports are essential ingredients of the production process. While competitive imports are treated as a column vector, non-competitive imports are treated as a row vector (Taylor, 1978, pp 14-15). However, due to lack of detailed statistics on imports

' For theoretical discussion on the I-O model, see Section 3.1.

by type and use in the production process and in final demand, imports have been treated as competitive and classified into 47-sectors without looking at specific type of use - intermediate or final. This has been done by assuming that imports of a particular good are proportional to the domestic production of that good. That is

$$Mi = m_i Xi \quad \text{.... 2.1.5}$$

where Mi and Xi are sectoral imports and domestic gross output and m_i is 'import-coefficient'.

Following the classification of total imports into 47-sectors, they have been added to domestic supply to derive total available supply of a particular commodity. Total availability, thus obtained, has been allocated to the various producing sectors and final demand categories without specifying the origin (domestic or imports). Obviously, this approach does not reveal the actual import content of the input-structure of producing sectors or of final demand.

d) Final Demand Categories: There are only five categories of sectoral final demand deliveries. They are : private consumption, public consumption of goods and services, gross capital formation, stocks changes and exports.

e) Valuation of Transactions: As there was not adequate information on the trade and transport costs of inputs, market prices have been used in recording the transactions in the I-O table.

f) Valuation of Exports and Imports: In the trade statistics exports and imports are recorded at F.O.B. and C.I.F. prices respectively. The F.O.B. price has been treated as the relevant market price of exports. The market price of imports is higher than C.I.F. price by the amount of import duty and the trade and transport margins. To value the imports at market prices an 'import conversion factor' has been estimated for each sector as :

$$Qi = Mi \,/\, \overset{*}{M}i$$

where Qi is the import conversion factor for sector i

$\overset{*}{M}i$ is the import of the ith commodity at C.I.F. price

Mi is the import of the ith commodity at market price.

g) Direct and Indirect Requirement Matrix: Using equations 2.1.4 and 2.1.5, equation 2.1.1 can be written as :

$$Xi + m_i Xi - \sum_j a_{ij} Xj = Ci + Gi + Ki + STi + Ei \qquad \text{.... 2.1.6}$$

In matrix form 2.1.6 can be rewritten as :

$$[\ I + M - A\ ]\ X = F \qquad \text{.... 2.1.7}$$

Therefore,

$$X = [I + M - A]^{-1} F \qquad \text{.... 2.1.8}$$

where

A is the matrix of technical coefficients

M is the diagonal matrix of import coefficients and

X is the column vector of sectoral gross output

F is the column vector of final demand deliveries.

The results of the 1976-77 I-O table have been used to formulate the Second Five Year Plan (1980-85) of Bangladesh. In the next section we will have a look into the I-O macro model, based on the 1976-77 I-O analysis, of the Second Five Year Plan (SFYP).

Even though the 1976-77 I-O table has been constructed following the conventional technique, the absence of a 'factor payments' block or a 'primary input coefficient' block makes it less useful in dealing with employment effects of any policy changes or in dealing with sectoral prices and hence with inflation. Also this I-O table cannot shed any light on the possibility of import substitutions as it does not distinguish between competitive and non-competitive imports. Finally, this I-O model could have been more useful if sectoral final demand deliveries were categorized at a more disaggregated level. This would have made it possible to analyse demand at a disaggregated level along with disaggregated supply.

2.2 THE MACRO MODEL FOR THE SECOND FIVE YEAR PLAN

The Second Five Year Plan (1980-85) of Bangladesh is based on a macro model whose analytical framework is provided by the Leontief input-output system, the Chenery two-gap model and the Harrod-Domar growth model.[10] While the I-O system is designed to ensure sectoral balance for consistent projections, the Harrod-Domar type aggregate model is used to describe alternative growth paths of the economy, concieved in terms of aggregate savings, investment and income relationships. At the same time the two-gap model seeks to investigate the gap between savings and investment, on the one hand, and the gap between exports and imports, on the other. While the Harrod-Domar type growth model treats capital as the only scarce factor of production, the elaboration of the two-gap model introduces an additional scarce factor, foreign exchange.

The building blocks of this macro model are the results of the 1976-77 I-O analysis. Although the I-O analysis constitutes the core of the model, it does not treat all the components of final demand as exogenous. Consumption has been divided into 'basic needs'[11] and 'non-basic needs' items. Basic needs consumption is determined outside the model on the basis of per capita income elasticity of demand and a postulated growth rate of per capita income. Non-basic

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[10] For details, see Government of Bangladesh, 1980d.

[11] Basic needs items include foodgrains (rice, wheat), sugar, edible oils and cloth.

needs consumption is 'endogenised' by using the assumption that sectoral share in non-basic needss delivery is a fixed proportion (consumption coefficient) of total expenditure on non-basic needs goods. Likewise, part of fixed investment is determined endogenously by linking investment demand with capacity expansion by way of incremental capital-output ratios.

The basic needs consumption expenditure drives the I-O macro model. For alternative gross domestic product (GDP) targets, the projected increase in the consumption of basic needs items is obtained from the Basic Needs submodel. This, in turn, drives the model to determine sectoral gross output in the usual solution of the I-O system to sustain the increase in basic needs consumption. Once sectoral gross outputs are determined, sectoral investment requirements are calculated from the incremental capital-output ratios. The model endogenously determines imports by way of sectoral import coefficients[12] once sectoral gross outputs are determined and hence, given exogenous export possiblities (targets), trade deficits can be calculated. The import-export gap, together with the volume of investment in the Plan terminal year (1985), determines the level of 'required' savings to achieve the targeted growth of GDP. With exogenous projection of public consumption, it is the increase in pri-

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[12] Sectoral import coefficient is defined as :
$m_i = Mi / Xi$, where Mi is import of commodity i and Xi is domestic production of commodity i.

vate non-basic needs consumption expenditure that is, therefore, residually determined in order to generate the 'required' savings. The simultaneous solution of the model ensures that sectoral output will grow in such a way that supply from domestic production and imports exactly matches all categories of sectoral demand (intermediate and final) in the terminal year.

To the extent that non-basic consumption expenditure and sectoral investment requirements are 'endogenised', this I-O macro model does have a demand dimension and can capture the feedback of the income propagation mechanism on to aggregate demand. However, this treatment of demand is inadequate. Employing the proportionality assumption (i.e., the sectoral share in a non-basic item is a fixed proportion of total expenditure on non-basic consumption) behavioural aspects of consumers are totally ignored and consumers are reduced to mere mechanical creatures. It is hard to distinguish between sectoral consumption coefficients[13] and sectoral technical coefficients.

Similarly, the treatment of investment solely in terms of incremental capital-output ratios is inadequate, because it implies no excess capacity, whereas in reality it has been found that the manufacturing sector of the Bangladesh economy is operating at less than full capacity (Faaland and Par-

[13] Sectoral consumption coefficients are defined as : $\bar{C}_i = c_i \Sigma \bar{C}_i$; $\Sigma c_i = 1$, where $\bar{C}_i$ is sectoral share of non-basic needs consumption and $\Sigma \bar{C}_i$ is total non-basic consumption expenditure.

kinson, 1976, p 10, Bangladesh Bank, Annual Report, 1979-80, p 20). Moreover, its reliance more on technical rather than behavioural aspects of investment makes it less useful for the purposes of policy making. If policy makers do not have information on other factors influencing private investment, beyond the portion determined by the incremental capital-output ratios, how can they prescribe policies to ensure the 'required' amount of investment will be forthcoming?

Similarly, not all imports are determined by constant 'import coefficients'. While technical factors play a large role in the determination of raw-material imports, imports of consumer goods cannot be treated in this fashion. Consumer imports are, by and large, related to factors that influence consumption behaviour and are dependent on government's import policy.[14] Though capital imports are dictated by technical needs, and like material imports are arguments in the production function, they are not entirely determined by technological facts. Decisions to import capital goods are related to the very decision of fixed investment and so they must be influenced by factors that influence the decision to invest in the first place.

Thus, it is important to predict components of final demand from equations rooted in economic behaviour in order to provide the supply-oriented I-O model with a proper demand

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[14] In Bangladesh imports are regulated through import policy, announced in the month of June for the following year.

dimension. Only then is it possible to deal with fiscal and monetary policies as an integral part of the model and not just as subsequent or subsidiary exercises once intersectoral flows are established.

2.3 MACROECONOMETRIC MODELS FOR BANGLADESH

Within the Keynesian framework, there are so far only two macroeconometric models for Bangladesh. The first attempt to construct a macroeconometric model for Bangladesh was made by Hossain (1973). The objective of Hossain's study is to describe the interrelated processes involving production, savings, investment and external trade. This model was used to simulate the future path of some macroeconomic variables as well as to check the internal consistency of the annual development plan of the Bangladesh government. The model has six basic components :

a) Production functions for five sectors : agriculture, manufacturing, social overhead, commercial and financial services and general services,

b) Import functions for consumer goods, capital goods and raw-materials,

c) Private and public consumption functions,

d) Direct and indirect tax functions,

e) Money demand function, and

f) Food grain demand function.

In general, production functions of the Harrod-Domar type with capital as the limiting factor are used. In particular, value added is assumed to be a function of capital stock and weather conditions (approximated by a dummy variable) in agriculture, of capital stock and imported raw-materials in manufacturing, of lagged capital stock in social overhead, of capital stock and agricultural value added in the commercial and financial sector and of capital stock in the general services sector.

Capital, consumer and raw-material imports are assumed to be functions of total investment, total value added and capital stock respectively.

Private consumption is postulated to depend on disposable income and public consumption on total investment and tax receipts.

While direct taxes is a function of current and lagged total value added, indirect taxes is a function of total current value added.

Demand for real cash balances is postulated to be a function of total current value added. Interest rates are excluded from this function on the ground that money markets and capital markets are almost non-existant in Bangladesh.

On the basis of calculated values for impact multipliers, Hossain identifies three crucial variables affecting GNP. Weather conditions have the greatest impact effects on GNP followed by capital stock and exogenous exports.

Hossain used his model to estimate the values of exogenous (policy) variables (e.g., public investment) required to achieve target values of the endogenous variables (e.g., GNP). In this way he concluded that the investment decisions of the Bangladesh government, as reflected in the Annual Plan (1972-73), were consistent with targets.

Hossain's work has brought out some interesting phenomena about the Bangladesh economy. For example, he investigated quite extensively the nature of technological progress in the Bangladesh economy by specifying a CES production function characterized by Hicks and Harrod-Solow neutral technical progress. He found no evidence of Hicks-neutral technical progress and the evidence in favour of Harrod or Solow neutral technical progress was not very conclusive, either. Neither did he find any evidence of constant returns to scale for the aggregate economy; rather, the evidence strongly suggests decreasing returns to scale.

These findings have serious implications for the process of economic development and growth. Absence of technical progress together with decreasing returns to scale leads one to believe that economic development in Bangladesh cannot proceed at a very rapid rate through large investment alone. Larger and larger additional output can be obtained by the same amount of investment only if we introduce technical progress by careful planning and create situations to secure increasing returns to scale. This result led Hossain to suggest more investment in research and development in order to induce technological progress.

However, Hossain's work suffers from short-comings. First, even if the model contains five sectoral production functions, the interdependence of the production structure (intersectoral/interindustry transactions) of the economy is ignored. While raw-materials are simultaneously inputs and outputs and can be 'washed' out in the aggregate production function, this is not so in the case of disaggregated production functions (Klein, 1974, p.48). Failure to recognise complementarities between components of the aggregates, makes many of the problems of the Bangladesh economy intractable. Since output in one sector depends not only on primary factors (labour, land, capital) but also on the availability of complementary supplies from other sectors, if essential raw-materials are not available the end result may be idle capacity; adding capital stock will worsen rather than improve the situation. For example, it has been found by many observers (Kabir, 1981; Kabir, Butterfield and Kubursi, 1981) that while agricultural supply is inelastic with respect to price in Bangladsh, the manufacturing sector has a substantial excess capacity. In that situation, increases in investment in the manufacturing sector will not only add to idle capacity but will also generate inflation through higher food prices (Kalecki,1976; Rao,1952; Taylor,1978). Thus, it is not surprising that Hossain had to explain structural inflation in terms of an aggregate supply lag in response to an increase in aggregate demand (e.g., investment). But structural inflation in Bangladesh is not due to an aggregate supply lag

it is because some sectors' (in particular agriculture and sectors dependent on imported raw-materials) supply is inelastic (Faaland and Parkinson, 1976, pp 52-55; Islam, 1977, pp 150-51). In the words of Myrdal (1968, vol. III, p 1953), "... it is much more important .... to know where supply bottlenecks occur than to postulate a general ceiling when we analyse inflation".

Second, Hossain's specification of some of the functions can be questioned. For example, it is not at all clear why government expenditure on goods and services would depend on total investment. Similarly, Hossain did not justify why only aggricultural value added and not the total value added (GDP) would be an argument in the production function for the commercial and financial sector. Given the fact that agriculture in Bangladesh is at a very primitive and subsistence stage and hence is largely outside the organised financial and commercial activities, it is unlikely to be an important determinant of the value added of the commercial and financial sector of the economy. It is also unclear why capital stock should be the only determinant of raw-material imports. Raw-material needs are directly related to production needs of the economy and capital stock would be expected to enter the raw-material import function only indirectly through various production functions. Moreover, Hossain did not give reasons for including current value added in the direct tax function. Since income tax in Bangladesh is assessed on the previous fiscal year income, one would expect that lagged income should suffice to explain the direct tax function.

Thirdly, since Hossain's effort in 1973 to construct an econometric model for Bangladesh, there have been many changes in the operation of the economy. For example, at the time of his writing Bangladesh had embarked upon a 'socialist' development path and all private investment was restricted within an investment ceiling.[15] Thus it was legitimate for him to treat investment as exogenous or dependent on government's over all development objectives. But in 1975 the investment ceiling was abolished and private investment assumed a greater role. Hence it is important to have an econometric study which embodies private investment behaviour within a macro model.

The only other econometric model for Bangladesh was constructed by Lackman and You in 1979. Though this model is recent, it is so aggregated that it yields very little useful information. It has only one aggregate private consumption function, one aggregate private investment function and one aggregate import function. A nominal direct tax function

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[15] The investment ceiling was 2.5 million Taka in 1973-74.

and an aggregate fixed-coefficient production function are the only institutional and technical relationships within the model.

The level of aggregation is such that any possible importance of intersectoral flows is lost completely. Nowhere is the importance of essential imported raw-materials and capital goods spelled out. Since the productivity of imported materials and equipment is ignored, the import multiplier is assumed negative. But in reality this may not be the case (Klein, 1974, p 48). When non-competitive[16] material (e.g., oil) and equipment imports decline, output declines, too. In order to capture the importance of complementary domestic intersectoral transactions and of non-competitive material and equipment imports, we must incorporate some type of I-O analysis into the model.

Moreover, some of the findings of Lackman and You (1979) are questionable. For example, according to their model the marginal propensity to consume (MPC) out of disposable income in the Bangladesh economy is only .58. For a country like Bangladesh with the lowest per capita income in the world, this low value of MPC can hardly be credited. The low estimate of the MPC may be due to the presence of autocorrelation as indicated by a first-order autocorrelation coefficent of .84. In fact, they have transformed the annual data into quarterly data by using the 1969-70 seasonals and

[16] Non-competitive imports are essential imports which are not produced domestically.

autocorrealtion may be the result of this transformation.

This discussion of the macro models for the Bangladesh economy will remain incomplete if the monumental work of Alamgir and Berlage (1974) is not mentioned. Alamgir and Berlage in their seminal work, Bangladesh : National Income and Expenditure 1949/50 - 1969/70, took the first step in developing a set of consistent series on national income and expenditure and their various components for the Bangladesh economy during the years prior to independence. Throughout the 1950's and early 1960's all estimates of national income related to Pakistan as a whole, and no attempt was made to draw up provincial accounts. Only in the late 1960's some steps were taken to separate out provincial income figures. But these were not complete accounts as there was no breakdown of the unallocated items[17] and inter-regional factor payments. Moreover, there was no attempt at estimating expenditure on a regional basis. As a result, no useful study could be done on the macroeconomy of Bangladesh for this period.

Making various ad-hoc adjustments and examining for consistency of data available from different sources, Alamgir and Berlage made available a consistent set of expenditure accounts for Bangladesh. A useful basis is thus provided to carry out research on the macroeconomy of Bangladesh. Fur-

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[17] Unallocated items include banking and insurance, central government, the Pakistan International Airlines, defence and net factor income from abroad.

thermore, they singled out some components of the national income and expenditure accounts to shed some light on structural changes that might have occurred in the Bangladesh economy. In particular, an analysis of the trends and fluctuations in GDP and its components was presented with a view to identify some factors that might have influenced them. It was found that in spite of a very slow growth rate in the 1960's agriculture remained the dominant sector with its share above 50% of the total GDP. The service sector maintained a stable share around 26% of the GDP. On the other hand, the contribution of industrial production declined over time from 18% in 1949/50 to 11% in 1969/70. Alamgir and Berlage contend that this decline in manufacturing is not surprising. The bulk of transfers of resources from agriculture to industry and to the urban centre in Bangladesh ultimately found its way to Pakistan, and not much was left for investment in Bangladesh.[18]

They also highlighted interrelationships between major macro variables and estimated various parameters, thus affording some insights into the operation of the economy. For example, besides direct and indirect tax functions, separate functions were estimated for aggregate private and public consumption. Though these functions are very simple, they nonetheless set the direction for future study.

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[18] For a good discussion on ways in which resources were transferred from East Pakistan (now Bangladesh) to West Pakistan, see Griffin, K. and A.R. Khan (eds.), Growth and Inequality, Macmillan, 1972.

Alamgir and Berlage also examined the relative importance of national savings and foreign capital inflows in financing investment towards income growth, with a view to assessing the potential of the Bangladesh economy for sustaining a reasonable level of economic activity out of domestic resources. While estimating the magnitude of the foreign capital inflow into Bangladesh, an analysis was conducted of the structure of imports and exports and their growth over time.

On the whole, Alamgir and Berlage's work remains as a hallmark in the study of the Bangladesh economy. Besides being the only source of data on national income and expenditure for the pre-independence period, it sheds light on major macroeconomic relationships, such as private and public consumption functions, consumer goods, raw-materials and capital goods import functions and direct and indirect tax functions. Though it is not a full macroeconometric model, the study establishes a foundation on which a macroeconometric model can be built.

2.4 SUMMARY

This chapter reviewed the 1976/77 input-output (I-O) table, the macro model of the Second Five Year Plan (SFYP), two other macroeconometric models and Alamgir and Berlage's work on national income and expenditure of Bangladesh.

The simple, static, open 1976/77 I-O system provided the building blocks for the macro model used in formulating the

SFYP (1980-85) of Bangladesh. The emphasis of this model is on the supply side and growth of the economy. Its attempt to capture the feedback of an income propagation mechanism on demand by 'endogenising' part of consumption and investment was found inadequate, because it does not explain any of the final demand components within the model on the basis of economic behaviour. Since this model remains essentially an I-O model, it lacks an appropriate demand dimension.

Of the two macroeconometric models, the one by Hossain (1973) was found more satisfactory than that by Lackman and You (1979). However, both are essentially demand oriented models and there is no mechanism whereby components of final demand can be allocated over producing sectors so that sectoral implications of demand behaviour may be analysed. Moreover, they were not constructed with a view to incorporate explicitly an I-O analysis. As a result, neither can be used to augment the 1976-77 I-O table with a proper demand dimension. This, however, does not mean that they are useless altogether. Each has contributed to our knowledge. For example, Hossain's discussion of technological progress and Lackman-You's results concerning structural shifts in the private consumption function after 1971 provide useful information for future researchers. Nonetheless, there remains a need for a macroeconometric model that can provide a proper demand dimension to the supply oriented I-O model of Bangladesh. The present study will attempt to construct such a macroeconometric model for the Bangladesh economy in Chapter IV. In any effort to study the macroeconomy of Bangladesh, the pathbreaking work of Alamgir and Berlage (1974) remains a foundation stone.

Chapter III

BASIC FEATURES OF AN INTEGRATED INPUT-OUTPUT MACRO MODEL

> The fact that input-output analysis has reached maturity as an active branch of applied economics during the working life of its founder is a tribute to the soundness of his original conception of inter-industry research.
>
> - Hollis B. Chenery (1970).

Ever since Leontief's formalization of Quesnay's 'Tableau Economique', the I-O system became a basic tool to understand the details of the supply side of an economy. In this chapter, the basic features of the Leontief static open I-O model and alternative methodologies of closing the system by integrating it with macroeconometric models will be discussed. Later in this chapter, applications of the integrated I-O macro model to the developing countries will be reviewed in order to indicate its usefulness in conducting and analysing economic policies.

3.1 BASIC FEATURES OF STATIC OPEN I-O ANALYSIS

The essence of I-O analysis is that it captures the interrelatedness of production arising through the flow of intermediate goods among producing sectors. Despite its simplifying linearity assumptions, the I-O model represents a powerful tool for applied general equilibrium analysis. The input-output or interindustry accounting system is shown in Table 3.1

This table is divided into three blocks :

a) Block I shows the inter-industry transactions. Each entry Xij is the amount of the ith sector's output used by the jth sector/industry as input.

b) Block II comprises the final demand deliveries by each producing sector/industry. This is usually referred to as the final demand block.

c) Block III contains payments to primary factors, i.e., those inputs which are not produced by any producing sector/industry in the system. We refer to this block as the factor income payments block.

Two crucial assumptions of the static, open input-output analysis are :

a) Production functions are of the fixed proportion type. That is, the demand for each input is proportional to the output of a using sector :

$$Xij = a_{ij} Xj \quad , \quad a_{ij} \geq 0$$

TABLE 3.1

Input-output Accounting System

Sales to Purchase from	Sales of i to j 1 2 3 ... n	Industry Final Demand Deliveries fi1 fi2 ... fim	Gross Output X
1	X_{11} X_{12} X_{13} .. X_{1n}	f_{11} f_{12} .. f_{1m}	X_1
2	X_{21} X_{22} X_{23} .. X_{2n}	f_{21} f_{22} .. f_{2m}	X_2
3	X_{31} X_{32} X_{33} .. X_{3n}	f_{31} f_{32} .. f_{3m}	X_3
Purchase of i from j	BLOCK I	BLOCK II	
n	X_{n1} X_{n2} X_{n3} .. X_{nn}	f_{n1} f_{n2} .. f_{nm}	X_n
Y_1	Wages paid by industry j	Spending → GNP	
Y_2	Interest paid by industry j		
	BLOCK III	Income → GNP	
Y_w	Rent paid by industry j		
X	Total inputs for industry j	→ GROSS OUPTPUT	↓ GROSS OUPTPUT

where Xij is the ith sector's output used as input by the jth sector, Xj is the output of the jth sector and a_{ij} is the technical or direct requirement coefficient.

b) Final demand deliveries (fij) from the producing sectors are determined exogenously or by administrative decision.

From the 1st and 2nd blocks of Table 3.1, we can form the following identities :

$$\sum_{j}^{n} X_{ij} + \sum_{j}^{m} f_{ij} = X_i \quad .... \quad 3.1.1$$

where Xij are sales of the ith sector to the jth sector as inputs

and fij are sales of the ith sector to the jth category of final demand

By using assumption (a), equations system 3.1.1 can be rewritten as :

$$\sum_{j}^{n} a_{ij} X_j + \sum_{j}^{m} f_{ij} = X_i \quad .... \quad 3.1.2$$

If we denote $\sum_{j}^{m} f_{ij}$ by Fi then 3.1.2 becomes :

$$\sum_{j}^{n} a_{ij} X_j + F_i = X_i \quad .... \quad 3.1.2a$$

In matrix form the equations system 3.1.2 can be written as :

$$AX + F = X$$

$$\text{or,} \quad [I - A] X = F \quad .... \quad 3.1.3$$

where A is the n x n matrix of technical coefficents

X is the n x 1 column vector of sectoral gross ouputs

and F is the n x 1 column vector of final demands.

Given assumption (b), i.e., sectoral final demand deliveries are exogenous, the system 3.1.3 can be solved for sectoral gross outputs in terms of final demands as :

$$X = [I - A]^{-1} F \qquad ..... \quad 3.1.4$$

Once the inverse $[I - A]^{-1}$ is computed, one can calculate not only the direct and indirect effects of an exogenous increase in final demand on each sectoral gross output, but also the effects on employment and capital (if data are available). Given the coefficients for sectoral import requirements, it is possible to determine the non-competitve import requirements arising out of, or associated with, various sectoral gross output levels which are consistent with estimates of exogenous final demands.

An input-output (I-O) model does not usually handle questions of price formation, except indirectly by postulating an equality between costs and prices in each sector (Klein 1953, 1956; Morishima 1956, 1957). It does not deal with fiscal and monetary policies, except as a subsequent or subsidiary exercise, once it has established inter-sectoral flows. The basic elements of a traditional input-output model are the exogenously determined final demands which drive the system and the fixed technical coefficients of production which quantify the intersectoral flows.

A fundamental short-coming of an I-O model is that it cannot explain the conditions governing the components of final demand. By assuming final demand to be exogenous, the I-O model short-circuits the income propagation mechanism. When an exogenous increase in final demand leads to an all round increase in sectoral gross output, increase in sectoral incomes should, in turn, feed back to final demand. The open I-O analysis misses this second loop of the multiplier process.

To complete the income propagation mechanism, Leontief himself suggested closing the system by endogenising consumption. This is done by treating households as another industry with labour services as output and consumption as inputs. Making the assumption of a constant coefficient for consumption so that $Ci = c_i C$, a new inverse matrix can be derived which is said to incorporate the complete multipliers.

However, three objections have been raised against this approach. First, consumption is not undertaken exclusively by workers but also by the recipients of non-employment incomes. Second, and more important, consumers are not technologically determined "processors"; rather, they are choice making agents. Thirdly, there are other elements of final demand, e.g., investment which are simultaneously affected by the process of income generation.

Thus an alternative is to close the model by explaining final demands from equations of economic behaviour as is commonly done in Keynesian type demand models. While the traditional I-O system does not explain the conditions governing final demands, Keynesian demand models deal with behavioural relationships such as consumption and investment functions and institutional relationships such as those relating to tax yeilds, money supply and price formation without looking at the details of interrelatedness of the production process. Thus both the Leontief I-O system and Keynesian demand models are complementary and together may form a complete macro model with proper feed-back between demand and supply. As Morishima and Nosse (1972, p 76) conclude:

> ....both views should be synthesised because, on the one hand, the Leontief process only gives partial streams of output, obtained by damming up the back flows through the channel of consumption and, on the other, Keynes' theory of the multiplier can be valid only if it is supplemented by accurate information about the structure of industrial outputs.

3.2 METHODOLOGIES OF LINKING I-O ANALYSIS TO A MACROECONOMETRIC MODEL

Demand and supply can readily be linked with complete feed-back if the elements of I-O final demand deliveries (F) can be explained in terms of Engel curves or some analogues of them (Klein, 1965, p 320). That is, we might specify the final demand deliveries, for example, as :

Ci = Ci (Yd) consumer demand for ith sectoral output

Ii = Ii (Y) investment demand for ith sectoral output

Ei = Ei (Xw) net export of ith sectoral output

Gi = Gi (N) government purchase of ith sectoral output where

Yd is disposable income

Y is GNP

Xw is world trade

N is population

The major problem with this approach, however, is that time series data on industrial final demand deliveries (Fi) are not available, except for the year(s) for which an I-O table has been computed. It would require much 'statistical faith' to base estimates of behavioural demand relations on one period or even very small samples (Klein, 1965, p 320). However, data on the components of GNE, which provide the empirical basis for Keynesian macro models, are usually available over time. Therefore, if the I-O final demand deliveries (Fi) can be linked to the usual components (C,I,G,X-M) of GNE, then we would have a complete model in which final demands will be determined from the equations of economic behaviour in the aggregate demand model and then allocated to the producing sectors by way of the I-O table.

Thus, the problem of linking I-O analysis to an aggregate demand model involves the following steps :

a) Link final demand categories (C,I,G,X-M) to I-O sectoral final demand deliveries (Fi).

b) Convert Fi to sectoral gross output (Xi) by the ususal I-O technique.

c) Link sectoral gross output (Xi) to sectoral value-added (Yi).

The evolution of the Brookings model is a good example of how an I-O table can be linked to a macroeconometric model. In an earlier version of the Brookings model, Fisher, Klein and Shinkai (1965) tackled the lack of time series data on sectoral final demand deliveries (Fi); given the time series data on sectoral gross outputs (Xi), Fi's were derived from the familiar I-O relationship :

$$F = [I - A]X \qquad .... \quad 3.1.3$$

where A is an n x n matrix of technical coefficients

X is an n x 1 column vector of sectoral gross outputs

and F is an n x 1 column vector of sectoral final demand deliveries.

This constructed series on sectoral final demand deliveries (Fi) was then linked to the GNE components (e.g., expenditure on consumer durables) by ordinary regression techniques. For example, if consumption (C) and investment (I) are the only components of GNE then final demand deliveries from the ith sector can be linked to C and I by regressing Fi on C and I, thus :

$$Fi = d_{i1} C + d_{i2} I + Ui$$

If there are m categories of final expenditures in GNE then the above equation can be expressed in matrix form as :

$$F = DG + U$$

where D is an n x m matrix of regression coefficients

G is an m x 1 column vector of GNE components

U is an n-component stochastic disturbance term.

With this relationship between G and F, the ususal I-O technique has been used to convert G to industry gross outputs (X). That is,

$$X = [I - A]^{-1} F$$

$$= [I - A] [DG + U]$$

$$X = [I - A]^{-1} DG + [I - A]^{-1} U \quad \ldots 3.2.10$$

Then the estimates of value-added were obtained from sectoral gross output (X), assuming a constant share of value-added in the sectoral gross outputs. This follows directly from the fixed input coefficient assumption of the static I-O model. Chalmers (1972) used almost the same methodology in linking demand to supply in the Thai economy.

However, the above procedure of regressing categories of final demand by use (e.g., demand for durables) on I-O sectoral final demand deliveries may run into a problem of degrees of freedom. In contrast to the ready availability of long time series data on sectoral value-added (Yi), frequently updated long time series data on sectoral gross output (Xi) are not usually available. This may leave us with a very small 'constructed' series of I-O sectoral final demand deliveries (Fi) as compared to categories of final demand (Gj) in a particular regression equation. But this problem can be solved either by keeping disaggregation of final demand by use within a reasonable dimension or by assuming *a priori* that some coefficients in the F matrix are zero, i.e., some producing sectors do not deliver to certain types of use; for example, it can be reasonably assumed that agriculture in general does not deliver to consumer demand for durables. Fisher-Klein-Shinkai (1965) and Chalmers (1972) followed the latter approach.

In a later version of the Brookings model, Kresge (1969) used an alternative method to connect aggregate expenditure categories to sectoral value-added (Yi). This method does not use the I-O relationship explicitly. Rather, Kresge assumed a stable relationship between categories of aggregate expenditure (Gj) and sectoral value-added (Yi) and regressed Yi on Gj, so that,

$$Y = EG + U$$

where E is an n x m matrix of regression coefficients

G is an m x 1 column vector of GNE components

Y is an n x 1 column vector of sectoral value-added

and U is an n-component stochastic disturbance term.

He used an iterative procedure until matrix E satisfies the property that its column sum is unity. That is, if e_{ij} is a typical element of E then $\sum_i e_{ij} = 1$. The E matrix was allowed to vary over time and it was shown to change continuously, but at a relatively slow rate. Thus he got around the assumption of constant technical coefficients in the usual I-O model and was able to capture some of the effects of technological change. However, Preston (1972, p 21) and Rao (1977, p 39) found that this technique presents difficulties for projection into the future as it is sensitive to starting E matrix in the successive iteration.

Later Preston (1972) used some of the elements of both these pioneering works in the evolution of the Brookings model and developed an alternative methodology. This methodology has been followed in constructing econometric models (e.g., the Wharton, the CANDIDE, the Bank of Finland model) which explicitly incorporate I-O relations. In this methodology, linking categories of GNE to the I-O sectoral final demand deliveries and hence to sectoral value-added may be summarized as follows.

If the static I-O framework is accepted, this implies a relationship between gross output and value-added in each sector. This relationship can be expressed as :

$$Y = BX \quad .... \; 3.2.11$$

where B is a matrix with off diagonal elements equal to zero and diagonal elements equal to one minus the column sums of the direct requirement matrix A. A typical element of B on the main diagonal is then

$$b_{jj} = 1 - \sum_i a_{ij} \; , \; j = 1,2....n \quad ... \; 3.2.12$$

Solving for sectoral gross output in terms of value-added results in

$$X = B^{-1} Y \quad ... \; 3.2.13$$

Substituting 3.2.13 into the static I-O framework, $AX + F = X$, we may write,

$$AB^{-1}Y + F = B^{-1}Y$$

$$\text{or, } F = [\,I - A\,]\,B^{-1}\,Y \quad \ldots\ 3.2.14$$

The properties of A and B ensure that matrix $[I - A]B^{-1}$ has the property of adding to unity columnwise. If dij is a typical element of $[I - A]\,B^{-1}$, then

$$\sum_i dij = 1\ , \quad j = 1,2,\ldots.n \qquad \ldots\ 3.2.15$$

After the link between the sectoral gross output and value-added, there remains the task of linking the I-O sectoral final demand deliveries (Fi) to GNE components (C,I,G,X-M). However, as mentioned before, in contrast to the ready availability of time series data on GNE components, we do not have time series data on I-O sectoral final demand deliveries (Fi). The only information we have on (Fi) is associated with the year(s) for which an I-O table is constructed. But if we assume that each producing sector's delivery (fij) to a GNE component (Gj) is a constant proportion (hij) of Gj then we can calcultate a matrix of coefficients (denoted the industrial distribution matrix, H) which provides, the link between the components of GNE and the I-O sectoral final demand deliveries.

This can be explained with a simple example. Let there be only two producing sectors and two categories of final expenditure. Therefore, for the year an I-O table is constructed, we have ,

$$F_1 = f_{11} + f_{12}$$

$$F_2 = f_{21} + f_{22}$$

where Fi are the total final demand deliveries by the ith sector

and f_{ij} are the ith sectoral delivery to the jth category of final demand.

Since time series data on Fi and f_{ij} are not usually available, we cannot use them in estimating demand relations. We can link them to GNE components on which time series data are usually available if we assume that each producing sector's final delivery is a fixed proportion of a particular component of GNE. That is, if Gj is a component of GNE then,

$$h_{ij} = f_{ij} / Gj \quad \text{is a constant}$$

such that $\sum_i h_{ij} = 1$ 3.2.16

Thus, we link Fi with Gj as :

$$Fi = \sum_j h_{ij} Gj$$

In matrix form,

$$F = HG \qquad .... \quad 3.2.17$$

where H is an n x m 'industrial distribution of final demand matrix'

G is an m x 1 column vector of GNE components

and F is an n x 1 column vector of sectoral final demand deliveries.

Substitution of 3.2.17 into 3.2.14 gives us

$$HG = [I - A] B^{-1} Y \qquad .. \quad 3.2.18$$

Solving for Y in terms of G gives the result,

$$Y = B[I - A]^{-1} HG \quad \ldots 3.2.19$$

The matrix $B[I - A]^{-1} H$ has as many rows as producing sectors in the direct requirement matrix A and as many columns as spending categories in the industrial distribution matrix, H, of final demand. If we denote $B[I - A]^{-1} H$ by E and call it the conversion matrix then we have (from 3.2.19)

$$Y = EG \quad \ldots 3.2.20$$

The properties of the $[I - A]B^{-1}$ and H matices, noted in 3.2.15 and 3.2.16 respectively, imply that the conversion matrix will satisfy the following :

$$\sum_i eij = 1, \quad \ldots 3.2.21$$

and from 3.2.21, it is clear that

$$\sum_i^n Yi = \sum_j^m Gj \quad \ldots 3.2.22$$

or, GNP = GNE in real terms.

That is, the sum of sectoral value-added equals the sum of final demands by spending categories. Thus, given the direct requirement matrix, A, and the industrial distribution of final demand matrix, H, a link can be established <u>in a given base period</u> between GNE spending categories and I-O sectoral value-added as

$$Y = EG \quad \ldots 3.2.20$$

The link between spending categories and sectoral value-added, given by 3.2.20, can be written more explicitly as :

$$Y_1 = e_{11} G_1 + e_{12} G_2 + \ldots + e_{1m} G_m$$

$$Y_2 = e_{21} G_1 + e_{22} G_2 + \ldots + e_{2m} G_m$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$Y_n = e_{n1} G_1 + e_{n2} G_2 + \ldots + e_{nm} G_m$$

where Gj are components of GNE and eij are elements of the conversion matrix, E.

Once this link is established, we can solve the sectoral value-added in terms of exogenous variables of the macroeconometric model. To show this we will consider a simple two sectoral I-O model with only two categories of final demand (consumption, C and investment, I). In this case, equations system 3.2.20 reduces to

$$Y_1 = e_{11}\ C + e_{12}\ I$$
$$\ldots\ 3.2.23$$
$$Y_2 = e_{21}\ C + e_{22}\ I$$

Having linked sectoral value-added to the usual components of GNE, the missing link of the income propagation mechanism in the usual I-O model can be established by assuming the following simple aggregate model :

$C = \alpha_1 Y_1 + \alpha_2 Y_2$ Consumption function

$I = I^*$ Exogenous investment

$Y = Y_1 + Y_2 = C + I^*$ National income identity

where α_i is the marginal propensity to consume (MPC) out of ith sectoral income.

Using the information contained in the above simple aggregate demand model, we can rewrite 3.2.23 as

$$Y_1 = e_{11}\ (\alpha_1 Y_1 + \alpha_2 Y_2) + e_{12}\ I^*$$
$$\ldots\ 3.2.24$$
$$Y_2 = e_{21}\ (\alpha_1 Y_1 + \alpha_2 Y_2) + e_{22}\ I^*$$

or

$$(1 - e_{11}\alpha_1)Y_1 - e_{11}\alpha_2 Y_2) = e_{12} I^*$$

... 3.2.25

$$- e_{21}\alpha_1 Y_1 + (1 - e_{21}\alpha_2)Y_2 = e_{22} I^*$$

or

$$LY = T \qquad \text{... 3.2.26}$$

$$\text{Therefore,} \quad Y = L^{-1} T \qquad \text{... 3.2.27}$$

where

$$L = \begin{bmatrix} (1 - e_{11}\alpha_1) & -e_{11}\alpha_2 \\ -e_{21}\alpha_1 & (1 - e_{21}\alpha_2) \end{bmatrix}$$

and

$$T = \begin{bmatrix} e_{12} I^* \\ e_{22} I^* \end{bmatrix} = \begin{bmatrix} T_1 \\ T_2 \end{bmatrix}$$

Thus, sectoral value-added (Yi) is explained by the exogenous variables of the aggregate model. This completes the loop in the multiplier process and we have a complete circle : demand - output - demand. And the exogenous variables of the aggregate demand model are the driving force.

With the link between demand and supply now in place, the multiplier[1] properties of the complete model may be examined. The reduced form of the complete model is given by equation 3.2.27, i.e.,

$$Y = L^{-1} T$$

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[1] A multiplier is defined as change in sectoral income due to a change in exogenously determined demand.

Therefore, the general formula for the multiplier is given by

$$\Delta Y = L^{-1} \Delta T \qquad \ldots 3.2.28$$

where

$$L^{-1} = 1/|L| \begin{bmatrix} (1 - e_{21}\alpha_2) & e_{11}\alpha_2 \\ e_{21}\alpha_1 & (1 - e_{11}\alpha_1) \end{bmatrix}$$

and $|L| = 1 - e_{11}\alpha_1 - e_{21}\alpha_2$

If we denote the elements of L^{-1} by wij, equations system 3.2.28 can be rewritten as :

$$\Delta Y_1 = w_{11} \Delta T_1 + w_{12} \Delta T_2$$

$$\ldots \quad 3.2.29$$

$$\Delta Y_2 = w_{21} \Delta T_1 + w_{22} \Delta T_2$$

From 3.2.29, we derive the following multipliers :

$$\Delta Y_1/\Delta T_1 = (1 - e_{21}\alpha_2)/|L| = w_{11} \text{ , given } \Delta T_2 = 0$$

$$\Delta Y_1/\Delta T_2 = e_{11}\alpha_2/|L| = w_{12} \text{ , given } \Delta T_1 = 0$$

$$..3.2.30$$

$$\Delta Y_2/\Delta T_1 = e_{21}\alpha_1/|L| = w_{21} \text{ , given } \Delta T_2 = 0$$

$$\Delta Y_2/\Delta T_1 = (1 - e_{11}\alpha_1)/|L| = w_{22} \text{ , given } \Delta T_1 = 0$$

From 3.2.30, it is clear that only if $\alpha_1 = \alpha_2$, (i.e., when MPCs out of each sectoral income are equal) will the 'aggregate' multiplier of the complete model reduce to the simple Keynesian multiplier. That is,

$$\Delta Y/\Delta T_1 = \Delta Y_1/\Delta T_1 + \Delta Y_2/\Delta T_1$$

$$= (1 - e_{21}\alpha_2)/|L| + e_{21}\alpha_1/|L|$$

$$= (1 - e_{21} \alpha_2 + e_{21} \alpha_1)/(1 - e_{11} \alpha_1 - e_{21} \alpha_2)$$

$$= 1 / \{1 - \alpha (e_{11} + e_{21})\} \quad ; \text{ since } \alpha_1 = \alpha_2$$

$$= 1 / (1 - \alpha) \; ; \text{ since } e_{11} + e_{21} = 1 \text{ from 3.2.21}$$

Therefore, $\Delta Y / \Delta T_1 = 1 / (1 - MPC)$

Similarly, $\Delta Y / \Delta T_2 = 1 / (1 - MPC)$

From 3.2.29 and 3.2.30, we can derive the following multiplier properties[20]

a) Given an increase in the exogenous demand for ith sectoral output, with the exogenous demand for all other outputs held constant,

i) the output of the ith sector increases (since $\Delta Yi / \Delta Ti > 0$);

ii) the output of every other sector increases, too (since $\Delta Yj / \Delta Ti > 0$);

iii) the output of ith sector increases by the largest amount (since $w_{11} > w_{21}$ and $w_{22} > w_{12}$).

b) Since the diagonal elements of L^{-1} are greater than the off-diagonal elements of the corresponding rows, the output of any sector j is (algebrically) more affected by the exogenous increase in demand for itself than by the exogenous increase in demand for the out-

[20] For the mathematical proof of these properties, please see Morishima and Nosse, in Morishima, M., Murta, Y., Nosse, T. and Saito, M. (eds), The Working of Econometric Models, Cambrodge University Press, 1972.

put of any other sector.

c) If $\Delta Y_1 = 0$, from the first equation of 3.2.29, we may write

$$\Delta T_1 = -(w_{12} / w_{11}) \quad \Delta T_2$$

Using this in the second equation of 3.2.29, we derive

$$\Delta Y_2^* / \Delta T_2 = (w_{22} w_{11} - w_{12} w_{21}) / w_{11}$$

where ΔY_2^* is the change in Y_2 due to change in T_2 when $\Delta Y_1 = 0$ If we take the difference between the last eqaution of 3.2.30 and the above equation, we get

$$\Delta Y_2 / \Delta T_2 - \Delta Y_2^* / \Delta T_2 = w_{12} w_{21} / w_{11} > 0$$

That is, an increase in output of any sector resulting from an increase in the exogenous demand for the same or some other sectoral output is less if outputs of a number of sectors are held constant than it will be if they are all permitted to vary.

Morishima and Nosse (1972) termed the properties (a i - iii) as Hicks law I, II and III respectively by analogy to Hicks'[21] derived laws for prices. They also termed properties (b) and (c) as Metzler's Theorem[22] and the Samuelson-LeChatelier Law[23] respectively.

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[21] Hicks, J.R., Value and Capital, Oxford University Press, 1939, pp 72-75.

[22] Metzler, L.A., 'A Multiple-Country Theory of Income Transfers', Journal of Political Economy, Feb. 1951.

[23] Samuleson, P.A., 'An extension of the LeChatelier Principle' Econometrica, April 1960.

The above multiplier properties show how any policy action or exogenous change in final demand works through different producing sectors. These simply are not tractable in a highly aggregate Keynesian model. This is why Klein (1978, p 1) says

> Yet the economic problems of today seem to be intractable when studied through the medium of simplified macro models. The new system should combine the Keynesian model of final demand and income determination with the Leontief model of intersectoral flows.

Of these multiplier properties, the last is the most revealing for the developing countries. It is held by many observers that in developing countries the supply of many sectors (specially of agriculture) with respect to price is inelastic (at the extreme is zero) due to structural bottlenecks and foeign exchange constraints on essential imported raw-materials (Kalecki, 1976; Rao, 1952; Taylor, 1978). In that situation, increase in demand for outputs of those sectors will result in increases in the general price level. That is, the Keynesian multiplier will work in nominal terms only; thus, we may observe a full-employment multiplier for an economy which has substantial underemployment of resources (Rao, 1952).

3.3 PRICE CONVERSION

One of the consequences of disaggregating demand relations is that the detailed expenditure flow will involve relative prices as prices carry the impact of supply back to demand. However, a theory of price formation is lacking in the general I-O model (Klein, 1953,1956; Morishima, 1956,1957). Usually price formation in the I-O model is dealt with by assuming that sectoral prices are cost determined.

Reading down the ith column of the I-O table, we get cost-determined output price in sector i is :

$$P_i = \sum_i a_{ij} P_j + a_{li} w + a_{ki} r + a_{mi} P_m \quad .. \quad 3.3.1$$

where Pi is the output price in sector i at factor cost and w, r and Pm are the price of labour, capital and non-competitive imports respectively. The a are the domestic I-O input coefficients while a_{li} , a_{ki} , a_{mi} are coefficients of labour, capital and non-competitive imports respectively.

Representing 3.2.1. in matrix form, we get

$$P'[I - A] = wa'_l + ra'_k + P_m a'_m \quad ... \quad 3.3.2$$

where P' is a row vector of sectoral prices and a'_l ,a'_k, a'_m are row vectors of labour, capital and import coefficients respectively. Inverting 3.3.2 we get,

$$P' = [wa'_l + ra'_k + P_m a'_m] [I - A]^{-1} \quad ... \quad 3.3.3$$

Equation 3.3.3 states that each sector's output price will be sum of direct and indirect primary factor costs in production (Taylor, 1979; Watanabe and Shishido, 1970).

However, prices determined in the producing sectors are not the prices that appear in the demand relations. The demand functions have price variables (e.g., consumer durable price) which is an index of several cost-determined prices in different producing sectors/industries. Thus, sectoral prices must be translated into a vector of final demand deflators.

Since the jth column of the commodity conversion matrix, E, fully describes the way in which the jth final demand is allocated to various producing sectors, it seems quite reasonable that these proportions could be used as weights when transforming the sectoral prices into the synthetic final demand prices (Kresge, 1969; Fisher-Klein-Shinkai, 1965; Preston, 1972; Chalmers, 1972).

One of the most important side conditions that the use of I-O theory satisfies is the identity

$$\sum_{i}^{n} Yi = \sum_{j}^{m} Gj \qquad \ldots \quad 3.2.22$$

or GNP = GNE in real terms.

That is, in real terms, expenditure components (Gj) sum to the same total as the sectoral value-added (Yi).

Maintenance of this consistency suggests that sectoral prices and final demand deflators must be linked by a conversion technique that preserves the current price identity corresponding to 3.2.22. Therefore,

$$\sum_{i}^{n} PiYi = \sum_{j}^{m} P^{*}jGj \qquad \ldots\ 3.3.4$$

or GNP = GNE at current prices.

This can be written in matrix form as :

$$P'Y = P^{*\prime}G \qquad \ldots\ 3.3.5$$

But Y and G are linked to each other via the commodity conversion matrix, E, as

$$Y = EG \qquad \ldots\ 3.2.20$$

Therefore,

$$P'EG = P^{*\prime}G \qquad \ldots\ 3.3.6$$

Thus, one definition of final demand deflators (P*) that satisfies 3.3.4, given P is

$$P^{*\prime} = P'E \qquad \ldots\ 3.3.7$$

That is,

$$P^{*} = E'P \qquad \ldots\ 3.3.8$$

A typical element of 3.3.8 is :

$$P^{*} = e_{1i} P_1 + e_{2i} P_2 + \ldots . + e_{ni} P_n$$

Thus, cost-determined I-O sectoral prices can be transformed into final demand deflators by using the weights of the transposed commodity conversion matrix, E.

3.4 A REVIEW OF MACRO MODELS INCORPORATING INPUT-OUTPUT RELATIONS : THE CASE OF DEVELOPING COUNTRIES

Ever since Klein posed the question, "what kind of macroeconometric model for developing countries?" and suggested a possible methodology in 1965, there have been very few attempts at constructing a complete macro model for developing countries explicitly incorporating I-O relations. The first attempt to construct a macroeconometric model for a developing country with feedback between supply and demand was made by Klein himself and Behrman. The objective of the Klein-Behrman model (1970) for the Brazilian economy was to extend and modify the standard Keynesian short-run model and the Harrod-Domar growth model in order to incorporate some features (e.g., supply deficiency in agriculture) which are peculiar to a developing country like Brazil.

While elements of aggregate final demand (consumption, investment, etc.) are explained as usual within the standard Keynesian short-run macro model, the supply side of the model is provided by production relations for three sectors (primary, secondary and tertiary). However, they did not use I-O relationships explicitly to explain the supply side. Rather, production of value-added in each sector is expressed in the form of demand relationships; the explanatory variables are elements of aggregate final demand. But these equations can be interpreted as transformation of an I-O type production process. However, they extended the production equation for the primary sector to incorporate some structural characteristics of this sector and estimated separate equations for coffee yeild and coffee acreage. The predictive power of this model was found to be satisfactory.

Chalmers'[24] (1972), attempt to integrate demand and supply in the Thai economy is important in many respect. Being an earlier attempt at constructing an integrated model for a developing economy, he confronted many problems that are peculiar to these economies. One particular problem is the non-availability of an input-output table. Besides formidable data scarcity, most of the developing countries do not have an explicit I-O table. In the absence of an I-O table for the Thai economy, Chalmers used the usual I-O linearity assumption that each sector uses a fixed proportion of other sectors' output as inputs in order to specify the sectoral input demand functions. In addition, he assumed that the final demand deliveries from each producing sector are a constant fraction of the components of GNE (C,I,G,X-M). With these two assumptions, sectoral value-added can be thought of as fixed proportions of the categories of final demand (C,I,G,X-M). When an I-O table is available, these proportions are the elements of the commodity conversion matrix, E. But in the absence of an explicit I-O table, Chalmers calculated these proportions by using least squares regres-

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[24] Though Chalmers' methodology is very similar to that of Fisher, Kelin and Shinkai (1965) and Kresge (1969), he claims that he was unware of Klein (1965), Fisher-Klein-Shinkai (1965) and Kresge (1969) until his own work was completed.

sion of sectoral value-added on categories of final demand, with the imposition of condition that the column sum of coefficients is one, so that properties of the conversion matrix, E, listed in equations 3.2.21 and 3.2.22 are satisfied. Thus, sectoral value-added is explained by GNE components (C,I,G,X-M) which themselves are explained by sectoral value-added by way of Engel curves or analogues of them.

Although supply (sectoral value-added) and demand (GNE components) can be linked even if there is no I-O table available, there could be a degrees of freedom problem in using this regression technique. Most developing countries do not have long time series data on GNE components; thus a detailed set of final demand categories used as explanatory variables will mean fewer degrees of freedom. Chalmers resolved this problem exactly the same way as Fisher, Klein and Shinkai (1965) did with the Brookings model. That is, he specified a priori zero restrictions on coefficients to reduce the number of explanatory variables in a particular regression equation. This amounts to finding a priori producing sectors independent of one another (in terms of input use) and sectors that do not deliver to a particular category of final demand. That is in the I-O sense, some of the elements in the direct-indirect requirement matrix and in the industrial distribution of final demand matrix are zero.

Klein and Del Rio (1974) constructed a macroeconometric model for the Mexican economy, whose supply side is provided by production relations for three sectors (primary, secondary and tertiary). The model specification is very much similar to the Kelin-Behrman (1970) model for Brazil with necessary modifications to take care of some charateristics which are peculiar to the Mexican economy. Value-added in each sector is specified as a function of elements of aggregate final demand with I-O interpretations. The model has been simulated with two alternative assumptions about the behaviour of the federal government - one deflationary and the other expansionary - in order to set up lower and upper bounds within which the real economy would probably move.

Marzouk (1975) developed a macro model for Sudan to provide an empirical description of the structural characteristics of the economy and to forecast its growth pattern. The supply side of the model is represented by equations for value-added by sector - with an input-output interpretation - and an aggregate production function. The model reveals the importance of primary production in the export sector (especially cotton and oil seeds) and of machinery imports in capital formation. Policy simulation indicates that real GNP - while its composition will remain basically stable - will double by 1985 growing at 6% per annum. Employment will grow at 4% annually while the rate of inflation will be around the 5% mark.

Thoguh these models attempt to incorporate feedback between supply and demand, none of them used I-O relationships explicitly for this purpose. The sectoral value-added has been specified as a function of elements of aggregate final demand and coefficients for output conversion have been estimated directly from these relations. But due to the presence of intercept terms and omission of certain GNE components from value-added relations, Kelin-Behrman (1970), Klein-Del Rio (1974) and Marzouk (1975) have found conversion coefficients whose columns do not add up to one. As a result, GNP is not equal to GNE in real terms and impacts of GNE components on sectoral value-added are found to be biased either upward or downward. This problem, however, does not arise if I-O relations are used explicitly. If I-O tables are not available, it is suggested that all sectoral value-added functions be estimated simultaneously with the restriction that there be no intercept and the column sum of coefficients be unity (Sapir, 1976).

Following the original ideas developed in the Brookings Econometric Model and the work of Preston (1972), Seguy and Ramirez (1975), for the first time, used an I-O table explicitly within a macroeconometric model for a developing country. They linked the 1960 I-O table of Mexico to a revised version of the DIEMEX-WEFA Forecasting Model of the Mexican economy. The integrated model was used to simulate policy measures. Particular attention was given to policies involving changes in technology, i.e., changes in the I-O direct requirement coefficients. For example, policy was simulated for an increase in government expenditure directed toward increasing the efficiency of certain sectors of the economy. Increase in efficiency was defined in two ways :

a) As a result of the policy change a given sector becomes more efficient in the sense that it uses less input per unit of its output. That is, column coefficients of the sector in question are reduced.

b) The sector in question becomes more efficient in the sense that it produces better products, so that the using sectors need less as input per unit of output. That is, row coefficients of the sector in question decline.

In view of their importance in economic development three sectors - agriculture, basic metal industries and transport - were selected to simulate the effects of government investment. It was found that investment in agriculture which tends to increase its efficiency (measured by reduction in row coefficients) would bring about a greater stimulus to industrial production than new government investment directed toward the industrial sector itself.

This exercise reveals the usefulness of incorporating inter-industry transactions in an aggregate model. It shows that the same policy can have different effects depending on sectors of the economy to which a particular policy is directed. Such information is particularly important in formulating a development plan in terms of allocating investment to various sectors.

Canlas, Encarnacion and Ho (1976) constructed a macro model for the Philippine economy, which explicitly incorporates an I-O table. Their objective was to show interrelationships among : (a) the distribution of employment in the production sectors, (b) a measure of income distribution (share of employment income in GNP) and (c) consumption demand, with their implications for economic development. The presence of an I-O structure in the model enabled them to link consumption demand to sectoral employment and to the share of employment income in GNP. The sectoral projections show that with a decrease in the share of employment income in GNP, the share of agriculture in total private consumption and in total employment increases. The service sector, on the other hand, moves in the opposite directions : its shares in total private consumption and in total employment declines, as the share of employment income in GNP declines.

Bonnici (1980), in his attempt to integrate the I-O and Keynesian models for the Maltese economy, tackled two important questions : (a) Is a time series of I-O tables useful and (b) how to combine a time-series of I-O tables with a traditional final demand model.

In contrast to Tilanus' (1966) negative answer to question (a) above, Bonnici found that time series data on I-O tables provide useful information. He observed that Tilanus' negative finding was mostly due to the fixed proportionality assumption of the traditional input-output model. As a result, Bonnici substituted Leontief fixed proportion production functions with the generalised cost function[25] to derive cost-minimizing input demand functions. These derived input demand functions allow for factor substitutions and reduce to the Leontief specification for the case of no factor substitution. This extension of the traditional I-O model provides the supply dimension of the macro model. The demand side of the economy is captured by setting up sectoral consumption functions. Contrary to the previous findings of Tilanus, Bonnici found that export forecasts, utilizing the time series of I-O tables, are superior to those of the traditional I-O model based on a single period sample.

One of the problems that remains in the integration of I-O and Keynesian macro models is the question of constancy of the direct requirement matrix (A) and the industrial distribution of the final demand matrix (H). Traditionally, this problem has been tackled by modelling the error on the assumption that the factors that cause the change in technology (A matrix) and industrial distribution of final demands (H matrix) are also the factors that are responsible for variations in the observed and predicted values of the

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[25] The generalised cost function is given by : $C = h(X) \sum_i \sum_j b_{ij} \sqrt{(p_i P_j)}$, where Pi is the price of input i, X is the sectoral output level and h(X) is a continuous and monotonically increasing function of X, such that h(0) = 0 with $h \longrightarrow \infty$ as $X \longrightarrow \infty$. Also parameter values satisfy $b_{ij} = b_{ji}$. For details, please see Diewert (1971), "An Application of Shephard Duality Theorem : a Generalised Leontief Production Function", Journal of Political Economy, LXXIX : 481-507.

sectoral value-added. Bonnici suggests an alternative solution to this problem, if a time series of I-O tables is available. He suggests modeling the A and H matrices directly. A can be modeled directly by using the generalized Leontief cost function which allows for factor substitution. And H can be modeled directly through behavioural equations such that sectoral I-O final demand deliveries are explained by Engel curves or some analogues of them.

Although these applications of the integration methodology are few, they nonetheless reveal 'what kind of macro models' might be constructed for developing countries. The macro model which explicitly incorporates inter-industry flows provides a much better understanding of the intricate problems of developing countries. The integrated model, having full feed-back between demand and supply, can be a useful aid to development planners.

3.5 SUMMARY

The basic features of an open static input-output model and its use in conjunction with a macro model have been discussed in this chapter. It has been found that although the I-O analysis is a useful technique in detailing the supply side of an economy, it has some shortcomings. In particular, it short-circuits the income propagation mechanism by the assumption that final demand is exogenous and thus not taking into account income elasticity of demand. This can be overcome by closing the model with households as another "sector" which supplies labour inputs and uses (consumes) commodities supplied by other sectors. But this is not satisfactory for at least three reasons : (a) households are treated as mechanical creatures with fixed coefficients of consumption, (b) it leaves out receivers of non-employment income in the "endogenized" households sector by assuming that households supply only labour inputs and only labourers consume, and (c) it does not take into account other components of demand (e.g., investment) that might also depend on income and hence misses part of the feed back of income on further demand.

Klein's (1965) suggestion to close the model by explaining the sectoral final demand deliveries with Engel curves or some analogues of them may run into statistical problems because time series on sectoral final demand deliveries are not generally available. This led Preston (1972) to suggest an alternative approach which links sectoral final demand deliveries to GNE components on which relatively long time series data are usually available. With this link in place, the loop of the income propagation mechanism becomes complete and a macro model can be developed with joint feedback solutions of the supply and demand process. However, this alternative methodology of integrating an I-O system with the Keynesian system has short-comings as well. In particular, it assumes constant technical coefficients and a fixed distribution of sectoral final demand deliveries in GNE components. This problem led to modeling the errors on the assumption that factors which make for changes in technology and taste are the same that give rise to deviations between the observed and predicted sectoral value-added. To resolve the problem of technological and taste change, Bonnici (1980) suggested replacing the fixed coefficient production function with a generalised Leontief production function and explaining sectoral final demand deliveries with behavioural equations. However, this alternative solution can be attempted only when a time series of I-O tables is available.

Another problem associated with disagregating demands is that detailed expenditure flows involve price relatives. The I-O system does not have a theory of price formation, other than postulating an equality between costs and prices in each sector. Attempts have been made to combine these cost-determined sectoral prices with input weights and thus create several final demand deflators needed in order to account for variation in the components of final demand. It has been found that the 'commodity conversion' matrix which links components of GNE to the sectoral final demand deliveries can be used to establish the link between final demand deflators and cost-determined sectoral prices.

After reviewing the methodology of integration, various multiplier properties of the 'complete' model have been examined in this chapter. These properties may be summarized as follows :

a) If MPCs out of different sectoral income are equal, then the aggregate multiplier[26] derived from the complete model is identical with the naive Keynesian multiplier.

b) Given an increase in exogenous demand for ith sectoral output, the exogenous demand for all other outputs being held constant : (i) the output of ith sector increases, (ii) the output of every other sector increases, and (iii) the output of ith sector increases most.

c) The ouput of any sector j is (algebrically) more affected by the exogenous demand for itself than by the exogenous demand for the output of any other sector.

d) An increase in output of any sector resulting from an increase in the exogenous demand for the same or some other sectoral output is less if outputs of a number of sectors are kept constant than if they are allowed to vary.

Of these, the last multiplier property is the most important for developing countries in which various sectoral supplies are generally inelastic due either to structural rigidity or to foreign exchange constraints on essential imported raw

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[26] The aggregate multiplier is defined as the sum of sectoral multipliers.

materials. In this situation, the Keynsian multiplier may portray developing economies as characterised by "full-employment" since the Keynesian multiplier will appear to work only in nominal terms (Rao, 1952).

Finally we reviewed some applications of the integrated model in developing economies and it has been found that a model with joint feed back between supply and demand can be a useful aid to development planners.

Chapter IV

A MACROECONOMETRIC MODEL OF BANGLADESH

> Models constitute a framework or a skeleton and the flesh and blood will have to be added by a lot of common sense and knowledge of details.
>
> - Jan Tinbergen
>
> (Nobel Lecture)

The purpose of this thesis is to construct an aggregate demand model with a view to integrating it with the 1976-77 input-output table of Bangladesh. That is, to explain the final demand deliveries by the producing sectors in the 1976-77 I-O table from the equations of economic behaviour as well as linking macroeconomic policy variables to the sectoral value-added. This, then, will complete the demand-supply-demand loop of a complete macro model with simultaneous interactions. In the light of the discussion in Chapter II, it is clear that there is a need to construct a macroeconometric model from which one can explain the final expenditure categories and this then can provide a demand dimension to the 1976-77 I-O table of Bangladesh. In this chapter, an attempt will be made to do so. The period of the present study is 1959-60 to 1980-81.[27]

4.1 SPECIFICATION OF THE MODEL

The model consists of a few relatively simple equations. It attempts to explain the behaviour of such economic variables as consumption, investment, imports, exports, government revenue and expenditure. The structure of the aggregate model is specified as follows :

CP = f(Yd)	Private consumption function
CG = CG*	Exogenous public consumption
I = f(Y,CR*,FCA*)	Gross fixed investment function
MC = f(Yd,CS*)	Consumer goods import function
MI = f(I)	Capital goods import function
MR = f(Y)	Raw-material import function
EX = EX*	Exogenous exports
Y = CP + CG* + I + EX* - MC - MI - MR	National income identity
Yd = Y - TR*	Disposable income

where CP = Private consumption of goods and services

CG* = Public expenditure on goods and services

I = Gross fixed investment

MC = Imports of consumer goods

MI = imports of capital goods

MR = Imports of raw-materials

EX* = Exports

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[27] The fiscal year in Bangladesh runs from July to June.

CS* = Capital accounts surplus

CR* = Credit advanced by Banks & financial institutions

FCA* = Foreign capital assistance

TR* = Real income tax

Y = Gross national products

Yd = Disposable income

Asterisks denote exogenous variables.

While the rationale of the above specification and regression results have been elaborated in the sections to follow, some preliminary comments about the model are in order. The structure of this model involves, in many respects, heroic simplifications of the working of a complex economy. In constructing this model, compromise had to be made in at least three respects : (a) the level of aggregation, (b) the specification of the equations and (c) the reilability of data.

The first compromise that had to be made was the appropriate level of disaggregation. Whereas the description of a complex economy may require a thoroughly disaggregated model, we could achieve a disaggregation consistent only with the final demand categories of the most recent (1976-77) I-O table for Bangladesh. Although this serves the present purpose, a more disaggregated macroeconomteric model will be more useful if an I-O table with more final demand categories becomes available in future. But the major hurdle has been the paucity of data. Nonetheless, to the extent data availability permitted, attempts have been made to incorporate a greater disaggregation. For example, for the period 1972-73 to 1980-81, separate functions for private consumption of food and other commodities and for private and public investments have been estimated.

The second trade-off is between elegance of specification and resulting degrees of freedom. Whereas "correct" specification is implied by high precision of the estimates, the precision level declines with the decline in the degrees of freedom. Therefore, in introducing variables and a lag structure a choice had to be made. The lag structure involves a maximum of one period lag and the equations have at most three explanatory variables.

Though this model is very much simplistic and cannot capture many aspects (e.g., internal migration, population, supply deficiency, external debt, etc.) of the Bangladesh economy, it still has the flavour of it. This flavour is retained by the way the monetary sector is linked to the real sector of the economy. Traditionally, investment functions link the monetary sector to the real sector via the interest rate. But it seems very unlikely that the interest rate would be significant in investment functions of an underderdeveloped economy like Bangladesh where organised money and capital markets are almost non-existent.[28] This model links the monetary sector to the real sector by specifying an in-

[28] This issue has been discussed more elaborately in Section 4.2.2.

vestment function with credit advanced by banks and financial institutions as one of the arguments in it. In Bangladesh where interest rates do not reflect the cost of borrowing and credit is regulated by the central bank's over-all monetary programmes, the credit market always remains in disequilibrium. Where there are so many worthwhile ventures, it is usually the case that demand for credit exceeds supply. Thus, credit availability is an effective constriant on investment.

The third compromise involves a very common problem, that is, the reliability of data. Time and financial limitations did not permit us to undertake collection of data from primary sources. Thus the model is constructed on the premise that data already published by various government and international agencies provide a basis for experimenting with an econometric model for Bangladesh. At times, however, our hope was seriously dashed when data published by the same agency showed inconsistencies. Data published by different agencies had to be cross-checked and it has been found that data compiled by the World Bank are more consistent than any other. The other major sources of data are the Bureau of Statistics and the Planning Commission, Government of Bangladesh. For the period 1959-60 to 1969-70, the sole source of data is Alamgir and Berlage (1974).

It may be mentioned, again, at this point that during the period prior to December 1971, most of the national income and expenditure data for Pakistan were not collected for the provinces of which Bangladesh was one. Alamgir and Berlage (1974) did a formidable job in attempting to separate Bangladesh national income statistics from the Pakistan national income accounts for the period 1959-60 to 1969-70. Not surprisingly, they had to use heroic and ad-hoc assumptions in adjusting these data for consistency. This leaves open the question of legitimacy in using this data series in constructing a macroeconometric model. Since there is no other source of data for the period prior to 1971, the choice was either to use whatever data series is available and thus take advantage of greater degrees of freedom, or to confine the study only to the period after liberation (1972-73 to 1980-81). The former option has been chosen, despite the possibility that there might have been major structural changes due either to reorganisation of the economy after independence or to expectations aroused by independence itself. However, in tests for such structural shifts, the dummy variable for the intercept has been found significant only in cases of the consumption function and of consumer goods and raw-material import functions (see Sections 4.2.1 and 4.2.3).

Another problem associated with the data is the high collinearity among variables.[29] In such a situation, it is difficult to disentangle effects of individual explanatory

[29] Correlation and co-variance matrices are given in Appendix E.

variables. However, with multicollinearity, the problem is one not of existence or non-existence but of how serious or problematic it is (Maddala, 1977, p 183). As long as the collinearity is not perfect, people use some rules of thumb and judgement in deciding whether multicollinearity is serious or not (Maddala, 1977, p 186). Even when it is found to be serious, there is no straight forward cure to it and sometimes a remedy may be worse than the disease (Gujarati, 1978 p 187). In our particular case, we do not consider multicollinearity a serious problem as long as we are concerned with over-all relationships and not with testing particular hypotheses. Since our aim is to find general relationships to be used later in the I-O model, we can ignore multicollinearity as long as signs of the parameters do not contradict the received theory.

As a first approximation, ordinary least squares (OLS) regression has been used to explore the preliminary specifications. Even though the OLS method does not give consistent estimates of the parameters in the presence of simultaneity (because of correlation between the residuals and the regressors), sometimes it is possible to discern the direction of the bias of the OLS estimates. More importantly, it has been found that the OLS method is more robust against specification errors than many of the simultaneous equation (consistent) methods and also that predictions from equations estimated by the OLS method often compare favourably with those obtained by the simultaneous equation methods (Maddala, 1977, p.231). Besides, even if OLS estimates are biased, they often have smaller dispersion about the mean value of a set of estimates.[30] Despite its failing so far as biasedness is concerned, OLS method remains a convenient, if somewhat untrustworthy means of testing individual equations (Wynn and Holden, 1974, pp 119-20). However, as Klein (1969, p 183) points out

> ....it does not follow that the system as a whole functions the same for the consistent and inconsistent method of estimation. .... Many small differences can have significant system-wide effects, and there is a pay-off in seeking consistent estimates.[31]

Consequently, after initial screening of the equations, the two-stage least square (2SLS) method has been used for the final version of the model. Though "this is less than satisfactory, but it is the way models of any complexity are in fact constructed" (Klein, 1971, p 22). The use of 2SLS estimation technique does not only ensure the consistency of estimates but it also takes care of over-identification of the model. In this particular case, the model has exacly the same number of independent and consistent equations as number of endogenous variables, so that it has unique mathematical solution. However, the model is statistically over identified. That is, we get multiple estimates of parameters. In this situation, the 2SLS produces some average of

[30] For details on this issue, see Beals (1972) pp. 151-52.

[31] Emphasis added.

the multiple estimates. The 2SLS estimates are asymptotically unbiased and consistent.

4.2 REGRESSION RESULTS

The OLS regression results of various functions are discussed in this section. The 2SLS estimate of the final version of the model will be presented in the section to follow. All variables are measured in 1972-73 constant prices if not mentioned otherwise. The data cover the periods 1959-60 to 1969-70 and 1972-73 to 1980-81. Data for the period 1970-71 and 1971-72 are not available. However, these two periods were the most unstable periods due to the civil war. Figures in parentheses are t-values.

4.2.1 Consumption Function

Aggregate consumption in the economy is composed of private and public consumption. Therefore,

$$C = CP + CG$$

where C is aggregate consumption

CP is aggregate private consumption

and CG is aggregate public consumption.

While public consumption (CG) is assumed to be exogenous, private consumption (CP) is assumed to be endogenous. To explain private aggregate consumption we have first tried a very naive Keynesian consumption function, i.e.,

$$CP = f(Yd)$$

where Yd is real disposable income.

The estimated equation for the period 1959-60 to 1980-81 is,

$$CP = 1807.3 + .868\ Yd \qquad \bar{R}^2 = .94,\ D\text{-}W = 1.97$$
$$(.605) \quad (16.721)$$

The estimated marginal propensity to consume (MPC) is .87 which seems quite plausible for a country like Bangladesh with a low level of income. Though the estimated MPC is very close to Hossain's (1973) findings (Hossain estimated the MPC to be .84), it is higher than Alamgir and Berlage's (1974) estimated MPC (=.79). The difference between our estimate and that of Alamgir and Berlage may be due to a shift in the consumption function. In fact, Lackman and You (1979) did find such a structural shift after 1971-72. A test for structural shift in the private consumption function after 1971-72 supports Lackman and You's (1979) findings. The regreesion result with dummy for the intercept is,

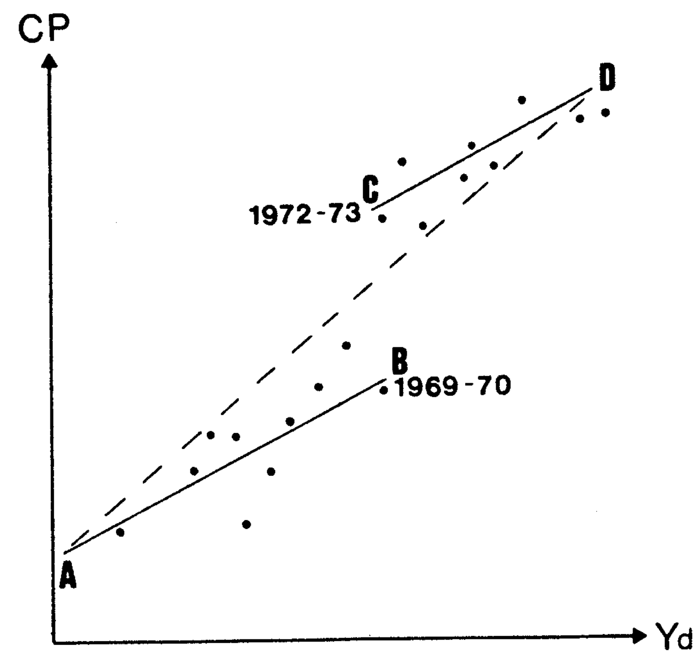
$$CP = 9246.2 + .78\ Yd - 3690.2\ D\ ;\ \bar{R}^2 = .99,$$
$$(5.316) \quad (27.911) \quad (-7.725) \qquad D\text{-}W = 2.01$$

where D = 1 for 1959-60 to 1960-70

= 0 for 1972-73 to 1980-81

The dummy variable is highly significant, indicating an upward shift in the consumption function in the later period. An interesting point to note is that the MPC (=.78) with the dummy variable is found to be almost the same as that found by Alamgir and Berlage for the period 1959-60 to

1969-70. These results support the hypothesis that there has been an upward parallel shift of the consumption function. Thus, our initial estimate and that of Hossain for the MPC are biased because no account was taken of this structural shift. This phenomenon can be illustrated in the the following diagram :



AB represents the regression line for the period 1959-60 to 1969-70 and CD for the period after independence. If a single regression line (AD) is fitted without accounting for an intercept change, then the slope (MPC) will be overestimated.

Private consumption is likely to be different in the rural and urban areas (Islam, 1965). Given the fact that Bangladesh is predominantly an agricultural country, with 90 percent of the total population living in the rural areas, it is worth investigating separate consumption functions for rural and urban areas. However, since we do not have separate data on consumption and income for rural and urban areas, we have estimated an aggregate private consumption function with agricultural income (YA) and income from all other sectors (YR). It is expected that agricultural income (YA) will be a close approximation for rural income as agricultural activities are confined mostly in rural areas. Similarly, as industrial and service sectors' activities are confined mostly in the urban centres, income from the rest of the sectors (YR) can be used to approximate urban income. Agricultural income (YA) includes income from crops, forestry, livestock and fisheries. This corresponds to nine (rice, wheat, jute, cotton, other crops, livestock, fisheries and forestry) sectors classified as agriculture in the 1976-77 I-O table of Bangladesh.

The estimated equation for the period 1959-60 to 1980-81 is

$$CP = 6263.6 + .618\ YA + 1.01\ YR\ ;\ \bar{R}^2 = .97$$
$$(1.974)\quad (3.906)\quad (10.718)\quad D\text{-}W = 1.62$$

Both variables are significant at the 1% level and as expected, MPC out of agricultural income is less than that out of all other sectors' income. The urban people exposed to 'modern' life style and influenced by 'demonstration effect' are expected to have higher MPC than the 'self-contained' rural people who are accustomed to a very modest living and to whom many of services and goods are simply not available. However, the exceptionally high value for the MPC (=1.01) out of other sectors' income (YR) is disturbing. This may be due to high collinearity between YA and YR; the correlation coefficient between them being .85, some of the effects of YA may have been captured by YR.

4.2.1.1 Consumption Functions for Food and Other Commodities

It has been hypothesised by many observers (Islam 1965, Vernardakis 1978) that changes in income and prices affect changes in consumption demand for food differently from that for other commodities in an underdeveloped economy. With a very low level of per capita income, it is very unlikely that relative price will really matter in the consumption demand for food, especially when the consumption basket is dominated by very low category of foods at the survival level. People may substitute among different types of food (lower category for better category) when food prices in general rise; but they will continue to spend nearly the same amount on food as it is already at a bare minimum (and in certain cases below minimum)[32] and cut back on other consumption (services, durables, etc). The single most important variable in the consumption function for food is, then, expected to be per capita income and our estimation results support this hypothsis. The regression results for the period 1972-73 to 1980-81[33] are,

$$PCF = -124.08 + 287.07\ RFP + .473\ PYd\ , \bar{R}^2 = .51$$
$$(-.393) \quad (.582) \quad (1.093) \quad D\text{-}W=2.29$$

$$PCF = 43.828 + .68\ PYD\ , \bar{R}^2 = .55,\ D\text{-}W=1.8$$
$$(.360) \quad (3.294)$$

where PCF is per capita consumption of food

RFP is relative price of food, defined as the ratio of the food price index to the all items CPI

and PYd is per capita disposable income.

The relative price of food (RFP) is not significant and has a positive sign. On the other hand, per capita disposable income (PYd) is highly significant and adjusted $\bar{R}^2$ increases when RFP is dropped from the equation.

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[32] One estimate shows that in rural areas about 84% and in urban areas about 76% of the population live under 'poverty line' defined by minimum acceptable consumption requirement, Alamgir, M., Bangladesh : A Case of Below Poverty Level Equilibrium Trap, Dacca: Bangladesh Institute of Development Studies, 1978 (pp 15-16).

[33] Data for the period prior to 1972-73 are not available.

The regression results for consumption of other commodities are,

$$PCO = 179.51 - 115.96\ ROP + .131\ PYd\ , \quad \bar{R}^2 = .61$$
$$(1.440) \quad (-1.440) \qquad (1.392) \qquad D\text{-}W = 2.46$$

$$PCO = 14.609 + .22\ PYd\ , \quad \bar{R}^2 = .55\ , \quad D\text{-}W = 1.80$$
$$(.361) \quad (3.295)$$

where PCO is per capita consumption of other commodities

ROP is relative price of other commodities, defined as a ratio of all other (except food) prices to the all items CPI

and PYd is per capita disposable income.

Relative price of other commodities (ROP) is significant at the 20% level and has the expected (negative) sign. Inclusion of relative price raises adjusted $\bar{R}^2$ from .55 to .61. Price elasticity of consumption of other commodities, evaluated at means is -.73. Less than unity price elasticity of demand implies that the consumption bundle is very much dominated by essential items.

These two sets of results show how important per capita income is in per capita consumption demand for food. Whereas 68% of incremental per capita income goes to consumption of food, only 22% goes to consumption of other commodities. This result broadly conforms with the findings of the 1973-74 Household Expenditure Survey by the Bureau of Statistics, (Government of Bangladesh, 1980a, p 19).

4.2.2 Gross Fixed Investment

Usually investment functions link the monetary sector to the real sector of an economy. The link between the two sectors is traditionally provided by the interest rate, which is determined in the money market and enters into the investment function. However, it is very unlikely that in the case of Bangladesh the interest rate would play such a role. The fundamental reason for this is the virtual non-existence of an organised capital market. The Dacca Stock Exchange (DSE) which remained defunct after 1971 was reopened and reactivated only from mid-1976. However, the total number of companies listed on the DSE still remains very small. The fact that only 18 companies are listed on the DSE[34] indicates that the major source of external financing is either commercial banks or various financial institutions, set up by the government to encourage private investment. However, the interest rates charged by banks and other financial institutions hardly reflect market conditions. The industrial lending rates are deliberately kept low to encourage private investment and are often so low that the real interest rate is negative. While the average nominal interest rate is 10% - 11%, the average annual (year to year) inflation rate is 18.5%.[35] Moreover, there is not much variation in the interest rate structure of Bangladesh as can be seen from Table 4.1

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[34] Annual Report, 1979-80, Bangladesh Bank, p 49.

[35] Bangladesh Current Economic Situation and Review of the Second Plan, World Bank, 1981, pp 188, 216.

TABLE 4.1

Interest Rate Structure of Bangladesh, 1971-1982

	December 1971 - June 1974	July 1974 - March 1976	April 1976 - April 1977	May 1977 - July 1977	August 1977 - Oct. 15, 1980	October 16, 1980 - present
Bank Rate						
- General rate for borrowing from Bangladesh Bank	5.0	8.0/a	8.0	8.0	8.0	10.5
- Rate for borrowing by Bangladesh Krishi Bank	3.0	6.0	6.0	6.0	6.0	8.5
- Rate for borrowing by Bangladesh Samabaya Bank (Apex Cooperative Bank)	3.0	6.0	6.0	6.0	6.0	8.5
Deposits						
(1) - Special notice accounts or deposits withdrawable at notice of 7 to 29 days	3.0	4.0	5.0	4.0	4.0	4.5
- Special notice accounts or deposits withdrawable at notice of 30 days or more	3.25	4.25	5.25	4.25	4.25	4.5
(2) - Savings bank accounts with checking facilities	4.0	5.0	6.0	6.0	4.5	8.5
- Savings bank accounts without checking facilities/b	4.5	6.0	7.0	7.0	7.0/c	10.0
(3) - Fixed (or term) deposits						
- For 3 months and over but less than 6 months	4.5	6.0	7.0	7.0	7.0/d	12.0
- For 6 months and over but less than 1 year	4.75	6.5	7.5	7.5	7.5/e	13.0
- For 1 year and over but less than 2 years	5.0	7.25	8.25	8.25	8.25/f	14.0
- For 2 years and over but less than 3 years	5.5	8.25	9.25	9.25	9.25	14.5
- For 3 years and over	6.0	9.25	10.25	10.25	10.25	15.0
(4) - Current accounts	-	-	-	-	-	-
Postal Savings Accounts						
- General	7.5	7.5	8.5	8.5	8.5	..
- Fixed: for 1 year	..	8.0	9.25/g	9.25	9.25	..
for 2 years	..	9.0	10.25/g	10.25	10.25	..
for 3 years	..	10.0	11.25/g	11.25	11.25	..
Advances						
- Advances extended by smaller banks	9.0	12-13	12-13	11-12/h	11-12	15.5/i
- Advances extended by larger banks	10.0	12-13	12-13	11-12/h	11-12	15.5/i
- Advances for jute, jute goods & tea exports	7.5	10.5	10.5	10.5	10.5	12.0
- Advances for other export commodities	..	..	11.5/j	10.5	10.5	12.0
Industrial Lending						
Bangladesh Shilpa Bank & Bangladesh Shilpa Rin Sangstha/k						
- Short-term loans	7.0	12-13	11.5-13/l	11.5-13	11.5-13/m	14.0/n
- Long-term loans	8.0	12-13	11.5-13/l	11.5-13	11.5-13/m	14.0/n
- Small Loans Scheme for small-scale and cottage industries/o	..	..	..	..	..	..
House Construction Lending						
Bangladesh House Building Finance Corporation Construction/rehabilitation loans for:						
- Multi-dwelling units	..	..	..	5.0	5.0	..
- Single-dwelling units	..	..	..	11.0	11.0	..
Agricultural Lending						
(1) Bangladesh Krishi Bank						
- Short-term loans	7.0	11.0	11.0	11.0	11.0	12.0
- Tea & Jute	..	10.5	10.5	10.5	10.5	..
- Potato storage	..	12.5	12.5	12.5	12.5	..
- Other purposes	..	11.0	11.0	11.0	11.0	..
- Medium- and long-term loans	8.0	11.5	11.5	11.5	11.5	..
- Shallow Tubewells	..	13.0	13.0	13.0	13.0	..
- Tea development	..	9.0	9.0	9.0	9.0	..
- Horticulture development in Chittagong Hill Tracts	..	5.0	5.0	5.0	5.0	..
(2) Bangladesh Samabaya Bank (Apex Cooperative Bank) to TCCAs/p	4.0	7.0	7.0	7.0	7.0	7.0
- Thana Central Cooperative Associations to KSSs/q	6.0	9.0	9.0	9.0	9.0	9.0
- Primary Societies (KSSs) to KSS members/r	9.0	12.0	12.0	12.0	12.0	12.0
Money Lenders (Unorganized Sector)						
Rates vary; typical annual rates are:	.... 30 and above					

.. = not available.

/a Effective from June 21, 1974.
/b Accounts from which withdrawals are allowed with withdrawal slip and on presentation of passbook only.
/c Since October 1, 1978, interest on accounts opened by individuals in rural areas was 7.75%.
/d Since October 1, 1978, interest on accounts opened by individuals in rural areas was 8.5%.
/e Since December 16, 1977, interest on accounts opened by individuals in rural areas was 8.5%, and since October 1, 1978, it was 9.0%.
/f Since December 16, 1977, interest on accounts opened by individuals in rural areas was 9.25%.
/g Effective from July 1, 1976.
/h Includes loans extended by Bangladesh Krishi Bank under the Tk 1 billion "Special Agricultural Credit Programme" launched with effect from February 15, 1977.
/i Increased to 16.0% in December 1981.
/j Effective from July 19, 1976.
/k Lending rate is 3.5% above the Bank Rate. Onlending of foreign aid funds is in accordance with the terms of the respective aid agreements.
/l Since April 1976.
/m To encourage development in Chittagong Hill Tracts, interest on loans and advances for this district was 11% only.
/n Only 13.0% in the Chittagong Hill Tracts and for certain industries in less-developed areas. These rates were increased to 14.5% (and 13.5% for the Chittagong Hill Tracts) in December 1981.
/o Special credit program for small and cottage industries, weavers, salt producers, rural bank project, and self-employment program.
/p Bangladesh Samabaya Bank borrows from Bangladesh Krishi Bank and lends to Thana Central Cooperative Associations.
/q TCCAs borrow from Bangladesh Samabaya Bank and lend to Farmers' Cooperative Societies (KSSs).
/r KSSs borrow from TCCAs and lend to individual members.

Notes:
- The Bank Rate was increased on June 21, 1974; rates on deposits and advances were increased effective July 1, 1974.
- For deposits, Bangladesh Krishi Bank and Bangladesh Shilpa Bank (Agricultural Development Bank and Industrial Development Bank of Bangladesh, respectively) are allowed to quote 1% more than the rates shown above. However, deposits with these institutions so far have been negligible because their services are more limited than those provided by commercial banks.
- For advances, the rates given are maximum rates. The nominal interest rate on advances to the private sector is on average about 10-11%. Effective rates are 2-3 percentage points higher because of margins (15-30%, depending on the creditworthiness of the borrower or on the type of commodity financed).
- Agricultural loans are routed by the Bangladesh Samabaya Bank to farmers through the Thana Central Cooperative Associations (TCCAs) and the Farmers' Cooperative Societies (KSSs).

Source: Bangladesh Bank.

Thus, since the interest rate does not appear to represent the cost of borrowing, the funds are basically rationed through the Central Bank's monetary programmes. The most important variable, then, in gross investment function is the availability of credit. Thus, while the link between the monetary and the real sectors is still through the investment function, the link is provided not by interest rates but by credit conditions which are proxied by actual loans and are governed by the Central Bank's over all monetary programmes.

At this point, it should be noted that in Bangladesh private investment is a very small fraction of total gross capital formation. In 1980 the relative share of private gross investment in total gross capital formation was only 17%.[36] Thus, the bulk of gross capital formation is public investment.

Therefore, it is important to investigate the determinants of gross public investment. For the reasons discussed above, it is very unlikely that interest rates would play an important role in the public investment. Besides borrowing from the banking system, one major source of raising investment funds is through government savings bonds. But interest on these saving bonds does not enter into the public investment function because the rates are structured mainly to en-

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[36] The Second Five Year Plan 1980-85, Draft, p IX-3.

courage domestic savings and there is not much variation in the rates over time. In this situation, we expect gross public fixed investment to depend on foreign capital assistance (which constitutes 80% of the development budget of the government) and the extent to which the government can resort to the banking system (i.e., deficit financing through borrowing from the banks and financial institutions).

Bangladesh imports almost all capital equipment. The import content constitutes the foreign exchange component of gross fixed investment. This is where foreign capital assistance plays a crucial role, since Bangladesh is in chronic deficit in her trading account. Foreign capital assistance indirectly affects private investment, too. Government regulates private fixed investment through the National Economic Council (NEC) and projects having a lower foreign exchange component get priority. Thus, foreign capital assistance is an important variable for total gross fixed investment.

Non-availabilty of relevant data forced us to estimate only one aggregate investment function. However, for the period 1972-73 to 1980-81, it was possible to estimate separate functions for private and public investment. The estimated gross fixed investment function for the period 1959-60 to 1980-81 is,

$$I = -6584.6 + .173\,Y + .419\,CR + .108\,FCA \;;\; \bar{R}^2 = .94,\ D\text{-}W = 1.89$$
$$\quad (-4.031)\quad (4.399)\quad (2.581)\quad (.902)$$

where I is total gross fixed investment

Y is Gross National Product (GNP)

CR is total credit advanced to public and private sectors

and FCA is foreign capital assistance in millions of constant taka.

All the variables have the correct sign. However, foreign capital assistance (FCA) is significant only at the 15% level. The inclusion of lagged GNP did not improve the result; indeed, lagged GNP had a negative sign.

After independence in December 1971, there has been a shift in government policy regarding private investment. The private sector was relegated to a secondary position. The first Industrial Policy Statement issued in January 1973 left the private sector virtually to operate in small and cottage industries within the investment ceiling of 2.5 million taka.[37]

In order to test whether there has been any structural shift in the total investment function after independence due to changed government policy regarding private investment, an equation with a dummy variable for the intercept change has been estimated. The dummy variable was found to be insignificant, indicating no shift in the total investment function. The regression result with the dummy variable is,

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[37] The Second Five Year Plan 1980-85, Draft, p IX-4.

$$I = -7011.9 + .175\ Y + .394\ CR + .19\ FCA + 339.7\ D$$
$$(-3.867)\quad (4.341)\quad (2.311)\quad (1.037)\quad (.599)$$
$$\bar{R}^2 = .93,\ D\text{-}W = 1.98$$

where D = 1 for period 1959-60 to 1969-70

= 0 for period 1972-72 to 1980-81

Stability in the investment function despite the change in government policy regarding private investment may be due to the fact that private investors in Bangladesh usually operate in the small scale sector and this did not change after independence, leaving them largely outside the investment ceiling.

4.2.2.1 Private and Public Gross Fixed Investment

In recognition of the importance of private sector, there has been substantial shift in the policy towards private investment. The investment ceiling was eventually abolished in 1975 and the private sector was given larger and liberal fiscal and monetary concessions including customs debenture, investment allowances and long-term finances.[38]

In view of the gradual shift of government policy to encourage private investment, it is important to investigate the private investment function separately, because this may shed some light on how to formulate policy in order to encourage private investment. Since relevant data are availa-

[38] The Second Five Year Plan 1980-85, Draft, p IX-1.

ble for the period 1972-73 and onward, separate functions for private and public investmwent have been estimated for that period only.

In addition to credit available to the private sector, government annual development expenditure (GDE) is expected to influence private investment indirectly. For example, government projects to build roads and bridges in a certain region may make that region viable economically as access to raw material sources and markets for final products becomes available. However, this type of government development expenditure involves long gestation periods, and there are substantial lags in its effects. With such a short time series (only 9 years), it was not possible to introduce a lag structure in the equation. Yet an equation for private investment with government expenditure (GDE) as one of the explanatory variables has been estimated and the result shows that it is a significant variable. The estimation results are :

$$IP = \underset{(2.94)}{1346} + \underset{(4.862)}{.54}\ CRP \qquad \bar{R}^2 = .74,\ D\text{-}W = 1.74$$

$$IP = \underset{(2.426)}{990.74} + \underset{(6.285)}{.421}\ GDE \qquad \bar{R}^2 = .83,\ D\text{-}W = 1.44$$

$$IP = \underset{(-4.938)}{-3855.4} + \underset{(6.081)}{.113}\ Y + \underset{(.384)}{.036}\ CRP + \underset{(1.953)}{.11}\ GDE$$

$$\bar{R}^2 = .98,\ D\text{-}W = 2.19$$

where IP is private gross fixed investment

CRP is credit advanced to the private sector

and GDE is government annual development expenditures.

While both CRP and GDE are significant when used separately, the significance level of CRP declines when both CRP and GDE are included together with GNP (Y). However, the adjusted $\bar{R}^2$ increases to .98 which implies that they together explain the private fixed investment function.

In the case of public gross fixed investment, credit advanced to the public sector, foreign capital assistance and GNP have been used as explanatory variables. The estimation results are :

$$IG = -2925.9 + 1.819\ CRG \qquad , \bar{R}^2 = .46$$
$$(-1.168) \quad (2.791) \qquad D\text{-}W = 1.93$$

$$IG = -1614.9 + 1.051\ FCA \qquad , \bar{R}^2 = .62$$
$$(-1.058) \quad (3.781) \qquad D\text{-}W = 1.57$$

$$IG = -1005.3 + .18\ Y + .79\ CRG + .13\ FCA \ , \bar{R}^2 = .89$$
$$(-4.44) \quad (3.097) \quad (2.235) \quad (.471) \qquad D\text{-}W = 2.34$$

where IG is public gross fixed investment

CRG is credit advanced to the public sector

and FCA is foreign project aid in million of constant Taka

While both CRG and FCA are highly significant with the expected positive sign, the coefficients are quite high when used separately as the only explanatory variable. Near unity in these coefficients is to be expected, if the entire increment in loan and project aid is invested. However, when both CRG and FCA are used together with GNP (Y) as regressors, the significance level of FCA drops. But adjusted $\bar{R}^2$ increases to .89.

Though the equations for both private and public investment have high adjusted $\bar{R}^2$, given the fact that the estimates are based on a nine year data series one has to be very cautious in using these parameter values. Nonetheless, they do shed some light on the over all relationships.

4.2.3 External Sector

Bangladesh is virtually dependent on imports for almost all of her raw-material and capital equipment needs. As a result, contrary to the implications of a traditional Keynesian aggregate model, a decline in the imports of raw-material and capital equipment will, at least in the short run, lead to a fall in output. Moreover, Bangladesh is not only a food deficit country, she depends on imports for many other essential consumer goods. Therefore, a decline in consumer imports will trigger an inflationary surge. Thus, in view of the crucial importance of different categories of imports, some disaggregation is necessary in analysing imports. In the present study, separate import functions for consumer goods, capital goods and raw-materials have been estimated.

On the other hand, even if one cannot deny the importance of exports and export earnings, exports have been treated as exogenous, chiefly because of data limitations. Bangladesh's main export item is jute. Jute export depends crucially on the price of synthetic fibre vis-a-vis the jute price. Synthetic fibre is largely a domestic product of the jute importing countries. No single index of various domestic synthetic fibre prices is available.

Jute being a raw-material used in the production of consumer goods, its export is also expected to depend on the incomes of importing countries. Here, too, it is difficult to find a common index due to differences in exchange rates, both across currencies and over time.

4.2.3.1 Consumer Imports

This category includes food, live animals, beverages, tobacco, animal fat, vegetable oil, manufactured goods classified as materials and manufactured goods not classified elsewhere.

Consumer imports (MC) are expected to depend on disposable income (Yd) and the regression equation for the period 1959-60 to 1980-81 is,

$$MC = -3430.34 + .094\ Yd, \qquad \bar{R}^2 = .36,\ D\text{-}W = 1.9$$
$$(-1.93) \qquad (3.064)$$

Though disposable income (Yd) is highly significant, adjusted R is very low. This implies that other variables are important in explaining consumer imports (MC). In Bangladesh, consumer imports are subject to heavy restrictions through quotas and licensing systems. Thus, a variable representing administrative decisions on quotas and licencing could be an important explanatory variable in this respect. However, it is difficult to construct such a variable. As a result, a proxy variable has been tried. The quantitative restrictions and licencing are reactions to scarcity of foreign exchange. In view of the fact that the current account is in continous deficit, the bigger part of the import bill is financed by foreign grants and aids (Faaland and Parkinson, 1976, p 17; Islam, 1977, pp 110-112, 142; The Second-Five-Year Plan, p V-2) which are recorded in the capital account. Hence, the capital account surplus (CS) seems to be the best available proxy for quantitative restrictions. The estimated equation is,

$$MC = -972.57 + .031\ Yd + .786\ CS\ ,\quad \bar{R}^2 = .66$$
$$(-.738) \quad (1.204) \quad (4.056) \quad D\text{-}W = 2.01$$

where CS is the capital account surplus in millions of constant Taka

Adjusted $\bar{R}^2$ increases quite considerably with the inclusion of a proxy variable for quantitative restrictions on consumer imports. Moreover, the proxy variable (capital account surplus, CS) is found to be quite significant and of the expected sign. The positive sign of CS indicates that the restrictions on consumer imports are adjusted from time to time.[39] If the capital account surplus is expected to rise due to an increased flow of foreign aid or of export earnings, restrictions on consumer imports are relaxed (Islam, 1977 p 110). Note, however, the marginal propensity to import (MPM) out of disposable income declines to only .031 and income is significant only at the 15% level.

In order to test for a structural shift in the consumer import function, a dummy variable has been introduced. The estimation result is,

$$MC = 948.34 + .03\ Yd + .242\ CS - 1834.1\ D$$
$$(2.056) \quad (3.552) \quad (3.089) \quad (-11.914)$$

$$\bar{R}^2 = .96,\ D\text{-}W = 2.4$$

where D = 1 for the period 1959-60 to 1969-70

= 0 for the period 1972-73 to 1980-81

The results show a significant dummy variable and an upward shift in the consumer import function. This is to be expected as consumer goods which used to come from West Pakistan and were thus regarded as domestic goods had to be imported after independence (Khan, 1972, pp 86-89). This phenomenon can be explained easily. For example, Bangladesh has a food deficiency to the tune of 100 tonnes. If 20 tonnes of rice came from West Pakistan, only 80 tonnes were recorded as im-

[39] A general import policy for the following year is announced in the last week of June.

ports. Moreover, there was no foreign exchange constraint on goods that used to come from West Pakistan. But after independence, all 100 tonnes of rice are recorded as imports and the foreign exchange constraint applies to all of it. Thus there was an upward shift in the consumer import function. The percentage distribution of imports into Bangladesh before independence is given in Table 4.2

TABLE 4.2

Percentage Distribution of Imports into Bangladesh by Source

Year	Consumer Goods		Raw-materials		Capital Goods	
	Foreign	Pakistan	Foreign	Pakistan	Foreign	Pakistan
1954-1960	53.9	55.1	37.4	62.6	88.5	11.6
1961-1965	38.9	61.1	49.2	50.8	85.8	14.2
1966-1970	40.8	59.2	44.7	55.3	92.3	7.6

Source : Alamgir and Berlage, 1974, p 115.

Finally a consumer import function with income from agriculture (YA) and from all other sectors (YR) has been estimated on the presumption that the marginal propensity to import (MPM) out of urban income will be greater than the MPM out of rural income because most of the imported consumer goods (e.g., fine cloths, electrical goods, automobiles, etc.) go to the urban people and simply do not reach the rural areas. However, the regression result is not very exciting. The estimated equation is,

$$MC = 833.52 - .187\ YA + .271\ YR\ ,\ \bar{R}^2 = .63,\ D\text{-}W = 1.85$$
$$(.415)\quad(-1.873)\quad(4.536)$$

Income from agricultural sector (YA), a proxy for rural income, has the wrong sign. This might be due to high correlation between YA and YR; their correlation coefficient is .85.

4.2.3.2 Capital Imports

Imports of capital goods include machinery and transportation equipment. It can be expected that capital goods imports (MI) will depend on the level of fixed investment. Since different types of investment do not have the same import content, different types of fixed investment should be included in the capital goods import function. However, as opposed to data on aggregate private and public fixed investment, data on various types of investment are not available. Since public investments are mainly in the heavy projects, a higher coefficient can be expected for public fixed investment. The estimated equation for the period 1959-60 to 1980-81 is,

$$MI = -100.35 + .296\ IP + .071\ IG\ ,\ \bar{R}^2 = .85$$
$$(-.944)\quad(4.576)\quad(1.742)\quad D\text{-}W = 1.85$$

where MI is capital goods imports

IP is aggregate fixed private investment

and IG is aggregate fixed public investment

Though both variables have the correct sign, public investment (IG) is less statistically significant than private investment (IP). Moreover, IG does not have a higher coefficient than IP, as was expected. This may, again, be due to high collinearity between IP and IG; the correlation coefficient between them is .82. As a result, total (public plus private) fixed investment has been used as a regressor and the result is,

$$MI = -32.795 + .156\ I \;, \qquad \bar{R}^2 = .82$$
$$(-.291) \quad (9.269) \qquad D\text{-}W = 1.90$$

where I is total fixed investment.

In order to test for structural shift, an equation with a dummy variable has been used. The dummy was found to be insignificant. The estimated equation is,

$$MI = 66.408 + .148\ I - 88.134\ D, \quad \bar{R}^2 = .81$$
$$(.402) \quad (7.694) \quad (-.827) \qquad D\text{-}W = 1.9$$

where D = 1 for the period 1959-60 to 1969-70

= 0 for the period 1972-73 to 1980-81

The insignificance of the dummy variable, indicating no structural shift is not unexpected. Pakistan does not produce many capital goods and before independence capital goods used to come from sources chiefly other than West Pakistan (see Table 4.2).So, after independence there has not been any significant shift of sources of capital goods as it was the case for consumer goods.

4.2.3.3 Raw-material Imports

This category includes crude materials, mineral fuels, lubricants and related materials and chemicals. This function is relatively simple. We expect raw-material imports (MR) to depend directly on gross domestic product (Y). The estimated equation is,

$$MR = -2057.03 + .059\ Y\ , \quad \bar{R}^2 = .53, \ D\text{-}W = 1.85$$
$$(-2.52) \quad (4.417)$$

Inclusion of a dummy variable shows that the raw-material import function has shifted upward after independence. The estimation result is,

$$MR = -1216.14 + .053\ Y - 675.397\ D\ , \quad \bar{R}^2 = .77$$
$$(-1.951) \quad (5.188) \quad (-4.093) \qquad D\text{-}W = 1.47$$

wehere D = 1 for the period 1959-60 to 1969-70

= 0 for the period 1972-73 to 1980-81

The reason for a shift in the raw-material import function is the same as for a shift in the consumer import function. After independence, Bangladesh imports raw-materials such as chemicals, mineral products, spare parts, and the like, which used to come from West Pakistan and were not considered to be foreign imports while Bangladesh was a province of Pakistan.

4.3 A BASIC MACROECONOMETRIC MODEL FOR BANGLADESH

Having screened the preliminary specification, a basic macroeconometric model for the Bangladesh economy is presented in this section. This basic model is expected to provide a demand dimension to the supply oriented input-output table (1976-77) of the Bangladesh economy.

All variables are measured at constant 1972-73 market prices, unless mentioned otherwise. Exogenous variables are indicated by asterisks. Figures in parentheses are t-values. The two-stage least squares (2SLS) method is used for estimating the model. The period of study is 1959-60 to 1980-81.

LIST OF EXOGENOUS VARIABLES

CR* = Total credit advanced to private and public sectors

FCA* = Foreign capital assistance

CS* = Capital account surplus

EX* = Total exports

CG* = Government expenditure on goods & services

TR* = Real income tax

D* = Dummy variable,

= 1 for the period 1959/60 - 1969/70

= 0 for the period 1972-73 to 1980-81

LIST OF ENDOGENOUS VARIABLES

Y = Gross national product (GNP)

Yd = Disposable income

I = Total gross fixed investment

CP = Private consumption expenditure

MC = Imports of consumer goods

MI = Imports of capital goods

MR = Imports of raw-materials

ESTIMATED MODEL

$$CP = 6852.834 + .812\ Yd - 3406\ D \; ; \qquad \bar{R}^2 = .98$$
$$(0.567) \quad (14.081) \quad (-7.725)$$

$$I = -9152.73 + .231\ Y + .245\ CR^* + .16\ FCA^* \; ; \quad \bar{R}^2 = .94$$
$$(-3.862) \quad (4.091) \quad (1.175) \quad (1.243)$$

$$MC = -328.51 + .045\ Yd + .342\ CS^* - 1501\ D \; ; \bar{R}^2 = .91$$
$$(-.389) \quad (2.738) \quad (2.591) \quad (-6.407)$$

$$MI = -82.942 + .164\ I \; ; \qquad \bar{R}^2 = .82$$
$$(-.648) \quad (8.722)$$

$$MR = -1155.79 + .052\ Y - 678.71\ D \; ; \qquad \bar{R}^2 = .77$$
$$(-1.748) \quad (4.79) \quad (-4.102)$$

Identity : $Y = CP + CG^* + I + EX^* - MC - MI - MR$

Identity : $Yd = Y - TR^*$

4.4 SUMMARY

In view of the lack of a satisfactory demand model for Bangladesh, which could have been used as a demand dimension for the supply oriented 1976-77 I-O model, we have attempted to construct one. The period of study is 1959-60 to 1980-81. In constructing this macroeconometric model, the main hurdle has been the non-availability of relevant data. As a result, we had to be satisfied with a very simple model. It was possible to achieve a disaggregation level consistent only with the final demand categories of the 1976-77 I-O table of Bangladesh. Though it serves the present purpose, a more disaggregated macro model will be more useful if an I-O table with more categories of final demands becomes available in future. However, to the extent data availability permitted, separate functions for consumption of food and non-food items and for private and public investment have been estimated for the period 1972/73 - 1980/81. Data limitations did not allow us to test for complicated specification of the equations. In particular, specifications with only a one period lag could be attempted. However, neither lagged consumption nor lagged income was found to be significant and with the right sign in the case of the consumption function. In the investment function, too, the coefficient for lagged income was of the incorrect sign. After exploring the preliminary specifications with the OLS method, the entire model was estimated with the 2SLS method.

To test for possible structural shifts after independence in December 1971, a dummy variable for intercept change was introduced. It has been found that there has been an upward parallel shift in the consumption function. Consumer and raw-material import functions, too, have shifted upward. The shift in the private consumption function may be due to a rise in expectation caused by the promise of independence and exposure to the outside world. Consumer and raw-matrial import functions have shifted upward as the source of those products shifted from West Pakistan (which was previously regarded as domestic source) to formal imports.

The MPC was found to be .78 when the structural shift in the consumption function is taken into account and this estimate is very similar to that of Alamgir and Berlage (1974) for the period 1959-60 to 1969-70. A separate consumption function with agricultual and non-agricultural incomes as arguments was estimated and it was found that the MPC out of agricultural income is less than the MPC out of non-agricultural income.

Following the conventional approach, the link between the real and monetary sectors has been established via the investment function. However, in the virtual absence of an organised capital market, this link is provided not by the interest rate but by government's over-all monetary programmes approximated by total loans from the banking system to both private and public sectors. The investment function also spells out the significance of foreign capital assistance in the gross fixed capital formation.

In view of the importance of capital and raw-material imports, separate functions for various categories of imports have been estimated. Capital imports have been found to depend on total fixed investment. Since various types of investment have different import content, it would have been desirable if different types of investment could have been used in the the capital goods import function. But, data limitation did not permit us to do so. Since consumer imports into Bangladesh are subject to quantitative restrictions, the capital account surplus has been used as a proxy variable and was found quite significant.

The estimated aggregate model of this chapter is expected to provide a demand dimension to the supply oriented 1976-77 I-O table of Bangladesh. The integration of this macroeconometric model with the I-O table is the subject of the next chapter.

Chapter V

A COMPLETE MACRO MODEL INCORPORATING INPUT-OUTPUT RELATIONS

> The trouble with their (aggregate macro models) present applicability, however, is that some of the contemporary economic problems are not macro. They deal with situations of particular groups, particular processes, particular markets. Over-all macro policy may not reach these issues at all or may do so in a highly inefficient way; therefore, alternative policy approaches must be sought, and theoretical support for these new policy thrusts should come from a system that goes beyond Keynesian macroeconomics.
>
> \- Lawrence R. Klein (1982).

In this chapter, an attempt is made to integrate the macroeconometric model constructed in the previous chapter with the 1976-77 input-output table for Bangladesh. That is, instead of treating I-O sectoral final demand deliveries as administratively fixed, they will be linked to the aggregate demand model, so that they will be explained from the equations of economic behaviour. This will also enable us to trace the effects of macroeconomic policies to the producing sectors.

The 1976-77 I-O table of Bangladesh has five categories of final demand : private consumption, public consumption, gross fixed capital formation, stock change and exports. In the macro model of the previous chapter, private consumption and gross fixed capital formation are explained from equations based on economic behaviour; public consumption and exports are exogenous variables of the model. In treating stock change or inventory, a few words of explanation are in order. Stock change has two parts - planned and unplanned. The unplanned part of inventory change is a disequilibrium component and it is not desired to be continued. In so far as interest is in the equilibrium component, the unplanned stock change has been left out of the model. On the other hand, data on planned inventory changes are not available. Thus, it was not possible to incorporate separate equations for inventory change and by necessity it has been assumed that there is no change in inventory.

In the attempt to incorporate I-O relations in the macro model, the methodology developed by Preston[40] (1972) will be followed. The structure of an integrated model can be shown in a flow diagram (Figure 5.1).

The final demthed block of an integrated model contains GNE components to be explained in the macroeconometric model. The final demands (components of GNE) are converted into I-O sectoral final demand deliveries through the industrial distribution of final demand matrix (denoted the H matrix) and thus drive the I-O block to determine sectoral gross outputs. These sectoral gross outputs are converted to sectoral

[40] For a detail discussion of alternative methodologies, see Section 3.2.

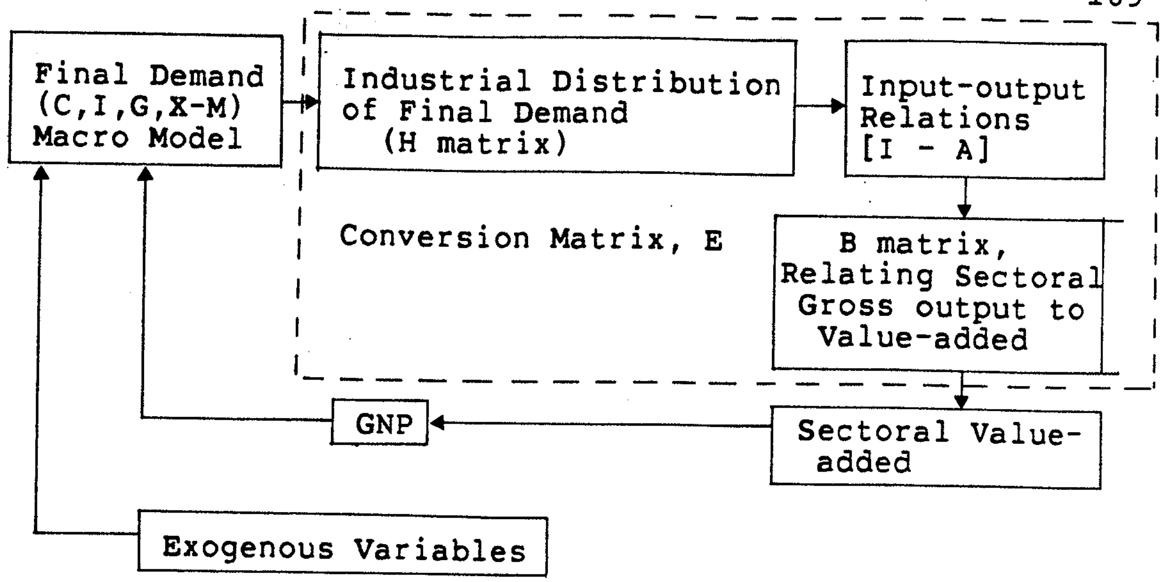

Figure 5.1: The Flow Diagram of an Integrated I-O Model

value-added through a diagonal matrix (denoted the B matrix), embodying a fixed relationship between sectoral gross outputs and value-added : this follows from the fixed input coefficient assumption of the traditional I-O model. This set of sectoral value-added yields gross domestic product (GDP) which together with other variables of the macro model determines elements in the final demand block. Thus, we have a complete circle : Demand - Value-added (GDP) - Demand. This is possible due to the existence of the H and the B matrices, which together with the I-O direct-indirect requirement matrix (I - A) form a matrix (E) which is termed here the 'conversion matrix'. This conversion matrix, E, connects the components of GNE in the final demand block to the sectoral final demand deliveries of the I-O block.

The structure and working of an integrated I-O macro model can be explained with a simple example. Let there be only two producing sectors (agriculture and industry) and two types of final demand (consumption and investment). Then the I-O accounting relationship can be written as :

Sales to / Purchase from	Sales of i to j		Final Demand		Total
	Agricul.	Indust.	Consum.	Invest.	
Agricult.	X_{11}	X_{12}	C_1	I_1	X_1
Industry	X_{21}	X_{22}	C_2	I_2	X_2
			C	I	

From the above table we have,

$$X_{11} + X_{12} + C_1 + I_1 = X_1 \qquad \ldots 5.1$$

and $$X_{21} + X_{22} + C_2 + I_2 = X_2$$

If we define $a_{ij} = Xij/Xj$ and $Fi = Ci + Ii$

then 5.1 can be rewritten as :

$$a_{11} X_1 + a_{12} X_2 + F_1 = X_1 \qquad \ldots 5.2$$

and $$a_{21} X_1 + a_{22} X_2 + F_2 = X_2$$

or, $$(1 - a_{11})X_1 - a_{12} X_2 = F_1 \qquad \ldots 5.3$$

and $$- a_{21} X_1 + (1 - a_{22})X_2 = F_2$$

In matrix form 5.3 can be expressed as :

$$(I - A)\, X = F \qquad \ldots\ 5.4$$

where

$$A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}, \quad X = \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} \quad \text{and} \quad F = \begin{bmatrix} F_1 \\ F_2 \end{bmatrix}$$

From 5.4 we can solve for X, given F as

$$X = (I - A)^{-1}\, F \qquad \ldots\ 5.5$$

where $(I - A)^{-1}$ is the direct-indirect requirement matrix. From the usual I-O assumption that each sector's input use is a fixed proportion of its gross output, it follows that there is a fixed relationship between sectoral value-added and gross output. This relationship can be expressed as :

$$Y_1 = b_{11}\, X_1$$

$$\ldots\ 5.6$$

and $$Y_2 = b_{22}\, X_2$$

where $b_{11} = 1 - a_{11} - a_{21}$

and $b_2 = 1 - a_{12} - a_{22}$

In matrix form 5.6 can be expressed as :

$$Y = BX$$

or, $$X = B^{-1}\, Y \qquad \ldots\ 5.7$$

where

$$B = \begin{bmatrix} b_{11} & 0 \\ 0 & b_{22} \end{bmatrix}, \quad X = \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} \quad \text{and} \quad Y = \begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix}$$

Putting 5.7 into 5.5, we get

$$B^{-1} Y = (I - A)^{-1} F$$

or, $$Y = B(I - A)^{-1} F \quad \ldots 5.8$$

Since time series data on sectoral final demand deliveries (F) are not usually available, they cannot be used in estimating demand relations. However, time series data on GNE components (C, I) are generally available. Therefore, sectoral final demand deliveries are linked to GNE components so that demand relations can be estimated and their implications can be analysed at the producing sector levels. This link is established by the assumption that each sector's final demand delivery is a fixed proportion of a particular GNE component. That is,

$$h_{11} = C_1 / C \quad ; \quad h_{12} = I_1 / I$$

$$h_{21} = C_2 / C \quad ; \quad h_{22} = I_2 / I$$

such that $h_{11} + h_{21} = 1$ and $h_{12} + h_{22} = 1$

Therefore, the sectoral final demand deliveries can be expressed as :

$$F_1 = h_{11} C + h_{12} I$$

$$\ldots 5.9$$

and $$F_2 = h_{21} C + h_{22} I$$

In matrix form, 5.9 can be rewritten as :

$$F = HG \quad \ldots 5.10$$

where

$$H = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix}, \quad G = \begin{bmatrix} C \\ I \end{bmatrix} \quad \& \quad F = \begin{bmatrix} F_1 \\ F_2 \end{bmatrix}$$

The matrix H is here called the industrial distribution of final demand matrix.

Using 5.10 in 5.8, we derive

$$Y = B(I - A)^{-1} HG \qquad \ldots\ 5.11$$

Denoting $B(I - A)^{-1} H$ by E, 5.11 can be rewritten as :

$$Y = EG \qquad \ldots\ 5.12$$

E is called the conversion matrix which is derived by post and pre-multiplication of the direct-indirect requirement matrix, $(I - A)^{-1}$, with the industrial distribution of final demand matrix, H, and the B matrix respectively.

The equations system 5.12 can be written more explicitly as :

$$Y_1 = e_{11} C + e_{12} I$$

$$\ldots\ 5.13$$

and $$Y_2 = e_{21} C + e_{22} I$$

With the connection between the GNE components and sectoral value-added in place, the complete loop of the multiplier process can be established by a Keynesian type macro model. Let a Keynesian type macro model be as follows :

$C = \alpha_1 Y_1 + \alpha_2 Y_2$ Consumption function

$I = I^*$ Exogenous investment

$Y = C + I^*$ National income identity

Using this information from the macro model, we have :

$$Y_1 = e_{11} (\alpha_1 Y_1 + \alpha_2 Y_2) + e_{12} I^*$$

$$\ldots\ 5.14$$

and $$Y_2 = e_{21} (\alpha_1 Y_1 + \alpha_2 Y_2) + e_{22} I^*$$

or, $(1 - e_{11}\alpha_1)Y_1 - e_{11}\alpha_2 Y_2 = e_{12} I^*$

$$... 5.15$$

and $- e_{21}\alpha_1 Y_1 + (1 - e_{21}\alpha_2)Y_2 = e_{22} I^*$

Thus, the equations system 5.15 represents the reduced form of the simplified integrated I-O macro model and can be solved in terms of the exogenous variables of the aggregate model.

The solution of equations system 5.15 can be presented as:

$$Y_1 = w_1 I^*$$

$$... 5.16$$

$$Y_2 = w_2 I^*$$

where $w_1 = (e_{12} - e_{21} e_{12}\alpha_2 - e_{11} e_{22}\alpha_2)/ |L|$

$w_2 = (e_{22} - e_{21} e_{12}\alpha_1 - e_{11} e_{22}\alpha_1)/ |L|$

and $|L| = 1 - e_{11}\alpha_1 - e_{21}\alpha_2$

Thus, sectoral value-added (Yi) is solved in terms of the exogenous variable, I*, so that effects of a change in an exogenous macro variable can be traced to the sectoral production level. For example, the coefficient, wi, of the total investment (I*) in the equations system 5.16 gives the change in the ith sectoral output required to sustain direct and indirect change in demand due to exogenous change in I*.

5.1 STRUCTURE OF THE COMPLETE MODEL

The structure of the complete I-O macro model of Bangladesh is presented in this section. As seen in the simplified example of the previous section, the complete model has an I-O Block and a Final Demand Block. The I-O Block is provided by the 1976-77 I-O table, compiled by the Bangladesh Planning Commission. The Final Demand Block involves the macroeconometric model which was developed in Chapter IV of the present study.

Input-output Block : According to the 1976-77 I-O table[41] of Bangladesh, the sectoral balance equation is :

$$Xi + IMi = \sum_j Zij + CPi + CGi + Ii + EXi$$

or, $$Xi + m_i Xi - \sum_j a_{ij} Xj = CPi + CGi + Ii + EXi$$

In matrix form :

$$(I + M - A)X = F$$

Therefore, $$X = (I + M - A)^{-1} F$$

where Xi = ith sectoral gross output

IMi = imports of the ith commodity

Zij = ith input used in the jth sector

a_{ij} = ith input coefficient in the jth sector

m_i = ith import coefficient

X = 47x1 column vector of sectoral gross ouput

M = 47x47 diagonal matrix of import coefficients

A = 47x47 matrix of input coefficients

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[41] For a detailed discussion of the 1976-77 I-O table, see Section 2.2.

F = 47x 1 column vector of final demand deliveries

I = 47x47 identity matrix

Therefore, the conversion matrix is :

$$E = B(I + M - A)^{-1} H$$

where B = 47x47 diagonal matrix with diagonal elements:

$$b_{jj} = 1 - \sum_i a_{ij}$$

H = 47x4 matrix of industrial distribution of final demand.

Having calculated the conversion matrix from the 1976-77 I-O table the components of GNE have been allocated over the producing sectors, by using the relationship, Y = EG. The distribution is presented in Table 5.1

With this link between the components of GNE and the sectoral value-added, we can estimate direct and indirect requirements for sectoral output to sustain a unit increase in final demand. This information is immensely important for an underdeveloped economy, plagued with structural bottlenecks of all sorts. For example, from the first equation, we know that a one unit increase in private consumption, among other things, must be met by .29 unit increase in rice production. Now if the production of rice cannot be increased by this required amount, then higher food prices may result which may, in turn, cause an inflationary surge. Therefore, with this connection between final demands and sectoral value-added, it is possible to identify which component of demand may cause structural inflation. Once that is identi-

TABLE 5.1

Impact of GNE Components On Producing Sectors, Y=EG

Sectors Final Demand	Private Consump.	Gross Fixed Investment	Public Consump.	Export
Rice (Y_1)	.290193	.000101038	.00402987	.0084886
Wheat (Y_2)	.0086052	.000000989	.00023201	.0000523
Jute (Y_3)	.0102934	.000706389	.00037958	.336482
Cotton (Y_4)	.0002666	.000016256	.00008135	.0000417
Tea (Y_5)	.0084795	.000000127	.00008120	.056833
Other crops (Y_6)	.0973216	.000200353	.00218277	.0077202
Livestock (Y_7)	.0772816	.000779717	.00160764	.0742756
Fisheries (Y_8)	.0775057	.000001119	.00072203	.0301343
Forestry (Y_9)	.0176873	.0561392	.00161589	.0044461
Sugar (Y_{10})	.014281	.000000725	.00016157	.0022154
Edible oil (Y_{11})	.0040221	.000043220	.00011155	.0000450
Salt (Y_{12})	.0068696	.000095491	.00024555	.0010161
Tobacco Prod (Y_{13})	.0137388	0	0	.0000545
Other Food (Y_{14})	.0093943	.000000278	.00007488	.0000311
Cotton Yarn (Y_{15})	.0034359	.000200556	.00104555	.0002539
Cloth: Mill (Y_{16})	.0015719	.000277614	.00126187	.000217
Cloth: Hand (Y_{17})	.0123657	.000010986	.00252909	.0000327
Jute Textile (Y_{18})	.0011573	.000330625	.00022230	.0944450
Paper (Y_{19})	.0015599	.000721176	.00289005	.0020239
Leather (Y_{20})	.0047459	.000037862	.00001102	.0284961
Fertilizer (Y_{21})	.0052932	.000015641	.00008775	.0055165
Pharmaceutic (Y_{22})	.0027624	.000006282	.00052077	.0000358
Other Chemic (Y_{23})	.0040797	.002288970	.00103543	.0022075

(Continued)

Cement (Y_{24})	.0001630	.005639640	.00036700	.0000412
Basic Metal (Y_{25})	.0017689	.045575300	.00218462	.0007863
Metal Produc (Y_{26})	.0022925	.014288400	.00135808	.0007980
Machinery (Y_{27})	.0009251	.016326600	.00089863	.0021149
Transport Equipmt (Y_{28})	.0003233	.011531500	.00120747	.0003041
Wood (Y_{29})	.0012243	.016846900	.00070894	.0020274
Misc. Indus (Y_{30})	.0095571	.030535700	.01233580	.0062396
Urban Housin (Y_{31})	.0005919	.018423700	.00000027	.0000029
Rural Housin (Y_{32})	.0011110	.013140900	0	0
Non-Res Bldg (Y_{33})	.0001433	.009324460	.00229838	.0001050
Construction Elec & Gas (Y_{34})	.0000317	.013250200	.00003003	.0001155
Construction Transp (Y_{35})	.0000898	.015073800	.00007263	.0000691
Other Constr (Y_{36})	.0000979	.035100200	.00000145	.0001365
Petroleum Produc (Y_{37})	.0003955	.000335889	.00037209	.0013675
Electricity (Y_{38})	.0010341	.000845744	.00119360	.0045875
Gas (Y_{39})	.0014458	.001043120	.00060560	.0023343
Transport Service (Y_{40})	.0440258	.012992800	.03775190	.0353623
Trade Service (Y_{41})	.0888215	.055233400	.01432350	.1173040
Housing Service (Y_{42})	.0917496	0	0	0
Health (Y_{43})	.0059689	.000023017	.03755770	.0001328
Education (Y_{44})	.0097706		.2287080	0
Public Admin (Y_{45})	.0019725	.000759876	.50803800	.0029302
Bank & Insur (Y_{46})	.0127683	.002311750	.00122307	.0133344
Other Services (Y_{47})	.0480199	.007079560	.01843580	.0120680

fied, measures can be taken to restrian that particular category of demand as a short-run solution; the long-run solution should aim at freeing the particular sector from the structural lock.

The above link between the categories of final demand and sectoral value-added, however, does not complete the feedback of sectoral value-added on to demand. Once exogenous increases affect sectoral value-added, sectoral value-added affects demand via Engel curves. To complete this loop, we must bring the macroeconometric model into the picture. Once that is accomplished, we will have a simultaneous model with joint feedback between demand and supply.

Final Demand Block : This contains the macroeconometric model, constructed in the previous chapter. The estimated aggregate model is :

$$CP = 6852.834 + .812\ Yd - 3406.85\ D$$

$$I = -9152.73 + .231\ Y + .245\ CR^* + .160\ FCA^*$$

$$M_i = m_i\ Y_i$$

$$Y + \sum_i M_i = CP + CG^* + I + EX^*$$

$$Yd = Y - TR^*$$

where CP = Private consumption

I = Gross fixed investment

$\sum_i Y_i = Y = GDP$

Yd = Disposable income

M_i = Imports of the ith commodity

CG* = Public consumption of goods and services

EX* = Exports

CR* = Institutional credit

TR* = Real income tax

FCA* = Foreign capital assistance

m_i = Import coefficients of the I-O table.

D = 1 for the period 1959-60 to 1969-70

= 0 for the period 1972-73 to 1980-81

Asterisks denote exogenous variables. Only those demand relations of the macro model, which conform to final demand categories of the I-O table, are reported here. Accordingly, imports are linked to GNP through import coefficients of the I-O table. Since the I-O table does not distinguish imports by use (final or raw-materials), it is not possible to tie import functions of the aggregate model to the I-O table.

Private consumption is a function of aggregate disposable income. Lack of data and the sample size did not allow us to estimate a private consumption function with disaggregated disposable income. Therefore, to tie aggregate private consumption to the sectoral value-added, it has been assumed that the marginal propensities to consume (MPC) out of all sectoral disposable income are same as MPC out of aggregate disposable income. In the basic model, gross fixed investment is a function of GNP, credit advanced by lending institutions and foreign capital assistance. Again, in integrating this model with the I-O table, it has been assumed that each sectoral value-added affects investment in the same way as does the total value-added (GDP).

These are very simplistic assumptions that had to be made due to data limitations. Given the sample size and the I-O sector classifications, the only other alternative would be to aggregate the sectors into some broader sectors consistent with our sample size. However, this alternative, too, implicitly assumes homogeneity of included sectors in each broad classification.

Therefore, using the estimated demand relations in the relationship, Y = EG, we link sectoral value-added to the exogenous and/or policiy variables of the aggregate model. This can be done as follows :

$$
\begin{aligned}
Yi = e_{i1}\,\{6852.834 + .812(\sum_j Yj - TR^*) - 3406.85\ D\} \\
+ e_{i2}\,\{-9152.73 + .231 \sum_j Yj + .245\ CR^* + .16\ FCA^*\} \\
+ e_{i3}\,CG^* + e_{i4}\,EX^* \qquad \ldots\ 5.17
\end{aligned}
$$

where $\sum_i Yi = Y = GDP$

e_{ij} = elements of the conversion matrix, E, listed in Table 5.1

Of the exogenous variables in the basic model of Chapter IV, public consumption (CG), real income tax (TR) and credit advanced (CR) can be regarded as policy variables. While public consumption and real income tax will reflect government's fiscal policy, credit advanced by the lending institutions is directly linked to the Central Bank's over all monetary programmes.

The equations system 5.17 can be solved for sectoral value-added in terms of exogenous and/or policy variables of the aggregate model. The solution of the complete model is presented in Table 5.2

TABLE 5.2

Reduced Form Matrix of the Complete Model

Sectoral output	Constant	CR	CG	FCA	EX	TR
Y_1	10082.8	.232	2.177	.151	2.097	-1.317
Y_2	298.977	.007	.065	.005	.062	-.042
Y_3	356.789	.009	.079	.006	.412	-.051
Y_4	9.243	.0002	.002	.0001	.002	-.001
Y_5	294.624	.007	.063	.004	.118	-.041
Y_6	3381.24	.078	.731	.051	.709	-.415
Y_7	2684.24	.062	.582	.041	.632	-.378
Y_8	2692.97	.062	.581	.040	.588	-.378
Y_9	546.185	.041	.254	.027	.247	-.151
Y_{10}	496.197	.011	.107	.007	.105	-.070
Y_{11}	139.697	.003	.030	.002	.029	-.020
Y_{12}	239.571	.006	.052	.004	.051	-.034
Y_{13}	477.914	.011	.103	.007	.099	-.067
Y_{14}	326.409	.008	.070	.005	.068	-.046
Y_{15}	119.138	.003	.027	.002	.025	-.017
Y_{16}	54.278	.001	.014	.0009	.012	-.008
Y_{17}	429.638	.010	.095	.006	.089	-.060
Y_{18}	39.808	.001	.010	.0007	.103	-.006
Y_{19}	53.321	.002	.016	.0009	.015	-.009
Y_{20}	164.852	.004	.036	.003	.063	-.023
Y_{21}	183.896	.004	.040	.003	.044	-.026

(Continued)

Y_{22}	96.098	.002	.021	.001	.020	-.014
Y_{23}	138.963	.004	.037	.003	.036	-.023
Y_{24}	-1.204	.003	.014	.002	.013	-.009
Y_{25}	5.959	.023	.113	.015	.107	-.061
Y_{26}	62.254	.009	.049	.006	.047	-.028
Y_{27}	12.102	.008	.043	.006	.042	-.023
Y_{28}	-2.810	.006	.028	.004	.026	-.015
Y_{29}	22.023	.009	.046	.006	.045	-.026
Y_{30}	294.881	.022	.149	.014	.138	-.082
Y_{31}	-13.683	.009	.041	.006	.039	-.022
Y_{32}	22.560	.007	.036	.005	.035	-.021
Y_{33}	-6.376	.005	.023	.003	.020	-.012
Y_{34}	-15.034	.006	.029	.004	.028	-.016
Y_{35}	-15.236	.007	.033	.005	.032	-.018
Y_{36}	-39.342	.017	.076	.011	.073	-.041
Y_{37}	13.333	.001	.004	.0003	.005	-.002
Y_{38}	34.900	.001	.011	.0008	.014	-.006
Y_{39}	48.964	.002	.014	.001	.015	-.008
Y_{40}	1698.53	.046	.436	.030	.417	-.226
Y_{41}	3018.88	.097	.797	.063	.870	-.438
Y_{42}	3187.88	.073	.687	.048	.660	-.388
Y_{43}	207.364	.005	.082	.003	.043	-.029
Y_{44}	339.484	.008	.302	.005	.070	-.048
Y_{45}	67.610	.002	.524	.001	.019	-.011
Y_{46}	440.824	.011	.102	.007	.110	-.065
Y_{47}	1659.85	.042	.398	.027	.372	-.223

The reduced form of the complete model shows the sectoral impact of a policy variable. For example, if credit advanced increases by one Taka due to expansionary monetary policy, the resultant direct and indirect increase in demand will have to be met with an increase in rice output by .232 Taka. Thus the coefficients of the exogenous variables in the complete model are the impact multipliers on sectoral value-added. Looking at these impact multipliers, we find that both monetary and fiscal policies (captured by credit advanced and government expenditure variables, respectively) have the largest expansionary impact on rice production. While the coefficient of credit variable for rice is .232, that of govenment expenditure is 2.177. Exogenous export has the greatest impact multiplier in rice production; it is 2.097, slightly below the government expenditure impact multiplier.

Regarding this integration exercise, two points of note are in order. First, aggregate multipliers[42] of the integrated model are greater than those of the basic macro model of the previous chapter. This is because in the integrated model, it was not possible to take into account additional induced leakeages through various import functions because the 1976-77 input-output table of Bangladesh does not have import as a final demand item.[43] However, this is not going

[42] Aggregate multipliers are defined as the sum of sectoral multipliers.

to affect our general policy conclusion in any fundamental way.

Secondly, the constancy assumption of the conversion matrix implies that there has not been any change in technology or in the industrial distribution of final demand. Various authors (Fisher-Klein-Shinkai, 1965; Preston 1972; Seguy-Ramirez, 1975) handled this problem by modelling errors, on the assumption that the factors which make for changes in technology (A matrix) and industrial distribution of final demand (H matrix) are the same that give rise to deviations between the observed and predicted sectoral value-added. This could not be done in the present case because historical data on detailed sectoral value-added are not available. Another way of taking into account for changes in the technology matrix A, is to update it by using the RAS method. The RAS method is essentially a method of linear extrapolation of the A matrix using some known marginals. But it is unusual that the technology would change during such a short period since 1976-77 and hence we do not expect any significant gain in updating the A matrix by using a mechanical device. However, this is unlikely to cause serious damage to our general conclusion for at least three reasons. First, previous studies show that there has not been any significant technological progress in Bangladesh (Hossain, 1973). Secondly, the I-O table employed is relatively recent (1976-77), and technological progress tends to occur over a long period of time. Thirdly, tastes and expectations that determine the industrial distribution of final demand (H) matrix are also likely to change very slowly and for all practical purposes, one may consider them stable over the period since 1976-77. Therefore, whatever technological and industrial distribution of final demand change might have occurred since 1976-77 is expected to be very negligible. In any case, these considerations do not detract from our main objective of indicating the critical policy variables and providing the range of choice of alternatives as a basis for a dialogue between the planners and policy makers.

5.1.1 Validation of the Integrated I-O Macro Model

No model should be accepted if it does not meet certain criteria regarding its ability to reproduce the historical path of the economy or if it fails to generate multiplier responses consistent with economic theory (Klein and Young, 1980, p.60). For example, one would reject a model where the impact multiplier, the first period effect of a change, of real government purchases on GNP was negative or too large/ low.

Impact multipliers are reduced form coefficients of the model and as can be seen from Table 5.2, the integrated I-O macro model does not produce sectoral impact multipliers whose values are implausibly high or whose signs contradict received theory. However, aggregate multiplier values are a bit on high side. But as mentioned in the previous section, this is because of the fact that in the integrated I-O macro model it was not possible to take into account additional induced leakages through various import functions, since the 1976-77 I-O table does not have import as a final demand.

Some of the summary statistics that are available to test a model's performance in tracing the experience in the economy include among others the mean square error (MSE), root mean square error (RMSE), average absolute percentage error (AAPE), the mean square percentage error (MSPE) and the root mean square percentage error (RMSPE). The major point to be recognised in using these statistics of fit is that they are not generally based on probability calculations from established distributions. There are no generally recognised methods of statistical inference available for validation of a model (Klein and Young, 1980, p.61). Thus, the choice of error statistics and acceptable error standards is clearly a function of the use to which a model is to be put. For example, if the model is for forecasting purposes then it must produce smaller errors at the turning points.

As to the use of this model, our claim is very modest : it is to present an econometric model, integrating both demand and supply sides of the Bangladesh economy, with a view to providing a basis for dialogue between planners and macroeconomic policy makers. This dialogue is expected to produce better co-ordination between sectoral development strategies and over-all macroeconomic policies. In a sense the present attempt can be thought of as an experiment towards developing a complete macroeconometric model with joint feed-back between demand and supply. Yet one cannot accept a model, for whatever modest purpose one has, which traces the experience in the economy very poorly.

Thus, in order to test the model's ability to track the past experience in the economy, root mean square percentage errors (RMSPE) have been calculated for sectoral outputs. Since time series data on all 47 I-O sectors are not available, the model has been simulated over the sample period only for seven broad sectors, namely, agriculture, industry, construction, power and gas, transport, housing services and other services.[44] RMSPE's for these seven sectoral outputs are presented in Table 5.3

RMSPE's are quite small except for construction and power and gas sectors. Though the error statistic is not based on any probability calculation, reasonably smaller RMSPE's can be taken as a measure of goodness of fit of a model. Whereas the RMSPE for GNP is 4.0% in the Lackman-You (1979) aggregate model, it is only 2.5% in the integrated I-O macro model. On the basis of this criterion, therefore, it can be concluded that the integrated I-O macro model performs better than a Keynesian type aggregate macro model. However,

[44] Agriculture includes sectors 1 to 9, industry 10 to 30, construction 31 to 36, power and gas 37 to 39, transport 40, housing service 42 and other services sectors 41 and 43 to 47 of the 1976-77 I-O table.

TABLE 5.3

Root Mean Square Percentage Errors for Sectoral Outputs

Sectors	RMSPE
GNP	2.50%
Agriculture	3.37
Industry	2.97
Construction	8.45
Power and Gas	7.74
Transport	1.33
Housing Services	2.29
Other Services	1.57

in order not to misrepresent reality, we understand the need for a succession of models. This can be regarded as mere a beginning.

5.2 CONSISTENCY CHECK OF 1981-82 BUDGET

In this section, the integrated I-O macro model is used to check the consistency of government's over-all revenue expenditure and monetary programmes for the 1981-82 fiscal year with sectoral output level projections of the Planning Commission. In order to do so, the sectoral classifications of the model have been reduced by vertical summation so that they are consistent with aggregate sectoral classifications of the Planning Commission. Accordingly, the modified reduced form of the integrated model is given in Table 5.4

TABLE 5.4

Modified Reduced Form of The Complete Model

Producing sectors	Impact Multipliers of : CR	CG	FCA	EX	TR
Agricultre (Y1+..+Y9)	.498	4.534	.325	4.867	-2.774
Industry (Y10+...+Y30)	.150	1.100	.099	1.177	-0.667
Construction (Y31+...+Y36)	.051	.238	.034	.224	-0.132
Power & Gas (Y37+...+Y39)	.004	.029	.002	.034	-0.016
Transport (Y40)	.046	.436	.030	.417	-0.226
Housing Service (Y42)	.073	.687	.048	.660	-0.388
Other Services (Y41+Y43+..+Y47)	.165	2.200	.106	1.484	-0.814

The estimated increases/decreases in exogenous variables of our model in the 1981-82 fiscal year at 1972-73 constant prices (in million Taka) are given in Table 5.5

Incorporating these changes in exogenous variables into our model, we estimate changes in sectoral output to sustain resultant direct and indirect increases in demand. These estimates are presented in Table 5.6

In order to check the consistency of the 1981-82 budget, we compare the model estimates of changes in the sectoral output due to estimated changes in exogenous and/or policy variables with the projections of the Planning Commission. These latter projections are given in Table 5.7

TABLE 5.5

1981-82 Budget Estimates of Selected Variables

Estimated changes (at 1972-73 prices, in million Taka)

Revenue Expenditure (CG)		+ 299.44
Income Tax		- 2.07
Credit to Private Sector	+ 1245.70	
Credit to Public Sector	+ 946.05	
Total Credit (CR)		+ 2191.75
Foreign Capital Assistance (FCA)		+ 381.55
Exports (EX)		- 558.47

Source:Bangladesh Economic Survey,1981-82,pp 82,84,97,
132,158.

Comparision of Table 5.6 and Table 5.7 shows excess demand for agriculture and transport and excess supply of all other sectoral output. Whereas the Planning Commission projects a decline in agricultural output in 1981-82 by TK. 828 million at 1972-73 prices, our model indicates a decrease by only Tk. 138.7 million in response to estimated changes in exogenous and/or policy variables, leading to an over-all excess demand of Tk. 689.30 million. If there is no buffer stock or import to meet this excess demand, this may lead to considerable increase in agricultural (food) prices. Food being the most dominant element in the consumer bas-

TABLE 5.6

Estimated Changes in Sectoral Value-added

Sectors	Due to changes in					
	CR	CG	FCA	EX	TR	Total
	(at 1972-73 prices, in million Taka)					
Agricul.	1091.93	1357.66	124.04	-2718.07	5.74	-138.7
Indust.	328.76	329.38	37.62	-657.32	1.38	39.82
Constr.	111.78	71.27	12.97	-126.77	.27	69.52
Power & Gas	7.67	8.68	.80	-18.99	.30	-1.80
Transp.	100.82	130.56	11.45	-232.88	.47	10.41
Housing Service	160.00	205.72	18.31	-368.59	.80	16.25
Other Services	361.64	658.77	40.44	-828.77	1.68	233.8

ket,[45] this might have an inflationary impact. Transport is the other sector that is expected to experience excess demand. Moreover, excess supply of manufacturing and some other sectors would mean that these sectors cannot take surplus labour from the agricultural sector. As a result, the 'disguised' unemployment situation will be aggravated.

Though these results are very much tentative and may be sensitive to the linearity assumption of the I-O model, they nonetheless support, in a very naive way, the hypothesis

[45] According to households expenditure survey by the Bureau of Statistics, 70% of income is spent on food (see Government of Bangladesh, Households Expenditure Survey 1973-74, 1980).

TABLE 5.7

Planning Commission Projections of Changes in Sectoral Output in 1981-82 (at 1972-73 prices, in million Taka)

Sectors	Projected Changes
Agriculture	- 828
Industry	292
Construction	136
Power & Gas	40
Transport	- 35
Housing Service	126
Other Services	368

Source : Bangladesh Economic Survey 1981-82, p. 307.

that Bangladesh agriculture is caught in structural inflation, whereas there is excess capacity in the manufacturing sector. Moreover, these findings do indicate the need for better co-ordination among stabilization policies and sectoral development programmes in order to deal with the co-existence of structural inflation and disguised unemployment.

5.3 SUMMARY

Using the technique developed by Preston (1972), the macroeconometric model of chapter IV has been integrated with the 1976-77 I-O table of Bangladesh. This thereby provides a demand dimension to the supply oriented I-O model, so that sectoral value-added can be explained by the exogenous and/or policy variables of the aggregate model. The integrated I-O macro model performs quite well in tracing the sample period. In fact, the integrated I-O macro model produces considerably smaller root mean square percentage error (RMSPE) for GNP than a Keynesian type aggregate model by Lackman and You (1979).

The reduced form coefficients show that expansionary monetary and fiscal policies have the greatest potential in affecting food (rice) production. Later the model was used to check the consistency of government's over-all revenue expenditure and monetary programmes for the 1981-82 fiscal year. The test reveals that government's over-all revenue expenditure and credit programmes for 1981-82 fiscal year are not consistent. They are likely to lead to excess demand for agricultural output and transport services while there will be excess capacity in all other sectors. The policy implication that follows is that government's credit and expenditure policies need to be geared to structural policies to raise productive capacity.

Chapter VI

CONCLUSION

> Models do not provide solutions, but only assist in finding them.......model building and model using became increasingly a part of dialogue between the model builders and those engaged in planning and policy making.
>
> - Nurul Islam (1970)
>
> First Deputy Chairman
>
> Bangladesh Planning Commission

The main objective of this thesis has been to construct a macro model for the Bangladesh economy, integrating both Leontief I-O and Keynesian final demand models. The need for such a model arises from a gap between the government's over-all structural programmes and macroeconomic policies. In a mixed economy such as Bangladesh, sectoral production and allocation plans often are not consistent with government's over-all fiscal and monetary policies. In part, this is because the analytical framework and focus of the models used for macroeconomic policy analysis differ from those used for the conduct of structural policies.

Since the macroeconomic policies are very much aggregative in nature they often do not extend to the micro level, or if they do, they handle micro problems very inefficiently (Klein, 1982). For example, government's over-all credit policy may determine the responding total volume of investment, but it cannot direct investment to a specific sector (e.g., agriculture) very efficiently without some other complementary measures. The fundamental problem of developing countries is neither an over-all excess capacity nor an over-all excess demand; rather it is a problem of excess capacity in certain sectors (e.g., manufacturing) and of supply inelasticity in others (e.g., agriculture) (Kalecki, 1976). Therefore, Keynesian type macro models are often inadequate in dealing with the problems of developing countries. On the other hand, the Leontief I-O model, which provides the basis for models which attempt to deal with sectoral problems, handles questions of economic policies as a subsequent or subsidiary excercise, to be explored only after sectoral flows are established; in short, it treats final demands as exogenous and thereby underestimates multipliers. Therefore, for the successful analysis and conduct of both economic and structural policies, the two analytical frameworks - macroeconometric model and I-O model - should be melded together.

Although the Bangladesh Planning Commission has a sufficiently detailed I-O table for use in sectoral investment allocation programmes, macroeconomic policies are dealt with largely by intuition and judgement. Neither the Planning

Commission nor the Ministry of Finance has a macroeconometric model with which to assess macroeconomic policies. The lack of knowledge of the parameters of behavioural and institutional functions confounds the situation. For example, if the parameters of the investment function were known, it would be easier to co-ordinate over-all credit policy with structural policy designed to direct investment to certain sectors. Therefore, in establishing a basis for dialogue between the two ministries of the government, our task has been to construct an aggregate model of the Keynesian type and then to integrate it with the most recent (1976-77) I-O table of Bangladesh.

Lack of data has forced us to construct a very simple aggregate model; we could only achieve a disaggregation level consistent with the final demand categories of the 1976-77 I-O table of Bangladesh. The period of analysis has been 1959-60 - 1980-81. Alamgir and Berlage's work (1974) on national income and expenditure of Bangladesh has been a useful source of data for the analysis of the period prior to independence in 1971. Other sources of data include the World Bank, the Planning Commission and the Bureau of Statisitics.

In addition to estimating aggregate consumption and gross investment functions, separate functions for consumption of food and non-food items and for private and public investment have been estimated for period (1972/73-80/81). The other estimated functions include imports of consumer goods, investment goods and raw-materials. After initial screening of the model's specifications by the OLS method, the entire model was estimated using the 2SLS method. Though the model is a very simple, linear and aggregated one, it explains elements of aggregate final demand, in conformity with the final demand classifications of the 1976-77 I-O table of Bangladesh.

Having constructed a macroeconometric model for Bangladesh, the next step was to integrate it with the 1976-77 I-O table. By so doing, final demand deliveries of the I-O table can be explained from equations of economic behaviour and at the same time sectoral output levels are explained by exogenous and/or macroeconomic policy variables. The major stumbling block to the integration of the I-O table with the macroeconometric model has been the lack of congruence between the ususal categorization of final demands (C,I,G,X-M) and the I-O final demand deliveries by sector (e.g., agriculture supplying to the household consumption). This problem has been overcome by using the technique developed by Fisher-Klein-Shinkai (1965) and Kresge (1969) and later modified by Preston (1972) to convert components of GNP to sectoral value-added. The integrated I-O macro model produces reasonably smaller root mean square percentage errors for sectoral value-added when simulated over the sample period.

With the link between the macroeconometric model and the I-O table in place, sectoral value-added has been expalined by the exogenous and/or policy variables of the aggregate model. According to the value of reduced form coefficients, it has been found that expansionary fiscal and monetary policies (approximated by government's revenue expenditure and credit programmes) have the greatest potential in affecting food (rice) production. However, the consistency check of the 1981-82 budget of the Bangladesh Government shows that its over-all monetary and fiscal programmes are not consistent with the sectoral output projections of the Planning Commission; this implies a severe inflationary situation, particularly in the food sector and idle capacity in most of the other sectors.

One policy implication that emerges is the reorganisation of credit and revenue expenditure policies so that more productive investment takes place in agriculture. There have often been complaints that any loan villagers receive is used for conspicuous consumption and various religious and social ceremonies. Steps must be taken to stop this so that agricultural credit is properly used in building infrastructure, improving land and cultivation techniques. Similarly, instead of expanding the bureaucracy, government should consider simple Keynesian type policies of employing the vast unemployed in public works such as building roads, digging canals for irrigation and flood controls and the like, which will go a long way in freeing the agricultural sector from structural locks. This will also give the poor the much needed income for the expansion of the domestic market. What all this implies is that expansionary policies must be co-ordinated with and supplemented by structural policies so that growth can be achieved with minimum inflation. Such co-ordination requires an integrated I-O macro model in which economic policies can be analysed as an integral part of intersectoral transactions. We will consider it an achievement if our work initiates attempts by relevant authorities in this direction.

6.1 LIMITATIONS OF THE PRESENT STUDY AND SUGGESTED EXTENSION

This model is obviously not free from limitations. These limitations can be categorised into two sets - those relating to the econometric model and those relating to the I-O table.

Limitations Related to Econometric Model

a) The econometric model of this study is highly aggregated. The data did not allow us to investigate final demands at a more disaggregated level such as the consumption of durables, or investment in agriculture. This has hidden much important information. For example, information on the responsiveness of agricultural investment to credit is much more important than information on the over-all responsiveness of gross investment, if economic policies are to be directed to sectoral levels.

b) Lack of data on sectoral wages did not permit us to specify wage-price formation equations. As a result, this model cannot deal properly with inflation.

c) Fiscal and tax measures are not fully dealt with as time series data on sectoral income taxes and indirect taxes are not available.

d) Since comprehensive measures of quantitative restrictions are not available, we could not comprehensively deal with commercial and exchange rate policies.

<u>Limitations Related to I-O table</u>

a) Final demand deliveries are categorised in a highly aggregate fashion. If the I-O table had final demand deliveries categorised into a more detailed set, then structural policies could be more usefully linked to economic policies. For example, if the ojective is to raise employment in certain sectors, then demand can be directed towards the output of those sectors by appropriate economic policies if sectoral demand deliveries are categorised accordingly.

b) One consequence of disaggregation is that relative prices enter into demand and supply relations. The present I-O table does not have primary input coefficients which can be used to derive sectoral prices, which in turn may be converted into final demand deflators. Primary input coefficients are also useful in the analysis of income and employment effects of any economic policy.

c) The present I-O model does not distiguish between competitive and non-competitive imports. As a result, the possibility of import substitution cannot be assessed.

All these limitations can be traced to one single source : lack of data. Once data are available, the model can easily be extended to make it more useful. If this study encourages attempts by the Planning Commission and the Bureau of Statistics to gather data along the above suggested lines then future efforts at constructing an integrated model ought to succeed.

However, not all limitations are solely due to data problems. The lack of any lag structure in the econometric model made the entire model static and this prevented us from undertaking any useful simulation study. Moreover, it is a short-term model as it leaves out demographic variables and technological change. Hence, it should not be confused with more longer term planning models. However it could be extended to a consistent planning model by incorporating a linear programming model with certain objective functions to be optimised subject to some constraints, e.g., foreign exchange and domestic savings. Moreover, since the problem of development is one of freeing the producing sectors from structural bottlenecks, the critical sectors (e.g., agriculture) which are most prone to supply inelasticity, can be modelled more explicitly in a series of submodels. If these 'satellite' models are included explicitly into an integrated model, then the model can be more usefully applied to formulate and conduct policies towards growth without inflation.

Apart from these deficiencies, the entire model suffers from another major limitation. This model remains essentially a model for commodity markets, detailing the workings of the forces behind the traditional I-S curve. However, commodity production has monetary aspect, too. An attempt was made to capture the monetary aspect in a very crude fashion via the credit variable. To discover the workings of the forces behind the L-M curve, one needs to integrate it with the flow-of-funds account. For this we need a broader system of national accounting. A more general social accounting framework, the 'Social Accounting Matrix (SAM)[46] provides a complete and consistent picture of the circular flow (both real and monetary) in an economy. This is an important task which the Bangladesh Planning Commission should undertake.

Finally, we do not claim this model gives final and decisive answers; it might be considered an accomplishment if it only inspires further research or if it furnishes an additional point of view for decision making. Indeed it can be

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[46] For a layman's guide to SAM, see King, B.B., 1981.

argued that the major usefulness of these types of study is not their particular empirical results, which may quickly become out-dated, but rather that they may provide a basis for dialogue between development planners and policy makers within a consistent analytical and informational framework.

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APPENDIX - A

DATA OF THE AGGREGATE MACRO MODEL

In million Taka, at 1972-73 prices

YEAR	Y	YA	YM	YS	TR	P
1959-60	43,253.73	25,510	3,260	13,502	477.61	33.50
1960-61	45,626.22	27,102	3,398	13,950	529.99	35.85
1961-62	49,090.65	28,285	4,541	14,903	642.72	35.63
1962-63	49,884.22	28,406	5,013	15,226	449.65	37.14
1963-64	54,536.44	29,111	6,895	17,210	769.68	34.30
1964-65	55,674.66	30,005	6,825	17,116	737.95	37.13
1965-66	58,193.38	31,310	7,232	17,125	755.73	39.30
1966-67	58,350.24	32,609	6,229	17,400	714.60	45.34
1967-68	63,650.11	35,025	7,397	18,928	753.95	44.30
1968-69	65,526.32	34,447	8,888	19,684	642.54	45.60
1969-70	66,851.06	36,718	8,365	19,111	708.87	48.81
1970-71	.... Not Available					
1971-72	.... Not Available					
1972-73	45,112.00	26,100	4,555	14,457	141.00	100.00
1973-74	50,569.12	28,827	5,212	16,530	236.13	140.60
1974-75	52,282.01	28,537	7,401	16,530	281.50	240.50
1975-76	58,686.13	31,865	7,755	19,066	439.10	183.10
1976-77	59,469.05	30,903	8,338	20,228	589.17	177.20
1977-78	63,982.11	34,019	9,014	20,949	609.04	203.60
1978-79	66,766.02	33,872	9,510	23,384	571.96	216.80
1979-80	69,210.21	33,909	9,744	25,557	706.66	249.20
1980-81	74,234.00	36,658	10,518	27,059	833.33	264.00

Y = Gross National Product; Source : 1959/60-69/70, Alamgir & Berlage, 1974, p 205; 1972/73-1980/81, World Bank, 1982, p 189

YA = Value-added in agriculture; Source : Ibid.

YM = Value-added in manufacturing; Source : Ibid.

YS = Value-added in service ; Source : Ibid.

TR = Income tax; Source : 1959/60-1969/70, Alamgir & Berlage, 1974, p 77; 1972/73-1980/81, World Bank, 1982, p 205

P = GNP deflator ; Source : 1959/60-1969/70, Alamgir & Berlage, 1974, pp 172-74; 1972/73-1980/81, Statistical Year Book - 1980, p 392

APPENDIX - A (contd.)

In million Taka, at 1972-73 prices

YEAR	CP	CG	IP	IG	L
1959-60	38,510.45	2,062.69	1,417.91	1,000.00	53.9
1960-61	40,529.99	2,189.68	1,500.70	1,152.02	55.6
1961-62	43,261.30	2,433.34	2.032.00	1,431.38	57.3
1962-63	44,582.66	2,372.11	2,670.98	1,696.28	59.1
1963-64	46,731.78	3,224.49	3,725.95	2,268.22	60.9
1964-65	47,656.88	3,239.97	3,121.47	2,588.20	62.8
1965-66	49,157.76	3,603.05	2,559.80	2,430.03	64.6
1966-67	50,465.37	3,063.52	2,871.64	2,322.45	66.5
1967-68	54,778.78	3,521.45	4,647.87	2,532.73	68.4
1968-69	56,078.95	3,932.02	4,782.90	2,552.63	70.4
1969-70	56,517.11	4,310.59	5,838.97	2,378.61	72.4
1970-71	....	Not Available	....		....
1971-72	....	Not Available	....		....
1972-73	41,776.00	2,667.00	1,768.00	1,632.00	74.3
1973-74	46,790.90	2,986.49	2,071.12	1,911.81	76.4
1974-75	50,101.04	1,727.24	2,121.41	2,116.84	78.0
1975-76	56,851.99	2,872.20	2,761.33	3,332.61	79.9
1976-77	53,523.14	3,891.08	2,782.73	3,207.11	81.8
1977-78	57,935.66	4,252.95	4,489.92	3,661.10	83.7
1978-79	60,343.63	4,434.50	4,523.99	4,153.14	85.6
1979-80	62,795.75	4,984.35	7,143.66	4,556.98	87.7
1980-81	66,740.91	5,701.89	7,500.00	5,280.68	89.9

CP = Private Consumption; Source : 1959/60-1969/70, Alamgir & Berlage, 1974, p 205; 1972/73-1980/81, World Bank, 1982, p 189

CG = Public Consumption; Source : ibid.

IG = Public Investment; Source: 1959/60-1969/70, Alamgir & Berlage, 1974, p 209; 1972/73-1980/81, World Bank, 1982, p 189

IP = Private Investment; Source : Ibid

L = Population in million; Source: 1959/60-1969/70, Alamgir & Berlage, 1974, pp 160-1; 1972/73-1980/81, World Bank, 1982, p 189.

APPENDIX - A (contd.)

In million Taka, at 1972-73 prices

YEAR	CRP	CRG	CR	FCA	GDE	CS
1959-60	N.A.	N.A.	1,983.45	125.37	N.A.	50.19
1960-61	N.A.	N.A.	2,500.50	1,330.54	N.A.	499.01
1961-62	N.A.	N.A.	2,892.31	973.90	N.A.	380.73
1962-63	N.A.	N.A.	3,901.34	1,313.95	N.A.	494.28
1963-64	N.A.	N.A.	4,112.51	2,323.62	N.A.	929.08
1964-65	N.A.	N.A.	4,902.77	2,558.58	N.A.	1,085.30
1965-66	N.A.	N.A.	5,112.23	1,852.42	N.A.	787.94
1966-67	N.A.	N.A.	5,638.51	1,795.32	N.A.	1,011.68
1967-68	N.A.	N.A.	6,652.37	1,945.82	N.A.	1,064.75
1968-69	N.A.	N.A.	6,617.76	2,228.07	N.A.	1,280.96
1969-70	N.A.	N.A.	6,460.97	2,253.64	N.A.	1,342.82
1970-71	.... Not Available					
1971-72	.... Not Available					
1972-73	2,593.95	3,973.92	5,542.50	4,279.00	3,978.00	519.00
1973-74	2,318.00	3,818.80	5,085.06	2,542.55	2,163.12	1,668.93
1974-75	1,255.95	2,136.56	3,250.15	3,254.58	1,638.33	1,008.30
1975-76	1,943.81	3,193.04	5,044.07	6,021.86	4,644.81	4,573.34
1976-77	2,929.12	3,618.20	6,423.53	4,395.48	5,681.92	588.16
1977-78	3,640.85	3,715.83	7,387.77	5,863.24	5,897.06	2,807.03
1978-79	5,065.67	3,543.37	8,609.04	6,825.81	7,385.25	1,933.94
1979-80	5,635.26	4,505.84	10,141.10	7,285.15	9,357.43	2,976.87
1980-81	7,510.00	5,306.00	12,816.00	6,791.17	8,973.49	3,048.90

CRP = Institutional credit to the private sector; Source : Bangladesh Economic Survey - 1980-81, pp 330-336

CRG = Institutional credit to the public sector; Source : Ibid.

CR = Institutional Credit Advanced to both Private & Public Sectors; Source: 1959/60-1969/70, Statistical Year Book, 1975; 1972/73-1980/81 Bangladesh Economic Survey - 1981/82, pp 330, 336

FCA= Foreign Capital Assiatance; Source: 1959/60-1969/70, Alamgir & Berlage, 1974, p 205; 1972/73-1980-81, World Bank, 1982, p 190

GDE = Annual government development expenditure; Source : World Bank , 1982, p 204

CS = Capital Account Surplus; Source: 1959/60-1969/70, Alamgir & Berlage, 1974, p 214; 1972/73-1980/81, Statistical Year Book - 1980, p 336.

APPENDIX - A (contd.)

In million Taka, at 1972-73 prices

YEAR	EX	MC	MI	MR	PX	PM
1959-60	2,019.32	394.15	357.22	810.32	71.44	83.90
1960-61	1,305.80	707.13	385.91	841.68	124.33	95.53
1961-62	1,773.66	534.72	493.83	861.28	95.96	91.13
1962-63	2,029.21	793.38	305.45	691.66	84.92	98.76
1963-64	2,087.58	924.73	795.38	1,013.08	83.13	85.73
1964-65	1,822.41	825.92	1,081.11	1,034.83	99.05	87.57
1965-66	2,268.90	912.32	779.45	1,059.05	95.51	92.32
1966-67	1,944.21	1,314.48	971.79	1,274.19	119.02	80.45
1967-68	2,310.22	817.67	941.28	1,433.70	98.22	80.93
1968-69	2,520.62	1,293.98	1,229.74	1,387.13	95.77	81.62
1969-70	2,731.73	1,668.93	1,065.60	1,516.93	94.95	81.88
1970-71	.... Not Available					
1971-72	.... Not Available					
1972-73	2,768.50	801.09	360.40	996.00	100.00	100.00
1973-74	2,776.18	2,631.03	583.05	921.41	107.50	177.00
1974-75	2,391.69	2,660.27	470.44	1,153.33	131.20	253.00
1975-76	4,878.47	3,590.78	960.43	2,228.33	113.80	216.80
1976-77	4,988.85	2,911.51	1,069.19	2,298.07	133.70	221.20
1977-78	4,539.91	4,139.20	1,262.35	2,517.41	159.20	230.60
1978-79	4,706.30	3,183.82	1,875.75	3,093.71	201.60	266.40
1979-80	4,724.95	3,782.66	1,754.68	2,264.87	229.20	363.20
1980-81	5,406.86	3,824.76	1,685.80	2,177.65	194.0	423.30

EX = Total Exports; Source: 1959/60-1969/70, Alamgir & Berlage, 1974, p 231; 1972/73-1980-81, Bangladesh Economic Survey- 1981/82, p 354

MC = Imports of Consumer Goods; Source: 1959/60-1969/70, Alamgir and Berlage, 1974, pp 223-226; 1972/73-1980/81, Monthly Statistical Bulletin, May, 1982, pp 120-122

MI = Imports of Capital Goods; Source: Ibid

MR = Imports of Raw-materials; Source: Ibid

PX = Export price index; Source : 1959/60-1969/70, Alamgir & Berlage, 1974, p 232; 1972/73-1980/81, Bangladesh Economic Survey -81/82, p 361

PM = Import price index; Source : Ibid.

APPENDIX - A (contd.)

In million Taka, at 1972-73 prices

YEAR	CF	CO	PF	PO	CPI
1972-73	29,261.25	9,753.75	100.00	100.00	100.00
1973-74	37,201.50	12,400.50	143.68	127.71	137.61
1974-75	39,912.00	13,304.00	254.20	187.96	230.04
1975-76	36,486.75	12,162.25	213.51	197.09	210.80
1976-77	32,863.50	10,954.50	216.45	205.16	215.89
1977-78	36,568.50	12,189.50	249.50	226.99	243.14
1978-79	35,658.75	11,886.25	266.45	245.42	263.18
1979-80	38,894.25	12,964.75	322.31	281.05	311.75
1980-81	39,864.75	13,288.25	339.58	340.28	350.86

CF = Consumption expenditure on food; Source : Monthly Economic Situation of Bangladesh, April 1982, pp 11-18

CO = Consumption expenditure on items other than food; Source : Ibid.

PF = Index of food prices; Source : Statistical Year Book - 1980, p 441

PO = Index of prices other than food; Source : Ibid.

CPI = Consumer price index; Source : Ibid.

NOTE : Disaggregated consumption data are not available for the period prior to 1972-73.

APPENDIX - B

Input-Output Flow Matrix for Bangladesh in 1976-77, Matrix
(At current prices)

(Tk. in '000')

Supplying Sectors.		Using Sectors. 1	2	3	4	5	6
1. Rice	..	126,37,89	0	0	0	0	0
2. Wheat	..	0	3,90,21	0	0	0	0
3. Jute	..	40,18	0	5,70,36	0	0	0
4. Cotton	..	0	0	0	2,38	0	0
5. Tea	..	0	0	0	0	22,20	0
6. Other Crops	...	0	0	0	0	0	61,43,70
7. Livestock	..	303,96,80	6,45,52	23,08,32	1,11	0	43,26,48
8. Fisheries	..	0	0	0	0	0	0
9. Forestry	..	7,61,64	20,38	76,26	2	14,46	2,13,51
10. Sugar	..	0	0	0	0	0	0
11. Edible Oil	..	0	0	0	0	0	0
12. Salt	..	0	0	0	0	0	0
13. Tobacco Products	..	0	0	0	0	0	0
14. Other Food	..	0	0	0	0	0	0
15. Cotton Yarn	..	0	0	0	0	0	0
16. Cloth : Mill made	..	0	0	0	0	0	0
17. Cloth : Handloom	..	0	0	0	0	0	0
18. Jute Textile	..	5,87,47	22,52	6,28	1	8,76	0
19. Paper	..	0	0	0	0	6,95	0
20. Leather	..	0	0	0	0	0	0
21. Fetilizer	..	104,31,81	3,34,13	8,19,31	36	1,62,25	18,42,84
22. Pharmacutical	..	0	0	0	0	0	0
23. Other Chemicals	..	5,26,36	16,71	19,95	3	31,19	1,03,74
24. Cement	..	0	0	0	0	0	0
25. Basic Metals	..	0	20	0	0	0	0
26. Metal Products	..	5,01,32	61,13	71,90	0	3,47	0
27. Machinery	..	20,81,72	53,34	1,73,36	45	96,15	2,46,81
28. Transport Equipment	..	70,50	0	7,25	0	7,48	0
29. Wood	..	0	0	0	0	3,30,67	0
30. Miscellaneous Industries	..	8,86,39	37,50	96,51	0	1,82,36	0
31. Urban Housebuilding	..	0	0	0	0	0	0
32. Rural Housebuilding	..	0	0	0	0	0	0
33. Non-Residential Building	..	2,41,44	0	0	0	0	0
34. Construction : Elec. and Gas		0	0	0	0	0	0
35. Construction : Transport	..	0	0	0	0	0	0
36. Other Construction	..	1,45,56	0	14,94	0	0	0
37. Petroleum Products	..	22,41,89	88,47	1,89,14	2	3,57,75	59,53
38. Electricity	..	1,51,69	50,00	25,59	2	7,86	20
39. Gas	..	0	0	0	0	0	0
40. Transport Service	..	25,49,08	80,00	12,70,62	37	1,51,83	45,09,00
41. Trade Service	..	76,47,24	2,39,96	39,02,38	1,13	6,07,32	135,27,00
42. Housing Service	..	0	0	0	0	0	0
43. Health	..	0	0	0	0	0	0
44. Education	..	0	0	0	0	0	0
45. Public Administration.	..	1,09,20	7,00	50,17	1	3,93	96,19
46. Banking and Insurance	..	1,55,00	7,40	4,53,87	0	32,27	1,01,64
47. Other Services	..	1,75,44	8,00	39,60	1	76,82	1,09,91
Total Inputs ($\sum_i Z_{ij}$)	..	723,38,62	20,62,47	100,95,81	5,92	21,03,72	312,80,55
Value Added (V_j)	..	2646,63,78	48,78,63	220,90,36	5,48	43,96,28	806,93,27
Gross Output (X_j)	..	3370,02,40	69,41,10	321,86,17	11,40	65,00,00	1119,73,82

APPENDIX - B (contd.)

(Tk. in '000')

Supplying Sectors	Using Sectors					
	7	8	9	10	11	12
1. Rice	98,04,18	0	0	0	0	0
2. Wheat	2,05,14	0	0	0	0	0
3. Jute	0	0	0	0	0	0
4. Cotton	0	0	0	0	0	0
5. Tea	0	0	0	0	0	0
6. Other Crops	30,95,16	0	0	164,80,28	73,27,93	0
7. Livestock	0	0	0	0	0	0
8. Fisheries	0	1,72	0	0	0	0
9. Forestry	40,60	9,03,02	10,00	59,95	0	0
10. Sugar	16,94	0	0	0	0	0
11. Edible Oil	0	35,80	0	0	5,77	0
12. Salt ..	6,79,60	0	0	0	0	0
13. Tobacco Products ..	0	0	0	0	0	0
14. Other Food ..	0	0	0	0	0	0
15. Cotton Yarn ..	0	0	0	0	0	0
16. Cloth : Mill made ..	0	6,00,00	0	0	0	0
17. Cloth : Handloom ..	0	0	0	0	0	0
18. Jute Textile ..	0	4,27,88	5,00	1,88,38	3,37	42,49
19. Paper ..	0	36,07	0	0	4,43	0
20. Leather ..	0	0	0	0	0	0
21. Fetilizer ..	0	0	0	0	0	0
22. Pharmaceutical ..	0	0	0	0	0	0
23. Other Chemicals ..	0	5,47,09	1,95	1,03,82	34,89	5,96
24. Cement ..	0	0	0	0	0	0
25. Basic Metals ..	0	0	0	0	94,17	0
26. Metal Products ..	26,20	11,20,85	30,00	20,00	1,67,97	5,00
27. Machinery ..	6,20	27,95	46,57	2,32,66	69,42	55,22
28. Transport Equipment ..	0	5,11,97	0	0	0	0
29. Wood ..	0	14,88	0	0	4,25	0
30. Miscellaneous Industries ..	32,60	16,47,10	0	5,12,87	58,22	0
31. Urban Housebuilding ..	0	0	0	0	0	0
32. Rural Housebuilding ..	0	0	0	0	0	0
33. Non-Residential Building ..	0	0	0	0	0	0
34. Construction : Elec. and Gas	0	0	0	0	0	0
35. Construction : Transport ..	0	0	27,10	0	0	0
36. Other Construction ..	0	0	0	0	0	0
37. Petroleum Products.. ..	0	1,84,94	90	1,53,46	64,98	0
38. Electricity ..	15,72	12,67	0	34,65	80,07	10,94
39. Gas ..	4,26	0	0	1,52	0	0
40. Transport Service ..	13,58,62	35,73,24	5,20,20	10,98,32	3,32,37	3,39,15
41. Trade Service	54,34,47	136,92,96	15,60,60	43,93,30	13,29,48	13,59,35
42. Housing Service	0	0	0	0	0	0
43. Health	0	0	0	0	0	0
44. Education	0	0	0	0	0	0
45. Public Administration.	1,80	1,91	1,25	1,84	1,24	50
46. Banking and Insurance	2,70	6,84	0	52,39	8,79	15,28
47. Other Services	4,36	98,10	2,00	22,54	9,50	0
Total Inputs ($\sum_i Z_{ij}$) ..	207,28,55	234,44,99	22,05,57	233,55,98	95,96,85	18,33,90
Value Added (V_j) ..	686,86,72	688,82,35	173,59,91	107,44,53	26,16,47	66,62,00
Gross Output (X_j) ..	894,15,27	923,27,34	195,65,48	341,00,51	122,13,32	84,95,90

APPENDIX - B (contd.)

(Tk. in '000')

Supplying Sectors.		Using Sectors 13	14	15	16	17	18
1.	Rice	0	0	0	0	0	0
2.	Wheat	2,00	43,53,87	0	0	0	0
3.	Jute	0	0	0	0	0	159,48,36
4.	Cotton	0	0	108,85,36	0	0	0
5.	Tea	0	0	0	0	0	0
6.	Others Crops	44,52,64	2,48,73	0	0	0	0
7.	Livestock	0	6,77,43	0	0	0	0
8.	Fisheries	0	0	0	0	0	0
9.	Forestry	0	3,52,96	0	3	3,70	0
10.	Sugar	0	20,92,51	0	0	0	0
11.	Edible Oil	0	18,19,76	0	0	0	0
12.	Salt	0	1,08	0	56,53	0	0
13.	Tobacco Products	20,15	0	0	0	0	0
14.	Other Food	0	2,23,71	0	0	0	0
15.	Cotton Yarn	0	0	0	29,37,80	153,52,19	56,77
16.	Cloth : Mill made	0	0	0	2,48,82	27,20,00	0
17.	Cloth : Handloom	0	0	0	0	0	0
18.	Jute Textile	53	0	29,42	26,79	0	1,58,00
19.	Paper	14,07,19	1,13,90	30,63	75,28	3,27,25	74,23
20.	Leather	0	0	5,10	6,20	0	0
21.	Fetilizer	0	0	0	0	0	0
22.	Pharmaceutical	0	0	0	0	0	0
23.	Other Chemicals	86,99	5,43,99	1,00,36	3,67,05	61,90,67	1,99,23
24.	Cement	0	0	0	0	0	0
25.	Basic Metals	0	30,82	0	0	0	0
26.	Metal Products	1,08,67	42,69	8,09	6,30	11,53	3,06,40
27.	Machinery	83,39	1,46,98	2,30,22	3,20,99	10,67,39	16,66,60
28.	Transport Equipment	0	0	0	0	0	0
29.	Wood	0	1.45	5,25	6,50	4,00	15,00
30.	Miscellaneous Industries	7,41,11	2,65,08	30,70	31,40	2,45,64	68,69
31.	Urban Housebuilding	0	0	0	0	0	0
32.	Rural Housebuilding	0	0	0	0	0	0
33.	Non-Residential Building	0	0	0	0	0	0
34.	Construction : Elec. and Gas	0	0	0	0	0	0
35.	Construction : Transport	0	0	0	0	0	0
36.	Other Construction	0	0	0	0	0	0
37.	Petroleum Products	27,29	2,49,31	1,86,92	1,25,10	0	11,16,00
38.	Electricity	20,53	94,78	4,42,56	1,93,31	1,23,43	10,93,70
39.	Gas	1,40	34,35	23,01	8,43	0	16,67
40.	Transport Service	5,97,35	12,81,90	11,93	2,28,48	7,96,05	6,55,00
41.	Trade Service	29,16,49	51,27,58	50,18	9,13,90	71,64,49	6,50,00
42.	Housing Service	0	0	0	0	0	0
43.	Health	0	0	0	0	0	0
44.	Education	0	0	0	0	0	0
45.	Public Administration.	5,61	2,57	15,20	12,81	1,10,65	1,20,29
46.	Banking and Insurance	41,71	8,57	63,56	43,56	5,22,30	3,32,48
47.	Other Services	9,63	33,08	96,51	10,49	14,21,20	5,31,59
	Total Inputs ($\sum_i Z_{ij}$)	105,22,68	177,47,10	122,15,00	56,19,77	360,60,49	230,08,98
	Value Added (V_j)	132,68,37	90,68,92	34,10,11	16,31,25	120,59,05	69,46,02
	Gross Output (X_j)	237,91,05	268,16,02	156,25,11	72,51,02	481,19,54	299,55,00

APPENDIX - B (contd.)

(Tk. in '000')

Supplying Sectors.		Using Sectors.					
		19	20	21	22	23	24
1. Rice	..	0	0	0	0	0	0
2. Wheat	..	0	0	0	0	1,02	0
3. Jute	..	20,89	0	0	0	0	0
4. Cotton	..	0	0	0	0	0	0
5. Tea	..	0	0	0	0	0	0
6. Other Crops	..	0	0	0	7,67	2,35,61	0
7. Livestock	..	0	127,20,72	0	73,74	16,90,75	0
8. Fisheries	..	0	0	0	0	0	0
9. Forestry	..	3,50,68	0	0	0	0	0
10. Sugar	..	0	0	0	1,20,36	1,99	0
11. Edible Oil	..	0	0	0	0	6,28,95	0
12. Salt	..	1,30,00	92,63	0	0	44,91	0
13. Tobacco Products	..	0	0	0	0	0	0
14. Other Food	..	0	7,29	0	0	1,40	0
15. Cotton Yarn	..	0	0	0	0	0	0
16. Cloth : Mill made	..	0	41,82	0	0	27,94	0
17. Cloth : Handloom	..	14	0	0	0	0	0
18. Jute Textile	..	3,43	10	5,01,28	0	39	1,47,50
19. Paper	..	5,81,93	6,48,75	0	40,67	1,81,71	0
20. Leather	..	15	48,90,46	0	0	6,64	0
21. Fetilizer	..	0	0	0	0	2,17	0
22. Pharmaceutical	..	0	0	0	6,40,03	0	0
23. Other Chemicals	..	6,53,92	18,55,78	9,87,81	8,23,28	20,00,72	14
24. Cement	..	52,91	0	1,72	0	14,06	15,97,87
25. Basic Metals	..	5,42	0	0	0	26,53	0
26. Metal Products	..	8,96	71,45	0	53,65	1,55,15	34,98
27. Machinery	..	74,52	3,00,63	1,36,09	19,94	1,16,30	0
28. Transport Equipment	..	0	0	0	0	0	0
29. Wood	..	1,26	1,86	0	32,27	51,82	0
30. Miscellaneous Industries	..	1,02,31	1,92,81	2,33,67	16,54,55	5,78,95	1,04,32
31. Urban Housebuilding	..	0	0	0	0	0	0
32. Rural Housebuilding	..	0	0	0	0	0	0
33. Non-Residential Building	..	0	0	0	0	0	0
34. Construction : Elec. and Gas		0	0	0	0	0	0
35. Construction : Transport	..	0	0	0	0	0	0
36. Other Construction	..	0	0	0	0	0	0
37. Petroleum Products	..	9,43,18	2,50	29,41	83,35	1,42,49	8,09
38. Electricity	..	1,39,72	14,40	1,92,93	38,99	1,11,87	50,40
39. Gas	..	0	0	5,27,34	4,89	21,56	39,21
40. Transport Service	..	2,05,69	13,41,32	7,97,19	1,66,21	3,54,77	2,90,91
41. Trade Service	..	8,22,77	53,65,31	18,83,37	14,95,93	31,92,94	11,63,66
42. Housing Service	..	0	0	0	0	0	0
43. Health	..	0	0	0	0	0	0
44. Education	..	0	0	0	0	0	0
45. Public Administration	..	5,18	6,83	1,56	21,36	17,44	80
46. Banking and Insurance	..	36,62	22,12	33,63	51,82	43,54	1,38
47. Other Services	..	28,57	10,81	26,85	6,82,79	8,69,45	4,98
Total Inputs ($\sum_i Z_{ij}$)	..	41,68,25	275,87,59	53,52,85	60,11,50	105,21,07	34,44,24
Value Added (V_j)	..	18,72,64	64,15,00	35,82,30	26,90,46	44,03,79	10,64,88
Gross Output (X_j)	..	60,40,89	340,02,59	89,35,15	87,01,96	149,24,86	45,09,12

APPENDIX - B (contd.)

(Tk. in '000')

Supplying Sectors		Using Sectors.					
		25	26	27	28	29	30
1. Rice	..	0	0	0	0	0	3,78
2. Wheat	..	0	0	0	0	0	0
3. Jute	..	0	0	0	0	0	0
4 Cotton	..	0	0	0	0	0	14,11
5. Tea	..	0	0	0	0	0	0
6. Others Crops	.	0	0	0	0	0	0
7. Livestock	..	0	0	0	0	0	0
8. Fisheries	..	0	0	0	0	0	0
9. Forestry	..	0	0	0	0	35,21,80	0
10. Sugar	..	0	0	0	0	0	0
11. Edible Oil	.	0	0	0	0	0	0
12. Salt	..	0	0	0	0	0	16,05
13. Tobacco Products	..	0	0	0	0	0	0
14. Other Food	..	0	0	0	0	0	0
15. Cotton Yarn	..	0	0	0	0	0	2,65,02
16. Cloth : Mill made	..	0	0	0	0	0	12,20,44
17. Cloth : Handloom	..	0	66	0	0	0	0
18. Jute Textile	..	5,02	15	3	0	23	10,17
19. Paper	..	2,82	4,77	42,17	51	5,18	16,29,09
20. Leather	..	0	0	1,55	0	0	0
21. Fetilizer	..	0	0	1,42	0	0	33
22. Pharmaceutical	..	0	0	0	0	0	0
23. Other Chemicals	..	49,96	1,31,70	2,23,34	53,42	35,30	79,20,41
24. Cement	..	0	0	4	0	0	1,24,94
25. Basic Metals	..	93,03,25	23,37,66	11,68,98	6,36,36	9,93	2,77,73
26. Metal Products	..	29,69	7,00,74	3,47,43	38,61	10,89	17,27,34
27. Machinery	..	4,12,67	67,17	7,28,58	53,75	79,89	3,10,50
28. Transport Equipment	..	0	0	14	4,10,48	0	0
29. Wood	..	2,22	1,64	20,51	3,34	1,24,45	12,63
30. Miscellaneous Industries	..	7,37,32	1,07,57	10,35,54	1,27,63	20,28	77,16,12
31. Urban Housebuilding	..	0	0	0	0	0	0
32. Rural Housebuilding	..	0	0	0	0	0	0
33. Non-Residential Building	..	0	0	0	0	0	0
34. Construction : Elec. and Gas		0	0	0	0	0	0
35. Construction : Transport	..	0	0	0	0	0	0
36. Other Construction	..	0	0	0	0	0	0
37. Petroleum Products	..	2,91,66	1,20,85	51,03	34,82	16	23,30,96
38. Electricity	..	2,51,26	60,48	39,18	11,60	7,23	2,86,45
39. Gas	..	21,06	31,63	4,58	17,08	0	1,48,43
40. Transport Service	..	6,05,07	3,67,35	3,13,03	1,62,71	3,35,27	18,94,51
41. Trade Service	..	24,20,28	11,02,03	12,52,16	6,50,85	10,05,80	81,78,03
42. Housing Service	..	0	0	0	0	0	0
43. Health	..	0	0	0	0	0	0
44. Education	..	0	0	0	0	0	0
45. Public Administration.	..	11,62	5,50	9,83	6,49	51	52,13
46. Banking and Insurance	..	21,48	10,22	21,40	21,72	66	3,06,11
47. Other Services	..	30,79	1,01,40	2,68,09	2,87,09	8,03	13,38,84
Total Inputs ($\Sigma_i Z_{ij}$)	..	141,96,17	51,51,52	55,29,03	25,16,46	51,65,61	357,84,12
Value Added (V_j)	..	89,97,99	45,36,32	35,90,38	22,14,47	37,74,90	148,08,42
Gross Output (X_j)	..	231,94,16	96,87,84	91,19,41	47,30,93	89,40,51	505,92,54

APPENDIX - B (contd.)

(Tk. in '000')

Supplying Sectors.	Using Sectors. 31	32	33	34	35	36
1. Rice	0	0	0	0	0	0
2. Wheat	0	0	0	0	0	0
3. Jute	25,86	25,50	0	0	0	0
4. Cotton	0	0	0	0	0	0
5. Tea	0	0	0	0	0	0
6. Other Crops	0	0	0	0	0	0
7. Livestock	0	0	0	0	0	0
8. Fisheries	0	0	0	0	0	0
9. Forestry	16,25,42	86,97,60	4,26,51	42,51	35,55	0
10. Sugar	0	0	0	0	0	0
11. Edible Oil	0	0	0	0	0	0
12. Salt	0	0	0	0	0	0
13. Tobacco Products	0	0	0	0	0	0
14. Other Food	0	0	0	0	0	0
15. Cotton Yarn	0	0	0	0	0	0
16. Cloth : Mill made	0	0	0	0	0	0
17. Cloth : Handloom	0	0	0	0	0	0
18. Jute Textile	0	0	0	0	0	0
19. Paper	0	0	0	0	0	0
20. Leather	0	0	0	0	0	0
21. Fetilizer	0	0	0	0	0	0
22. Pharmaceutical	0	0	0	0	0	0
23. Other Chemicals	5,46,15	0	2,96,87	9,74	26,77	0
24. Cement	30,93,42	8,68,00	17,95,50	6,43,91	6,90,72	3,18,00
25. Basic Metals	46,99,13	24,91,35	23,94,76	43,55,22	14,12,58	2,27,97
26. Metal Products	15,66,38	74,74,05	7,98,26	23,94,06	14,12,58	6,83,90
27. Machinery	0	0	0	11,96,20	0	1,98,10
28. Transport Equipment	0	0	0	0	6,04,10	0
29. Wood	20,07,82	8,66,40	8,18,96	28,65	78,79	0
30. Miscellaneous Industries	87,18,97	28,42,60	47,11,08	9,16,81	43,51,51	25,14,43
31. Urban Housebuilding	0	0	0	0	0	0
32. Rural Housebuilding	0	0	0	0	0	0
33. Non-Residential Building	0	0	0	0	0	0
34. Construction : Elec. and Gas	0	0	0	0	0	0
35. Construction : Transport	0	0	0	0	0	0
36. Other Construction	0	0	0	0	0	2,93,00
37. Petroleum Products	0	0	0	38,42	9,63,32	0
38. Electricity	0	0	0	0	0	0
39. Gas	0	0	0	0	0	0
40. Transport Service	0	0	0	44,34	40,00	0
41. Trade Service	0	0	0	0	0	0
42. Housing Service	0	0	0	0	0	0
43. Health	0	0	0	0	0	0
44. Education	0	0	0	0	0	0
45. Public Administration	0	0	0	38,41	0	0
46. Banking and Insurance	0	0	0	0	0	0
47. Other Services	0	0	0	0	0	0
Total Inputs ($\sum_i Z_{ij}$)	222,80,15	232,65,50	112,41,94	97,08,27	96,15,92	42,35,40
Value Added (V_j)	34,73,39	31,43,50	17,21,96	21,23,09	24,76,27	56,25,03
Gross Output (X_j)	257,53,54	264,09,00	129,63,90	118,31,36	120,92,19	98,60,43

APPENDIX - B (contd.)

(Tk. in '000')

Supplying Sectors.		Using Sectors. 37	38	39	40	41	42
1.	Rice	0	0	0	0	0	0
2.	Wheat	0	0	0	0	0	0
3.	Jute	0	0	0	0	0	0
4.	Cotton	0	0	0	0	0	0
5.	Tea	0	0	0	0	0	0
6.	Other Crops	0	0	0	0	0	0
7.	Livestock	0	0	0	0	0	0
8.	Fisheries	0	0	0	0	0	0
9.	Forestry	0	0	0	0	1,55,80	0
10.	Sugar	0	0	0	0	0	0
11.	Edible Oil	0	0	0	0	0	0
12.	Salt	0	0	0	0	0	0
13.	Tobacco Products	0	0	0	0	0	0
14.	Other Food	0	0	0	0	0	0
15.	Cotton Yarn	0	0	0	0	57,71	0
16.	Cloth : Mill made	0	0	0	55,63	8,66	0
17.	Cloth : Handloom	0	0	0	55,63	20,20	0
18.	Jute Textile	0	0	0	0	9,30,00	0
19.	Paper	0	63	60	0	2,65,44	0
20.	Leather	0	0	0	0	0	0
21.	Fertilizer	0	0	0	0	0	0
22.	Pharmaceutical	0	0	0	0	0	0
23.	Other Chemicals	79,86	0	20,10	0	0	0
24.	Cement	0	0	0	0	0	0
25.	Basic Metals	0	0	0	0	0	0
26.	Metal Products	14,47	0	0	0	4,73,18	0
27.	Machinery	43,41	6,46,98	40,85	38,40	1,44,26	0
28.	Transport Equipment	0	0	0	14,62,77	1,44,26	0
29.	Wood	0	0	0	42,63	11,90	12,00
30.	Miscellaneous Industries	1,39	1,86,00	5,49	2,01,79	12,66,63	0
31.	Urban Housebuilding	0	0	0	0	0	42,14,98
32.	Rural Housebuilding	0	0	0	0	0	90,07,10
33.	Non-Residential Building	0	0	0	0	4,27,08	0
34.	Construction : Elec. and Gas	0	1,70,00	50,00	0	0	0
35.	Construction : Transport	0	0	0	5,04,60	0	0
36.	Other Construction	0	0	0	0	0	0
37.	Petroleum Products	179,92,95	21,62,52	16,00	101,73,85	7,77,97	0
38.	Electricity	20,06	4,48,46	8,00	41,62	4,25,96	0
39.	Gas	0	3,80,53	0	2,02,14	51,84	0
40.	Transport Service	3,75,45	1,03,30	5,08	20,52,06	0	0
41.	Trade Service	11,26,35	0	0	1,67,13	0	0
42.	Housing Service	0	0	0	0	0	0
43.	Health	0	0	0	0	0	0
44.	Education	0	0	0	0	0	0
45.	Public Administration	3,90	19,74	2,57	5,91,81	4,18,49	0
46.	Banking and Insurance	13,74	5,37	6,20	7,34,02	25,01,74	4,21,50
47.	Other Services	46,38	48,01	7,99	1,02,20	8,00,00	0
	Total Inputs ($\sum_i Z_{ij}$)	197,17,96	41,71,54	1,62,88	164,28,28	88,81,12	136,55,58
	Value Added (V_j)	5,51,34	13,83,64	14,61,48	540,94,92	915,15,92	885,41,62
	Gross Output (X_j)	202,69,30	55,55,18	16,24,36	705,23,20	1003,97,04	1021,97,20

APPENDIX - B (contd.)

(Tk. in '000')

Supplying Sectors.	Using Sectors 43	44	45	46	47	Total Input Deliveries. $(\sum_{j=1}^{47} Z_{ij})$
1. Rice	1,34,27	0	2,23,78	4,80	0	228,08,70
2. Wheat	28,91	0	48,18	1,04	0	50,30,37
3. Jute	0	0	0	0	0	166,31,15
4. Cotton	0	0	0	0	0	109,01,85
5. Tea	3,35	0	5,58	12	0	31,25
6. Other Crops	66,84	0	1,11,39	2,40	0	381,72,35
7. Livestock	29,87	0	49,79	1,08	0	529,21,61
8. Fisheries	26,99	0	44,99	96	0	74,66
9. Forestry	0	0	0	0	0	173,12,40
10. Sugar	13,15	0	21,91	47	0	22,67,33
11. Edible Oil	19,04	0	31,76	68	0	25,41,76
12. Salt	1,00	0	1,66	0	0	10,23,46
13. Tobacco Products	0	0	0	0	0	20,15
14. Other Food	7,78	4,25	12,96	31	0	2,57,70
15. Cotton Yarn	0	0	0	0	0	186,69,51
16. Cloth : Mill made	1,38,79	44,64	4,77,99	14,06	42,04	56,40,81
17. Cloth : Handloom	1,38,79	44,64	4,77,99	14,06	0	7,52,11
18. Jute Textile	42,08	16,00	16,00	0	0	31,79,28
19. Paper	1,00,58	66,96	6,92,24	48,23	77,00	64,65,21
20. Leather	0	0	0	0	0	49,10,10
21. Fertilizer	0	0	0	0	0	135,94,62
22. Pharmaceutical	4,57,80	0	60,00	2,15,16	0	13,73,08
23. Other Chemicals	0	0	30,00	0	253,00	248,78,27
24. Cement	0	0	0	0	0	91,98,09
25. Basic Metals	0	0	0	0	0	294,72,06
26. Metal Products	0	0	6,00,00	0	5,96	210,93,25
27. Machinery	0	58,74	5,98,00	22,77	51,70	119,44,87
28. Transport Equipment	2,98,73	41,40	7,00,00	56,40	0	43,15,48
29. Wood	12,50	14,35	17,66	12,00	4,97	45,62,63
30. Miscellaneous Industries	15,51,03	3,73,97	20,30,05	6,22,17	1,54,17	478,95,33
31. Urban Housebuilding	0	0	0	21,36	0	42,36,34
32. Rural Housebuilding	0	0	0	0	0	90,07,10
33. Non-Residential Building	1,25,00	2,19,00	7,66,00	1,50,00	0	19,28,52
34. Construction : Elec. and Gas	0	0	0	0	0	2,20,00
35. Construction : Transport	0	0	0	0	0	5,31,70
36. Other Construction	0	0	0	0	0	4,53,50
37. Petroleum Products	5,44,42	60,20	1,96,84	89,61	26,71	421,27,01
38. Electricity	60,10	23,00	1,48,96	60,00	22,68	48,21,07
39. Gas	0	0	0	0	0	15,39,93
40. Transport Service	3,17,78	62,12	22,52,19	82,98	43,60	315,66,44
41. Trade Service	0	0	0	8,89	43,72	1003,97,05
42. Housing Service	0	0	0	0	0	0
43. Health	0	0	0	2,15,15	0	2,15,15
44. Education	0	0	0	0	0	0
45. Public Administration	7,88,55	96,97	4,91,53	4,34,56	1,87,03	37,54,98
46. Banking and Insurance	0	0	0	0	0	61,01,59
47. Other Services	0	0	8,79,75	5,55,16	64,17	88,10,13
Total Inputs $(\sum_i Z_{ij})$	49,07,44	11,26,24	109,87,20	26,34,42	9,76,75	5936,49,95
Value Added (V_j)	76,28,06	207,86,76	273,66,99	131,49,87	487,64,11	10298,25,00
Gross Output (X_j)	125,35,50	219,13,00	383,54,19	157,84,29	497,40,86	16234,74,95

APPENDIX - C

Sector-wise Distribution of Final Demand Categories, 1976-77.

(Tk. in lakh).

Sectors.		Private Consumption. (C)	Government Consumption (G)	Gross Fixed Investment (K)	Stock Changes (S1)	Export (E).
1. Rice	..	3293,85	..	..	(—)79,83	..
2. Wheat	..	233,45	..	..	(—)53,22	..
3. Jute	..	9,91	..	..	(—)30,90	176,54
4. Cotton	..	..	..	..	..	62
5. Tea	..	14,36	..	..	(—)5,50	55,88
6. Other Crops	..	818,80	..	..	..	2,61
7. Livestock	..	396,00	..	..	..	4,42
8. Fisheries	..	895,97	..	..	..	26,95
9. Forestry	..	23,54	..	..	..	50
10. Sugar	..	317,88	..	..	..	45
11. Edible Oil	..	173,22	..	..	..	..
12. Salt	..	76,56	..	..	..	..
13. Tobacco Products	..	243,33	..	..	..	4
14. Other Food	..	394,55	..	..	..	9
15. Cotton Yarn	..	..	..	..	..	..
16. Cloth: Mill made	..	96,85	..	..	..	61
17. Cloth: Handloom	..	473,67	..	..	..	..
18. Jute Textile	..	16,25	..	..	(—)17,11	268,62
19. Paper	..	39,27	..	..	..	3,77
20. Leather	..	205,26	..	..	..	86,19
21. Fertilizer	..	..	..	..	(—)35,02	36
22. Pharmaceutical	..	167,73	..	..	..	..
23. Other Chemicals	..	222,92	..	..	..	3,15
24. Cement	..	..	..	..	..	..
25. Basic Metals	..	..	..	..	..	..
26. Metal Products	..	155,25	..	110,07	..	6
27. Machinery	..	63,52	..	372,06	..	62
28. Transport Equipment	..	18,59	..	234,16	..	1,51
29. Wood	..	13,63	..	34,06	..	19
30. Misc. Industries	..	280,88	..	..	..	11,63
31. Urban Housebuilding	..	..	..	215,17	..	..
32. Rural Housebuilding	..	..	..	174,02	..	..
33. Non-Residential Building	..	..	..	110,35	..	..
34. Construction : Elec. and Gas	..	..	..	116,11	..	..
35. Construction : Transport	..	..	..	115,60	..	..
36. Other Constcruction	..	..	..	94,07	..	..
37. Petroleum Products	..	23,98	..	..	(+)8,56	22,19
38. Electricity	..	7,34	..	..	..	..
39. Gas	..	84	..	..	..	..
40. Transport Service	..	283,57	..	..	..	..
41. Trade Service	..	..	..	..	..	..
42. Housing Service	..	1021,97	..	..	..	..
43. Health	..	92,57	30,63	..	..	..
44. Education	..	99,48	119,65	..	..	..
45. Public Admn.	..	..	345,99	..	..	..
46. Banking and Insurance	..	96,83	..	..	..	..
47. Other Service	..	409,31	..	..	..	..
Correction term [1]	..	(—) 1032,79	..	..	..	..
Total	..	9648,34	496,27	1575,67	(—)213,02	667,00

[1] Correction term for transport and trade inputs relating to imports and scarcity premium on imports.

APPENDIX - D

Sectoral Import Coefficients and Transport and Trade Service Input Co-efficients, 1976-77.

Sectors.	Import Coefficients (m_j).	Transport service input Coefficients ($q_{40,j}$).	Trade service input Coefficients ($q_{41,j}$).
1	2	3	4
1. Rice	0·0214	0·0566	0·0
2. Wheat	2·3213	0·0566	0·0
4. Cotton	19·0000	0·0182	0·0363
5. Tea	0·0007	0·0065	0·0347
6. Other Crops	0·0745	0·0403	0·2600
7. Livestock	0·0397	0·0502	0·2380
8. Fisheries	0·0004	0·0769	0·3130
9. Forestry	0·0077	0·0533	0·2450
11. Edible Oil	0·6264	0·0397	0·2800
12. Salt	0·0216	0·0	0·0
13. Tobacco Products	0·0238	0·0601	0·2480
14. Other Food	0·4813	0·0310	0·3190
15. Cotton Yarn	0·1948	0·0181	0·1081
16. Cloth: Mill made	1·1220	0·0178	0·1077
19. Paper	0·7827	0·0431	0·2670
20. Leather	0·0015	0·0150	0·2740
21. Fertilizer	0·1335	0·1718	0·0738
22. Pharmaceutical	1·0853	0·0334	0·2900
23. Other Chemicals	2·1816	0·0532	0·2900
24. Cement	1·0399	0·1697	0.3397
25. Basic Metals	0·2707	0·0236	0·0877
26. Metal products	3·9166	0·0317	0·2520
27. Machinery	5·0929	0·0309	0·2740
28. Transport Equipment ..	5·2866	0·0143	0·2740
29. Wood	0·0459	0·0423	0·2600
30. Misc. Industries	0·5248	0·0524	0·2520
37. Petroleum Products	1·3484	0·0168	0·0337

NOTE: Only sectors having import co-efficients and trade and transport service input co-efficients are included in this table.

APPENDIX - E

CORRELATION & VARINACE-COVARINACE MATRICES

VARIANCE-COVARIANCE MATRIX OF COEFFICIENTS

VAR			
5	0.2503D-01		
21	-0.1269D-01	0.8942D-02	
INT	-0.4578D+03	0.1682D+03	0.1007D+08
	5 GDA	21 GDR	

CORRELATION MATRIX OF COEFFICIENTS

VAR			
5	1.00000		
21	-0.84799	1.00000	
INT	-0.91182	0.56062	1.00000
	5 GDA	21 GDR	

VARIANCE-COVARIANCE MATRIX OF COEFFICIENTS

VAR				
1	0.1544D-02			
10	-0.5065D-02	0.2632D-01		
13	0.7924D-03	-0.1169D-01	0.1435D-01	
INT	-0.6232D+02	0.1786D+03	-0.2565D+02	0.2668D+07
	1 Y	10 CR	13 FCA	

CORRELATION MATRIX OF COEFFICIENTS

VAR				
1	1.00000			
10	-0.79454	1.00000		
13	0.16836	-0.60171	1.00000	
INT	-0.97104	0.67400	-0.13106	1.00000
	1 Y	10 CR	13 FCA	

VARIANCE-COVARIANCE MATRIX OF COEFFICIENTS

VAR			
9	0.4169D-02		
8	-0.2150D-02	0.1672D-02	
INT	-0.3322D+01	-0.2669D+00	0.1131D+05
	9 IP	8 IG	

CORRELATION MATRIX OF COEFFICIENTS

VAR			
9	1.00000		
8	0.81438	1.00000	
INT	-0.48377	-0.06137	1.00000
	9 IP	8 IG	

Variable #	Variable Names
1	GNP
5	Agricultural Income
8	Public Investment
9	Private Investment
10	Institutional Credits
13	Foreign Capital Assistance
21	Other Sectoral Income