Impact of Macroeconomic Policy Reforms in Bangladesh
A General Equilibrium Framework for Analysis

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Paper Presented at the

Micro Impacts of Macroeconomic
and Adjustment Policies (MIMAP)

Third Annual Meeting

November 2-6, 1998
Kathmandu, Nepal

Contents

List of Tables

List of Figures

Appendices

1 Introduction

In Bangladesh, the low level of income and pervasive poverty make it imperative for the government to focus on poverty reduction as the central concern of public policy. Despite government efforts and implementation of various programmes targeted to the poor since the early 1970s, the success in poverty reduction has not been significant. Over the past few decades, the economy has not been able to sustain high growth. The unsustainable growth is also manifested in macroeconomic imbalances in the form of high fiscal deficit, low domestic savings, and sizable external account deficit. As a result, both inflation and interest rates were high, making the economy highly uncertain and not conducive to accelerated investment.

1.1 Economic Reforms and Structural Adjustments

With slow growth and crisis in macroeconomic management characterizing the economy, the focus of macroeconomic policy since the 1980s has been on adjustments in economic structure per se to generate consistent long-term growth. For this, a comprehensive economic reform programme was launched to open up and establish a liberalized, market-based, and private sector-driven economy. The underlying objective of these efforts, supported by development partners, has been to accelerate economic growth through more efficient allocation of resources and better economic management. Under the programme, considerable success has been achieved in maintaining macroeconomic stability. In particular, inflation was reduced, fiscal and current account deficits were narrowed, stable and market-responsive exchange rate was maintained, and foreign exchange reserves increased. The achievement of macroeconomic stability, however, proved to be necessary but not sufficient for accelerating growth. The achievement of sound macroeconomic fundamentals has not been translated into higher investments and growth, with transition from stability to high growth appearing to emerge as the major challenge. The production and export bases of the economy still remain narrow. Such structural weaknesses and other pervasive bottlenecks limit the economy's capacity to respond and adjust to changes and support higher levels of growth and employment generation needed for sustained poverty reduction.

In order to accelerate economic growth and put the economy to a poverty reduction path, it is necessary to push forward the reform agenda with attention to restoring and maintaining macroeconomic stability, removing distortions in the product and factor markets, and accelerating human resource development. This requires policy and institutional reforms to increase savings and investment, remove infrastructure bottlenecks, develop an efficient financial sector, and enhance agricultural productivity. As for the reform agenda, it is recognized that wide-ranging reforms and structural adjustments are needed in the economy through relaxation of government interventions and other measures in various fields to promote both internal and external competitiveness and adjust to changes in the global economy. In the process, the economy, however, has structural rigidities and constraints for which specific plans and programmes are needed to accelerate growth with poverty reduction.

Although economic adjustments are necessary, there is some evidence that unwarranted impacts arise, especially on the poor and the vulnerable groups. Experience of several countries undertaking adjustment policies suggests that there are differential impacts of these adjustment policies at the household level, and that vulnerable groups of the society bear a disproportionate burden of the adjustment costs (Demery and Addison, 1987; Cornia, Jolly and Stewart, 1987).

1.2 Objectives of the Paper

The basic objective of the Monitoring Adjustment and Poverty (MAP) Project in Bangladesh is to examine and monitor the impacts of adjustment measures on poverty situation. It intends to analyse the consequences of macroeconomic adjustment policies on household welfare and income distribution. Understanding the impact of adjustment policies is important since it helps the policymakers in formulating and implementing countervailing measures that would offset, or at least reduce, the deleterious impact on the poor households. In order to monitor and examine the consequences of adjustment policy, a general equilibrium framework has been developed to examine the impacts on resource allocation, income distribution, growth and poverty reduction, and welfare. The present paper analyses the results of the modelling exercise in terms of several issues e.g.

- What would be the impact of reduction of nominal rate of protection on allocation of resources and distribution of income?
- What would be the effects of tariff reduction under neutrality of government revenue constraints on allocation of resources and distribution of income?
- What are the potential revenue and incidence implications of raising additional revenue from manufacturing VAT base and services VAT base?
- Does incorporation of imperfect competitive behaviour change allocation of resources compared to competitive behaviour?
- What are the scale economies effects on allocation of resources?

- What are the income and own and cross price elasticities of food items for different household groups in Bangladesh?
- What are the impacts of macroeconomic policy changes on the micro level decision making (e.g. nutrition status of household groups)?
- What would be the impact of sectoral growth on poverty?

The methodology and framework of analysis is discussed in section 2. The results of the simulation experiments are reported in section 3. Finally, the future research areas are outlined in section 4.

2. Outline of the Methodology

The general methodology has been to use a framework of analysis, which allows to examine the consequences of various macro economic policy changes at sectoral, and at macro level and to estimate their impact at the household level. To examine the above issues a modular approach is adopted under which different modelling techniques are employed. A Computable General Equilibrium (CGE) model examines the consequences of policy reforms within a constrained optimization framework. A Social Accounting Matrix (SAM) prepared for the year 1992/93 serves as the consistent and comprehensive data base for the above-mentioned exercises. An elasticity model has been developed to estimate the relevant elasticities by occupational classes. Finally, a linked model approach is used to examine the impact of macroeconomic policy (trade and tax reforms) changes at the micro level (e.g. household groups). The SAM based fixed price model and flex price CGE model are adapted to examine the consequences of policy changes on allocation of resources, income distribution, and poverty situation. The SAM based fixed price modeling technique uses derived multipliers to examine the impacts of policy changes.

The framework of analysis, therefore, consists of (i) a CGE model to examine resource allocation, and income distribution effects under different market structure and trade and tax structure; (ii) an elasticity model to estimate own and cross price elasticity for major food items and income elasticity by household groups; (iii) a linked model that uses estimates of elasticity and price and income changes from CGE model to examine the macro policy impact at micro level; and (iv) a SAM based modeling framework to estimate poverty alleviating impacts of sectoral growth.

2.1 General Equilibrium Formulation for Tariff and Tax Reforms Analysis

A CGE model has been developed under the project to examine the consequences of adoption of adjustment policies in Bangladesh. The model is treated as the `Core' model which incorporates different features related to specific issues. The specification of the core model is given at Appendix A1. As an integral part of the adjustment programme, a consumption type value-added tax was introduced in Bangladesh in 1991. Initially the new tax replaced the excise tax system and was confined only to the manufacturing sector. Recently, value-added tax has been extended to services and construction sectors. The Government also introduced a supplimentary duty. In order to examine the impacts of changes in the tax system, the core model incorporates the features of the new tax system. The model explicitly captures the specific features of a consumption-type and destination principle-based value-added tax system which has been adopted in Bangladesh. The model also shows the decomposition of sectoral and household consumption expenditures into committed and supernumerary expenditures within a linear expenditure system.

General Equilibrium Formulation of the Value-Added Tax System

The theory of value added tax (VAT) suggests three broad types of value added taxes which differ in their treatment of capital goods and depreciation of the capital stock in calculating their respective tax bases (Ferh et al, 1994 and Shoup, 1990). These are *consumption, income, and gross product type VAT*. For instance, under the consumption type, each firm computes its tax base by subtracting all its purchases of intermediate and capital goods and depreciation of the capital stock from its total sales. The tax base for an income type VAT is calculated by deducting purchases of intermediate inputs and depreciation of the capital stock from total sales. The gross product type VAT base is computed by subtracting only the purchases of intermediate inputs from total sales. The purchases of capital goods and depreciation are not subtracted. Thus the difference between the three types of value-added tax bases is in their treatment of capital goods and depreciation of the capital stock. Under the consumption type VAT, both purchases of capital goods and depreciation are deductible. In the case of income VAT, only the depreciation of the stock is subtracted. The deduction of purchases of capital goods or depreciation is not allowed under the gross product type VAT.

Sullivan (1965) argues that three concepts of national income accounts are related to the three bases suggested for the value-added tax. These three concepts of national income accounts are personal consumption expenditures; national income proper; and gross national product. The corresponding tax bases are the consumption-type, income-type and gross product-type respectively. To show the linkages between national income accounts and the tax bases, Ferh et al (1994) consider a closed economy at an aggregate or macro level. At an aggregate level, total sales minus total outlays on intermediate inputs yields the gross national product. Purchases of capital goods are equal to gross investment expenditures (net investment and depreciation). When gross investment is deducted from gross national product, one obtains aggregate consumption as the aggregate tax base. Under the income VAT, only the depreciation is subtracted from gross national product. In this case, the aggregate tax base equals aggregate net value added or national product. In the case of gross product type VAT, gross investment is not deductible from gross national product. The aggregate tax base, therefore, equals the gross national product.

With respect to international trade taxation, two distinct principles are in operation (Ferh et al, 1994 and Shoup, 1990). Under the 'destination principle', exports leave a country free of any VAT, while imported commodities are subject to (import) VAT at the rate applied to comparable domestic goods. The 'destination principle' ensures that commodities are taxed in a country where they are consumed (the country of destination), regardless of the country where they are produced. Exports are zero rated under this principle. This means that no VAT is charged on export sales, and that VAT on all inputs used in the production of exports is rebated. In contrast, under the 'origin principle' there is no rebate for VAT on exports, and imports are not taxed in the importing countries. If this principle is applied, commodities are taxed in the country where there are produced, regardless of the country where they are consumed.

There are three methods by which a taxpaying firm can assess its tax liability. These are subtraction, tax credit and addition. However, tax credit method is widely used as it is compatible with consumption VAT system.

Almost all countries that have introduced the value-added tax system, adopt the consumption-type VAT because it is easier to compute and all purchases including purchase of capital goods from other firms are deductible from a firm's sale (Shoup, 1990). However, certain countries such as Argentina, Peru and Turkey have adopted the income type VAT. On the other hand Finland, Morocco and Senegal have employed a gross product type VAT. The gross product VAT, as it does not allow deduction of both purchases of capital goods and depreciation, discriminates against the use of capital goods which perhaps explain its restricted use (Shoup, 1990). The developed and semi-industrialised economies mostly use the VAT system in its comprehensive form. A comprehensive VAT refers to a system that includes producers, wholesaler and retailers.

The Government of Bangladesh introduced the value added tax (VAT) in 1991. Like many other developing economies, the VAT is restricted to domestic manufacturing activities and imports. The VAT system introduced in Bangladesh is of the consumption type and is based on the destination-principle. Thus, all imports and domestic production, excluding primary agriculture type products and most services, intended for final consumption, are subject to VAT. In accordance to the destination-principle, exports are zero-rated. This means that no VAT is charged on export sales, and that VAT and other indirect tax on all inputs used in the production of export goods is rebated. The VAT is consumption-type since all VAT paid on intermediate inputs and capital machinery is creditable against VAT payable on the sale of domestic output.

To incorporate the VAT system in the model, we start with revenue specification of the VAT system. Under the VAT formulation, the excise duty on domestic manufacturing activities and sales taxes on import are replaced by VAT, and the VAT paid on intermediate and capital goods are credited to the domestic manufacturers as offset against the VAT on domestic output. Thus, only the domestic sales are subject to the VAT and there are no VAT on intermediate and capital inputs. In a generalised framework, assuming that domestic sales (D_i) equal the sale of the i-th manufactured product and that the VAT paid on composite intermediate inputs are rebated against the VAT on domestic sales, revenue under the VAT system (VATREV) equals :

$$VATREV = \sum_i PD_i \cdot D_i \cdot tv_i + \overline{PWM_i} \cdot M_i \cdot ER \cdot tv_i - \sum_j \boldsymbol{t}_{ij} \cdot (P_j - PN_j) \cdot IN_j \qquad (1)$$

where, tv_i is the uniform value-added tax rate. The first component of the above equation denotes revenue from domestic VAT base; second part shows the VAT from the imports and the third component captures the rebated amount of VAT paid on composite intermediate inputs. The government income equation of the core model incorporating the revenue from the VAT system (i.e. VATREV).

$$\begin{aligned} YG &= \sum_h th_h \cdot Y_h + \sum_i tm_i \cdot \overline{PWM_i} \cdot M_i \cdot ER + \sum_i td_i \cdot X_i \cdot PD_i + tc \cdot YC \qquad (2) \\ &\quad + YKG + VATREV \end{aligned}$$

The rebate or credit mechanism is specified through the composite intermediate input price equation . The adjusted composite intermediate input price is defined as:

$$PN_i = \sum_j \boldsymbol{t}_{ji} \cdot [\, P_j - \frac{\{(PD_j \cdot D_j + \overline{PWM_j} \cdot M_j \cdot ER) \cdot tv_j\}}{Q_j}] \qquad (3)$$

The second part of the right hand side of $[\{(PD_j \cdot D_j + \overline{PWM_j} \cdot M_j \cdot ER) \cdot tv_j\} / Q_j]$ depicts the amount of VAT paid on composite intermediate inputs which are deducted from the gross price of composite intermediate inputs.

The domestic price of import is also modified by the value added tax payable on c.i.f. imports:

$$PM_i = \overline{PWM_i} \cdot ER \cdot (1 + tm_i + tv_i) \tag{4}$$

The other price that is directly influenced by the VAT system is the domestic sale or activity price. Thus, the domestic sale or activity price is adjusted to include the VAT specification:

$$PX_i = \frac{PD_i \cdot (1 - td_i - tv_i) \cdot D_i + PE_i \cdot E_i}{X_i} \tag{5}$$

Subject to the condition that when $tv_i > 0$, $td_i = 0$, and when $tv_i = 0$, $td_i > 0$, so that, the VAT and excise duty can not be applied on the same product simultaneously.

The export supply equation is also modified to include the value added tax;

$$E_i = D_i \cdot \left[\frac{PE_i \cdot (1 - g_i)}{PD_i \cdot (1 - td_i - tv_i) \cdot g_i} \right]^{y_i} \tag{6}$$

Similarly, in order to incorporate the supplimentary duty, all the above 6 equations are modified to represent supplimentary duty into the system. It should be noted that in the core model production function has been specified by a Cobb-Dougluas function while, in the VAT version, the production function is specified as a CES combination of value-added and intermediate inputs.

Specification of Imports

The specification of foreign trade and its interaction with the domestic economy constitutes an important part of the model. In the classical theory of international trade, a traded good is assumed to be one for which (i) the country is a price-taker (i.e. the small country assumption) and (ii) the domestically produced good is a perfect substitute for the corresponding imported good. This specification leads to the results that the domestic price of a traded good is equal to its world price[*]. Finally, when domestic and imported goods are perfect substitutes, the trade creation effects of trade policies tend to be larger than when products are imperfect substitutes.

[*] This assumption implies that cross- hauling is ruled out and net trading status of a country takes place, commensurately reducing the revenue figures. Secondly, imports become a residual and except for the case of complete specialisation, there are no explicit import demand functions; rather there are demand functions for imported goods. Thirdly, since the domestic prices are determined completely by world prices, given the small country assumption, there is a tendency for over-specialisation, a feature pointed out as early as 1953 by Samuelson and later discussed by Travis (1972) and Malvin (1968).

On the other hand, a large part of the literature adopts a specification of imperfect substitutability between domestic and imported goods (Dervis et al, 1982, Devarajan et al, 1995). The models invoke the Armington (1969) assumption which treats goods of the same type but different countries of origin as imperfect substitutes. According to this assumption, each country produces a unique set of goods which, to a varying degree, are substitutes for, but not identical to, goods produced in other countries. This has two advantages. First, it can accommodate cross-hauling in trade data. Second, it avoids the over-specialisation problem discussed earlier. According to Fretz, Srinivasan, and Whalley (1986) this is achieved by 'bounding the production response to trade policy changes from the demand side, since commodities subscripted by country are treated only as imperfect substitutes'. Since imported and domestic goods are only imperfect substitutes, a certain percentage change in the domestic price of imports due to say a change trade tax, will lead to a smaller percentage change in the price of the domestically traded goods. Thus, dropping of perfect substitution between imports and domestic goods solves the specialisation problem noted above (de Melo, 1987).

In the Bangladesh model, the Armington specification is adopted because the perfect substitution assumption seems unrealistic for two reasons. First, in Bangladesh there are quality differences between imports and domestic substitutes for most products. Second, at the high level of aggregation adopted in the model, each sector represents a bundle of different goods. For example, the machinery sector includes goods which are produced in Bangladesh (e.g. machine tools) and others (e.g. heavy machinery) which are not produced domestically. It is, therefore, reasonable to suggest that these two goods are not perfect substitutes; rather they are imperfect substitutes.

Thus for each commodity category an "aggregate" or composite commodity Q_i is defined, which is a CES function of imports M_i and domestic good D_i. Domestic consumers are assumed to have a CES utility function over these two goods:

$$Q_i = AQ_i \cdot [d_i \cdot M_i^{-r_i} + (1-d_i) \cdot D_i^{-r_i}]^{-1/r_i} \qquad (7)$$

where, AQ_i and d_i are shift and share parameters respectively and s_i, elasticity of substitution is given by $s_i = \frac{1}{1+r_i}$. This formulation implies that consumers choose a mix of M_i and D_i depending on their relative prices. Minimising the cost of obtaining a 'unit of utility', subject to (7) yields the following import demand function;

$$M_i = D_i \cdot \left[\frac{PD_i \cdot \delta_i}{PM_i \cdot (1-\delta_i)} \right]^{\sigma_i} \qquad (8)$$

As a result of this specification, PD_i is no longer equal to PM_i and PD_i is endogenously determined in the model.

2.2 General Equilibrium Specification of Non-competitive Behaviour and Increasing Returns to Scale

Under the framework, the specification of the core model have been modified to incorporate the features of imperfect competition and increasing returns to scale. Such a modification involves the estimation of marginal costs, the number of firms in each industry, the excess profit condition and the market demand elasticity for the domestic goods. The above information is necessary to simulate the effects of trade liberalisation in Bangladesh in the presence of non-competitive structure. Since econometric estimates of market structure variables such as marginal cost and the market demand elasticities are not available for the manufacturing sectors in Bangladesh, a calibration procedure is used for their estimation. The following steps are involved:

1. For computational purposes, the 35 production sectors are aggregated to 14 production sectors which include 3 agricultural sectors, 7 manufacturing sectors, 2 services sectors and 1 energy sector and 1 construction sector. The 14 production sectors are first sub-divided into competitive and non-competitive sectors on the basis of their degree of concentration (Khondker, 1996). It is observed that the estimated concentration ratios are rather low for the jute sector. The ratio, however, could not be computed for the ready made garment sector due to paucity of data. The ready made garment industry is composed of a large number of roughly equal-sized firms. Therefore, the scope of collusion between firms appears to be small and the industry may be characterised as being competitive. Accordingly, the export oriented sector is treated as competitive. The other seven manufacturing sectors are treated as non-competitive. Evidence of concentration is not available for the agricultural, construction, service and trade and transport sectors and these sectors are assumed to behave in a competitive manner.

2. On the import side, it is assumed that world prices are unaffected by developments in the economy of Bangladesh. However, since domestic and imported commodities within a sector are assumed to be imperfect substitutes, domestic firms retain some market power in the domestic market in the non-competitive industries.

3. The marginal cost is derived from the solution of the minimisation of total cost subject to a given output level. For sector i this yields:

$$MC_i = \frac{1}{A_i}\prod_{l=1}^{7}(\boldsymbol{v}_{il}\cdot W_l/\boldsymbol{a}_{li})^{a_{li}}\cdot(R_i/\boldsymbol{a}_{ki})^{a_{ki}}+\sum_j \boldsymbol{t}_{ji}\cdot P_j \qquad (9)$$

4. The market demand elasticity for the domestic goods is calculated, using information from the Armington specification under which each composite good is defined as a CES aggregate of domestically produced and imported goods. Domestically produced goods within a composite good are treated as perfect substitutes for each other. The market demand elasticity is calculated as the percentage change in domestic demand for the domestic goods in response to a unit percentage change in the price of domestic goods, i.e. PD, while keeping all domestic expenditure on the relevant composite goods constant. The calculated market demand elasticity takes the following form:

$$\varepsilon_i = -\sigma_i + (1-\sigma_i)\cdot \frac{\delta_i^{\sigma_i}\cdot PD_i^{(1-\sigma_i)}}{(1-\delta_i)^{\sigma_i}\cdot PM_i^{(1-\sigma_i)} + \delta_i^{\sigma_i}\cdot PD_i^{(1-\sigma_i)}} \tag{10}$$

where, σ_i and δ_i are the Armington elasticity and the share parameter for sector i respectively. This elasticity specification implies that the market demand elasticity ε_i will change under any policy reform since it changes with PD_i and PM_i. Equation (10) also shows that ε_i increases in absolute value whenever the relative price of imports (i.e. PM_i/PD_i) falls. It implies that the domestic firms will behave more competitively as a consequence of trade liberalisation (since the direct consequence of trade liberalisation is a fall in the relative price of imports). The inverse relationship between market demand elasticity and the relative price of imports is depicted by the following equation:

$$\frac{\partial \varepsilon_i}{\partial \frac{PM_i}{PD_i}} = (1-\sigma_i)\cdot \frac{-(1-\sigma_i)\cdot(1-\delta_i/\delta_i)^{\sigma_i}\cdot(PM_i/PD_i)^{-\sigma_i}}{\left[(1-\delta_i/\delta_i)^{\sigma_i}\cdot(PM_i/PD_i)^{1-\sigma_i}+1\right]^2} < 0 \tag{10a}$$

5. The number of domestic firms is endogenous in the model. The Lerner symmetry condition is used to derive the number of domestic firms. The Lerner condition states that:

$$\frac{PD_i\cdot(1-td_i)-MC_i}{PD_i\cdot(1-td_i)} = \frac{-1}{N_i\cdot\varepsilon_i} \tag{11}$$

It is assumed that the non-competitive firms behave in a Cournot-Nash fashion. Under this hypothesis, the firm's perceived demand elasticity for a domestic sale is $N_i\cdot\varepsilon_i$, where N_i

is the number of firms in sector i. Further manipulation of equation (10) yields the number of domestic firms:

$$N_i = \frac{PD_i \cdot (1 - td_i)}{\boldsymbol{e}_i \cdot \left[PD_i \cdot (1 - td_i) - MC_i \right]} \tag{12}$$

For export sales, the Lerner symmetry condition takes the following form:

$$\frac{PE_i \cdot (1 - td_i) - MC_i}{PE_i \cdot (1 - td_i)} = \frac{-1}{N_i \cdot \boldsymbol{h}_i} \tag{13}$$

where, $\boldsymbol{h}_i$ is the price elasticity of export demand. The export demand elasticities are exogenous and are different from the endogenously determined market demand elasticities. It is observed that the right hand side and the left hand side of equation 13 are conceptually different because the number of firms is already derived, and export demand elasticities are exogenous. However, the two sides of equation 13 should be equal and the equality between the two sides is not attained unless either $\boldsymbol{h}_i$ or PE_i are allowed to adjust. To satisfy the equality condition PE_i is allowed to adjust while keeping $\boldsymbol{h}_i$ constant. In this case PE_i will be marginally less than unity. Alternatively, export demand elasticities, $\boldsymbol{h}_i$s may be allowed to adjust setting PE_i equal to unity. In this case, $\boldsymbol{h}_i$ would always be equal to $\boldsymbol{e}_i$ and therefore the developments in the domestic economy would directly influence the world market which appears to be a highly unrealistic assumption.

6. The level of excess profits is an important dimension of imperfect competition. The level of excess profits is defined to be those profits above the normal which is necessary to keep entrepreneurial resources committed (Richardson, 1989). The excess profit function for the non-competitive sector i is specified as:

$$\boldsymbol{p}_i = [PX_i \cdot (1 - td_i) - AC_i] \cdot (N_i \cdot XF_i) \tag{14}$$

where, XF_i is the output per firm. No information is available regarding the amount of excess profits in the non-competitive sectors. In previous studies, part of the return from capital has been treated as pure or excess profits. To generate the amount of excess profits, sectoral rental rates of capital (R_i), as observed in the SAM, are reduced by 30 percent across all sectors, so that the total excess profits amount to 15 percent of total corporate capital income. This implies that in the non-competitive variant, the sectoral rental rates (R_i) are different for each of the 14 sectors but are less than the sectoral rental rates observed in the SAM data base. Therefore, in the non-competitive sectors, any excess of revenues over wage, capital and intermediate costs is treated as excess profits. While in the competitive sector, this excess revenue is denoted as if it is a return to specific factors, although no sector-specific factor is used in the model.

7. The first order conditions (for labour and capital) for non-competitive sectors are modified to capture the effects of imperfect competition, while the first order conditions for the competitive sectors remain unchanged.

8. In the non-competitive variant, since the gross return to capital is now decomposed into returns to capital; excess profits; and returns to sector-specific factor, the distribution of capital income among institutions (e.g. household, government and corporation) have been re-specified.

9. The results of the calibration procedure are provided in Appendix Table A1.

Calibration with imperfect competition and increasing returns to scale

To incorporate increasing returns to scale, the total cost is usually separated into fixed and variable cost components. The increasing returns to scale is then assumed to stem from the fixed cost part of the total cost. The problem is to ascertain the split between fixed and variable costs. In Cox-Harris type models, fixed cost is calculated using available econometric estimates of the minimum efficient scale of production and cost saving achievable (cost disadvantage ratio). It shows the decline in cost when a firm increases its output from the actual level to the efficient level. The specification requires information on minimum efficient scale and cost disadvantage ratio. These estimates are not available for Bangladesh nor it is possible to estimate them as the required information is not available. Furthermore, the extent of fixed cost by major industry groups is also not available. In the absence of such information, an alternative approach (in line with Devarajan and Rodrik, 1991) has been adopted to specify increasing returns to scale based on the following assumptions.

- ♦ Like other models, increasing returns are assumed to stem from the fixed cost element of the total cost. It is also assumed that the fixed cost consists of labour and capital costs in the same proportion as in the total value added.

- Scale elasticity which depicts the extent of unrealised scale economies is defined as a ratio of the average and marginal cost (i.e. $\theta_i = AC_i/MC_i$). A uniform scale elasticity of 10 percent is assumed for all non-competitive sectors. This implies that average cost is assumed to be 10 percent higher than the marginal cost for each non-competitive sector. This parameterizes the degree of increasing returns to scale in the benchmark equilibrium. However, the scale elasticity is only fixed initially and it varies across simulation outcomes as firm output, factor costs and input prices change.

The scale elasticity is then used to calculate the fixed cost from:

$$FC_i = (AC_i - MC_i) \cdot X_i \tag{15}$$

or $FC_i = MC_i \cdot (AC_i / MC_i - 1) \cdot X_i$ (16)

or $FC_i = MC_i \cdot (\theta_i - 1) \cdot X_i$ (17)

where, FC_i denotes total fixed cost in sector i.

Given FC_i, the fixed amount of labour and capital inputs can then be estimated as:

$$\overline{LD}_{il} = \frac{\alpha_{il} \cdot FC_i}{W_l \cdot \nu_{il}} \tag{18}$$

$$\overline{K}_i = \frac{\alpha_{ki} \cdot FC_i}{R_i} \tag{19}$$

- The production function is modified to incorporate the fixed amount of labour and capital inputs. The modified production function takes the following form:

$$X_i = A_i \prod_l (LD_{il} - \overline{LD}_{il})^{\alpha_{il}} \cdot (K_i - \overline{K}_i)^{\alpha_{ki}} \tag{20}$$

- The first order conditions (for labour and capital) for non-competitive sectors are also modified, while the first order conditions for the competitive sectors remain unchanged (see Appendix A2).
- The calibration results with increasing returns to scale are presented in Appendix Table A2.

2.3 Estimation of Price and Income Elasticity

In order to examine the impact of macreconomic policy changes on household nutritional status, own and cross price elasticity for major food items and income elasticity of household groups are needed. While estimates of such elasticity are available for some specific years, they are not available by occupational classes as classified in the 1992/93 SAM data-base. Therefore, in order to link the estimates of the elasticity model and price and income changes generated in the CGE model, estimates of price and income elasticity are required for the eight occupational classes for 1992/93. The price and income elasticity for the major occupational groups have been estimated for 1992/93 using the food characteristics demand system (FCDS).

The FCDS Model

In the FCDS model, utility is assumed to be a function of characteristics of quantities of food consumed namely, energy, variety and tastes and of non-food purchases. The total utility derived from the three characteristics and from the non-food item is the weighted sum of the individual utilities that these food and non-food items provide. Following Bouis (1991), this can be expressed as:

$$U = \boldsymbol{a}_b U_b(\boldsymbol{b}) + \boldsymbol{a}_e . U_e(r) + \sum_{i=1}^{n} \boldsymbol{a}_{ti} U_{ti}(Q_i) + \boldsymbol{a}_{nf} U_{nf}(Q_{nf}) \qquad (21)$$

Where, U=total utility derived from all food and non-food items, Q =quantity of a commodity, $\boldsymbol{b}$=a measure of energy, r=a measure of variety, U_b=utility derived from energy U_e=utility derived from variety, U_i Q_I =utility derived from the taste of units of commodity I, $U_{nf}(Q_{nf})$=utility from non-food item, $\boldsymbol{a}_b$ =weight of utility from energy, $\boldsymbol{a}_e$ =weight of utility from variety, $\boldsymbol{a}_{ti}$ =weight of taste from food I, $\boldsymbol{a}_{nf}$ =weight of utility from the non-food commodity

The utility from energy can further be expressed as

$$\boldsymbol{b} = \sum_{i=1}^{n} \boldsymbol{q}_i Q_i \qquad (22)$$

Where $\boldsymbol{q}_i$ is a factor that converts quantity of the ith food into energy. In the model, calories have been used as proxies for the $\boldsymbol{q}_i's$ in estimation. $\boldsymbol{b}$ is the total calories consumed which has been adjusted with adult equivalent ratio. The functional form of Ub ($\boldsymbol{b}$) is

$$U_b(\boldsymbol{b}) = b_2\boldsymbol{b} + b_3\boldsymbol{b}^2 \quad \text{where,} \quad b_2>0 \text{ and } b_3<0. \qquad (23)$$

At low levels of total energy, additional units increase utility at a decreasing rate. This functional form implies that at sufficiently high intakes of energy, utility from additional units of energy decrease marginally.

$$\boldsymbol{b}_i = \boldsymbol{a}_b(b_2\boldsymbol{q}_i + 2b_3\boldsymbol{b}\boldsymbol{q}_i) > 0 \text{ for low income groups} \tag{24}$$

where, $\boldsymbol{b}_i = \dfrac{\partial U}{\partial U_b(\boldsymbol{b})} \cdot \dfrac{\partial U_b(\boldsymbol{b})}{\partial Q_i}$

and $$\boldsymbol{b}_{ij} = 2\boldsymbol{a}_b b_3 \boldsymbol{q}_i \boldsymbol{q}_j < 0 \tag{25}$$

where, $\boldsymbol{b}_{ij} = \dfrac{\partial \boldsymbol{b}_i}{\partial Q_j}$

The utility from taste is expressed as

$$U_{ti}(Q_i) = \log(Q_i) \tag{26}$$

$$T_i = \boldsymbol{a}_{ti}(1/Q_i) > 0 \tag{27}$$

where, $T_i = \dfrac{\partial U}{\partial U_{ti}(Q_i)} \dfrac{\partial U_{ti}(Q_i)}{\partial Q_i}$

$$T_{ii} = -\boldsymbol{a}_{ti}(1/Q_i)^2 < 0 \tag{28}$$

$$T_{ij} = 0 \tag{29}$$

Where, $T_{ij} = \dfrac{\partial U_{ti}(Q_i)}{\partial Q_i}$

The above suggests that additional unit of taste of good i increases utility but at a decreasing rate. The first order derivative is positive whilst the second order is negative. For taste across food, the second derivative is zero.

The utility from variety is defined as

$$U_c(r) = \frac{\boldsymbol{d}}{\boldsymbol{y}} \tag{30}$$

where, d = nonstaple kilograms of food consumed per adult equivalent, and y = total kilograms of food consumed per adult equivalent. Moreover, $r_i = -a_c \frac{d}{y^2} < 0$, for i ≤ s

$$r_i = a_c[(y - d)/d^2] > 0 \qquad \text{for } s<i\leq n \qquad (31)$$

where, i= 1, 2, …. n are staple foods.

The above implies that each additional unit of a staple good reduces utility from variety and each additional unit of a non-staple good increases utility from variety.

As stipulated for energy and variety,

$$V_{ij} = 2\, a_c \, {}^{d}\!/_{y^3} > 0 \qquad \text{for } i,j \leq s$$

$$V_{ij} = ({}^{a_c}\!/_{y^3})[2d - y] \qquad \text{for } i \leq s \text{ and } s<j \leq n \qquad (32)$$

$$V_{ij} = (\,({}^{2a_c}\!/_{y^3})[d - y] < 0 \qquad \text{for } s<i,\, j\leq n$$

and for all $V_{ij} = V_{ji}$

Unlike the food items, no explicit functional form is specified for utility from the non-food. In order to solve the model for the (n+1) by (n+2) matrix of food demand elasticities, it is necessary with respect to utility from the non-food, only to specify the following relationship:

$$\frac{\partial(\frac{\partial U}{\partial Q_{nf}})}{\partial Q_{nf}} = l \frac{P_{nf}}{Q_{nf}}[\frac{f}{h_{nf}}] \qquad (33)$$

where, f = money flenisility, h_{nf} = non-food income elasticity, P_{nf} = price of the non-food item, l = lagrange multiplier or the marginal utility of income.

Solving the Model

For any food i (i = 1,2,…., n) the first order conditions give

$$P_i = \frac{\partial U}{\frac{\partial U}{l}[\frac{\partial U_b}{\partial b}.\frac{\partial b}{\partial Q}]} + \frac{\partial U}{\frac{\partial U_c}{l}[\frac{\partial U_c}{\partial r}.\frac{\partial r}{\partial Q_i}]} + \frac{\partial U}{\frac{\partial U_T}{l}[\frac{\partial U_T}{\partial T}.\frac{\partial T}{\partial Q_i}]} \tag{34}$$

There are n equations associated with (34) and if we assume that the first food is a staple we get:

$$P_1 = \frac{a_b}{l}[b_2 q_1 + 2b_3 q_1 b] + \frac{a_c}{l}[-\frac{d}{y^2}] + \frac{a_{ti}}{l}[\frac{1}{Q_1}] \tag{35}$$

Thus shadow prices for energy and variety can be obtained by multiplying the coefficient outside the brackets with the first partial derivatives inside the brackets for the first and second terms in equation (35). The shadow prices sum to the retail price for each food at all income levels and the proportion of the retail price for each food accounted for by the shadow price of each characteristic will vary by income group.

With the data on food prices and food quantities and values for $a_b b_2, a_b b_3$, and a_c it is possible to solve the n equations represented by equation (34) for the n $a_{ti}S$. In addition, given a value for $\frac{f}{n_{nf}}$ and data on non-food expenditures, it is possible to obtain values for the entire (n+1) by (n+1) matrix of second partial derivatives of the utility function with respect to n foods and the non-food commodities. Then, these values can be used to estimate the full matrix of (n+1) by (n+1) demand elasticities[2]. Thus four parameters along with data on prices and quantities of consumption are required to solve the model.

Data Requirement and Estimation Technique

From the above, it is clear that in order to estimate the elasticities, one needs two types of information. These include price and quantity data across various occupational groups and the values of the parameters associated with the utility function. The price and quantity data include (i) per capita quantities consumed for each of the n food items, (ii) unit price of the food items, (iii) calorie conversion rate per unit of each food item, (iv) total non-food expenditure, and (v) ratio of adult equivalent over total persons. For the present study, data on (i), (ii) and (iv) have been obtained from the Household Expenditure Survey (HES) 1991-92 of the Bangladesh Bureau of Statistics (BBS). The calorie conversion rates have been taken from the published

[2] See, for example, Henderson and Quandt, (1980), p.25-35.

document of the Institute of Food and Nutrition of Dhaka University. However, the adult equivalent ratio was not readily available and some `educated guesses’ were made.

Prior knowledge about the values of the parameters of the utility function was another precondition for implementing the methodology. It is possible, however, to estimate the values of the parameters. One can rewrite equation (35) as

$$P_1 = \frac{a_b}{l}[b_2 q_1 + 2b_3 q_1 b] + \frac{a_c}{l}[-\frac{d}{y^2}] + \frac{a_{ti}}{l}[\frac{1}{Q_1}] = a_1 + a_2(b) + a_3\,(\frac{d}{y^2}) + a_4\,(\frac{1}{Q_1}) \qquad (36)$$

Equation (36) may be estimated to get the values of the parameters as in a system with n foods, there would be n equations to estimate with identical parameters associated with energy and variety in each of the n equations. In order to make the model operational, assumptions about the values of the parameters are made. Studies are available with reasonable values of these parameters in other countries and on the basis of the aforementioned findings, reasonable prior assumptions have been made. The assumed values of the parameters are given in MAP Technical Paper No.5.

Once the data and the values of the parameters are available, the estimation is straightforward. The first order conditions give the absolute shadow prices disaggregated by bulk, variety and taste by groups. This explains the components of shadow prices by characteristics inherent in particulars food groups. From the second order conditions, the bulk, variety and taste matrix can be deducted. The sum of bulk, variety and taste matrix will result in the overall utility matrix. Thus:

$$b_{ij} + r_{ij} + T_{ij} = U_{ij} \qquad (37)$$

However, T_{ij} would be a diagonal matrix and for T_{ij}, i=j. Once the overall utility matrix is obtained from the second-order conditions with the prices of the commodities, the Bordered Hessain matrix can be constructed to estimate the elasticity. With five food and one non-food commodities, the Bordered Hessian matrix will look like:

$$\begin{vmatrix} b_{11}+r_{11}+T_{11} & b_{12}+r_{12} & b_{13}+r_{13} & b_{14}+r_{14} & b_{15}+r_{15} & 0 & -P_1 \\ b_{21}+r_{21} & b_{22}+r_{22} & b_{23}+r_{23} & b_{24}+r_{24} & b_{25}+r_{25} & 0 & -P_2 \\ b_{31}+r_{31} & b_{32}+r_{32} & b_{33}+r_{33} & b_{34}+r_{34} & b_{35}+r_{35} & 0 & -P_3 \\ b_{41}+r_{41} & b_{42}+r_{42} & b_{43}+r_{43} & b_{44}+r_{44} & b_{45}+r_{45} & 0 & -P_4 \\ b_{51}+r_{51} & b_{52}+r_{52} & b_{53}+r_{53} & b_{54}+r_{54} & b_{55}+r_{55} & 0 & -P_5 \\ 0 & 0 & 0 & 0 & 0 & f_{66} & -P_6 \\ -P_1 & -P_2 & -P_3 & -P_4 & -P_5 & -P_6 & 0 \end{vmatrix}$$

where, f_{66} implies the shadow price of the non-food item. From the overall utility matrix for a particular occupational group, own and cross price elasticities for food and non-food items can be estimated. For example, if we want to estimate the own price elasticity of food item 5 (m_{55}) the following formula can be used:

$$m_{55} = \frac{P_5}{q_5}\left[\frac{D_{55}}{D} + \frac{Q_5 D_{65}}{D}\right]$$

where, P_5 = price of commodity 5, Q_5 =quantity of commodity 5, D = the determinant of the entire Bordered Hessian matrix, D_{65} = the cofactor of the element in the sixth row and fifth column.

The cross price elasticities can also be obtained from the overall utility matrix. If we want to estimate the elasticity of food item 5 with respect to price of the first commodity, the required formula is

$$m_{51} = \frac{P_1}{Q_5}\left[\frac{D_{15}}{D} + \frac{Q_1 D_{65}}{D}\right]$$

where, P_1 = price of commodity 1, Q_5 = quantity of commodity 5, D_{65} = the cofactor of the element in the sixth row and fifth column of the Bordered Hessian, D_{15} = the cofactor of the element in the first row and fifth column of the Bordered Hessian.

2.4 Framework of the Linked Model

It has been pointed out that macro economic policy changes may have substantial impact on households in terms of consumption of food, health care, and labour force participation. The macro policy changes usually affect the household groups through their impacts on prices and income levels of the household groups. That is, changes in output and input prices as well as changes in income levels are the primary transmission mechanisms through which the effects of a macro economic policy change influence the household groups. Within the purview of the MAP project, the impact of macro economic policy changes on the nutrition status of the eight household groups has been simulated using a linked model. The linked model provides a framework where estimates of elasticity from the elasticity model and changes in sectoral prices and household income derived from the CGE model are combined to generate impacts on nutrition status of household groups.

The income and price elasticity (own and cross) of demand for food are estimated in the elasticity model using the household expenditure survey data and adopting the FCDS technique. Price and income changes as a result of macro economic policy changes are obtained from the general equilibrium model. The resulting price and income changes are then combined with estimated price and income elasticity to estimate changes in demand for food. The changes in the demand for food are then translated into changes in calorie and protein consumption using vectors of calorie and protein contribution by commodities. It is assumed that other household characteristics remain unaffected by policy changes. Within the system, one can use the average contribution of each food item to specific nutrients of interest to derive the implications of macro economic policy changes on nutrient consumption of households groups.

Formally, the demand for food can be expressed in percentage terms as follows

$$\hat{QD}_j^h = \sum_J \mathrm{E}_{ij}^h \cdot \hat{P}_j + \mathrm{T}_i \cdot \hat{Y}^h \qquad \textbf{\textit{(38)}}$$

Where, QD indicates percentage change in quantity demanded. E denotes own and cross price elasticity. T refers to income elasticity by household groups. P and Y depict percentage changes in prices and income.

One can then use the average contribution of each food item to specific nutrients of interest (e.g. calorie and protein) to derive the implications of macro economic policy changes on nutrient consumption of households using the following relation:

$$\hat{NC}^{h} = \sum_{j} K_{j} \cdot \hat{QD}_{j}^{h} \tag{39}$$

Where, NC refers to changes in nutrition consumption by household groups and K denotes initial nutrient contribution of commodity.

An overview of the linked model is shown in Figure 1.

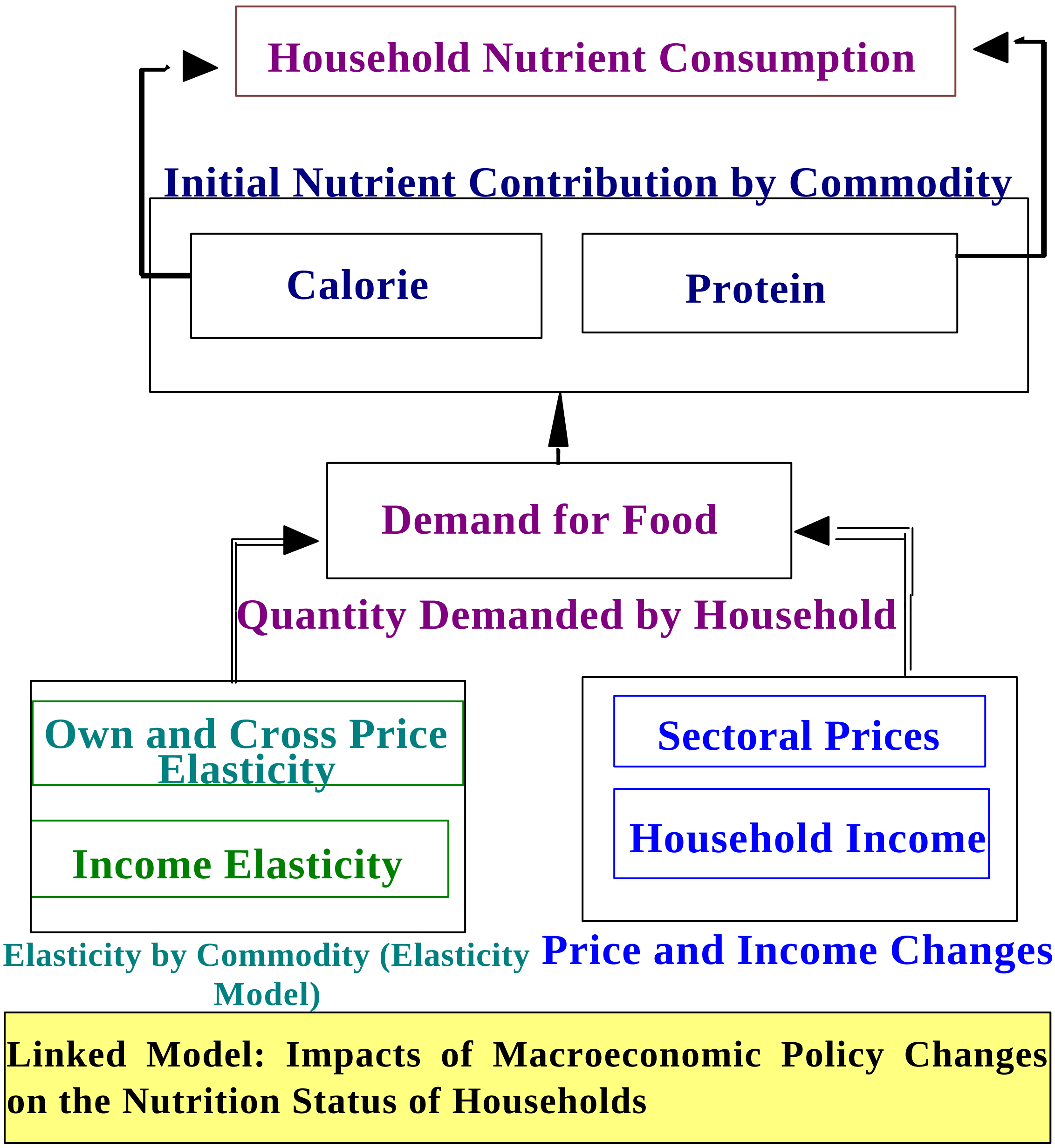


Figure 1

2.5 Poverty Measures And Association With Accounting Multipliers

The SAM based accounting multiplier and selected poverty measures have been used to analyse the poverty alleviating effects of policy intervention at the sectoral level. Accordingly, in order to establish the linkage between a poverty measure and accounting multiplier, we have adopted the FGT measures of poverty proposed by Foster, Greer and Thorbecke (1984). According to the FGT measures, deprivation depends on the distance between a poor household's income and the poverty line, not the number of households that lie between a given income and poverty line. The measures satisfy the monotonicity and weak transfer axioms of Sen (1979) and the transfer-sensitivity axiom of Kakwani (1980). The FGT index has an additional property of decomposability, i.e. overall poverty can be treated as a weighted sum of the sub-group poverty indices, the weights being the fraction of population accounted for by each group. This decomposability property has led us to adopt the FGT measures that are suitable for groupwise poverty analysis. The FGT Index is

$$P_\alpha = (1/nZ^a)\,\Sigma\,(Z-Y_i)^\alpha \qquad (40)$$

where `Z' is the poverty line, $Y_i$ is the income of the household below the poverty line and `n' is the number of households in a particular household group (e.g., occupational class). α may take the value 0, 1 and 2 and above. When $\alpha = 0$, P_0 becomes the head-count ratio and when $\alpha = 1$, P_1 is the income-gap measure and for $\alpha = 2$, P_2 becomes a distributional-sensitivity measure. α can be viewed as a measure of poverty aversion.

The poverty sensitivity is determined by the elasticity of the poverty measure with respect to mean income for the occupational groups, and their growth rates. The change in poverty measure is thus:

$$(dP_{\alpha ij} / P_{\alpha ij}) = \eta_{\alpha j}\,(dY_i / Y_i) \qquad (41)$$

Where $\eta_{\alpha j}$ is the elasticity of poverty measure $P_{\alpha ij}$ with respect to mean income of each household group i resulting from an increase in the output j[3]. In the present analysis, the focus is on linking the increase in the mean income with the accounting multiplier m_j. This relates to the part of the multiplier matrix that links production activities (e.g. account 3) to household groups (e.g. account 2). More specifically, this would be captured by matrix M_{23} that relates production

[3] Kakwani (1993) provides the computation of elasticities for various poverty measures with respect to mean income. $\eta_{\alpha j}$ for P_0 is the percentage of poor who cross the poverty line as a result of 1 percent growth in the mean income. $\eta_{\alpha j}$ for P_1 and P_2 is $-\alpha\,[P_{\alpha-1} - P_\alpha] / P_\alpha$ for $\alpha \neq 0$, which will always be negative because P_α is monotonically decreasing function of α.

activities to household groups. The M_{23} can be decomposed into two effects, the distributional effects and the inter-dependence effects.

$$M_{ij} = M_{23} = R_{ij} \cdot D_{ij} \tag{42}$$

The distributional effects (D_{ij}) show the indirect impacts of a change in output of the production sectors on the incomes of the eight household groups. The distributional effect can be explained in the following way. One unit of additional demand for a given output will increase the demand for other intermediate inputs ($I-A_{33}$) as well as factors of production A_{13}. The additional income generated by factors of production will flow into the household groups according to their participation in the production process (A_{21}). Hence, in our case $D_{23} = A_{21} A_{13} (I-A_{33})^{-1}$. The inter- dependence effects capture the initial first round of spending and subsequent rounds of responding by household groups. This is the same as the close-loop effect or indirect effects. Thus multiplier M_{23} can be specified as:

$$M_{23} = R_{22} D_{23} \tag{43}$$

If m_{ij} is an element of M_{23}, it can be decomposed multiplicatively. $M_{ij} = r_{ij} d_{ij}$, where d_{ij} is an element of D_{ij}, or $r_{ij} = m_{ij} / d_{ij}$. The accounting multiplier assures an unitary marginal expenditure proportion i.e. the average propensity is equal to the marginal propensity. Hence equation (43) can be written as:

$$dY_i = m_{ij} dX_{ij} \tag{44}$$

Therefore, equation (41) becomes

$$(dP_{\alpha ij}) = \eta_{\alpha I} m_{ij} (dX_j / Y_i) \tag{45}$$

The group-wise poverty alleviation effects can be aggregated to get overall poverty alleviation effects. According to the FGT's additive decompositivity axiom.

$$P_{\alpha j} = \Sigma_{I=1}^{m} P_{\alpha ij} (n_i / n) = \Sigma_{I=1}^{m} (dP_{\alpha uj} / P_{\alpha j}) [\Sigma_{k=1}^{qi} (Z-Y_k) Z)^{\alpha} / (\Sigma_{I=1}^{q} ((Z-Y_1)/Z)^{\alpha}] \tag{46}$$

q_i is the number of poor in the ith group and $q=\Sigma_i^m q_i$ is for the whole economy. The second term of equation (45) implies the poverty share of household group i out of total poverty, i.e. $s_{\alpha i}$. Then,

$$(dP_{\alpha j} / P_{\alpha j}) = \Sigma_{I=1}^{m} (dP_{\alpha ij} / P_{\alpha ij}) s_{\alpha I} \tag{47}$$

Combining equations (41) and (47) we have

$$(dP_{\alpha j} / P_{\alpha j}) = \Sigma_{I=1}^{m} s_{\alpha i} \eta_{\alpha j} m_{ij} (dX_j / Y_i) \tag{48}$$

We can use the multiplier decomposition, $m_{ij} = r_{ij} d_{ij}$, to find out the rout of poverty alleviation effects through the multipliers. Then equation (48) becomes

$$(dP_{\alpha j} / P_{\alpha j}) = \Sigma_{I=1}{}^{m} s_{\alpha i} d_{ij} r_{ij} \eta_{\alpha I} (dX_j / Y_i) \qquad (49)$$

The term $s_{\alpha I}$ d_{ij} = $m_{\alpha ij}$ may be defined as the "*effective distributional effect*" and the term $\eta_{\alpha I}$ (dX_j / Y_i) = $q_{\alpha ij}$ may be denoted as the "*poverty sensitivity effect*". The "*poverty alleviation effects*" of an increase in the output of sector `j', (-($dP_{\alpha j}$ / $P_{\alpha j}$), is a product of two components: (i) the mean-income change of the poor across all household groups ($m_{\alpha j}$); and (ii) sensitivity of the selected poverty measure.

3 Selected Simulation Results

The selected simulation results of various tariff liberalisation, and tax experiments are reported in this section. In particular the distributional consequences of tariff reforms, revenue and incidence effects of introduction of supplementary duty, and impacts of nutrient availability by household groups are outlined. The resource allocation effects under imperfect competition and scale economies are also reported along with poverty alleviating effects of sectoral interventions.

3.1 Distributional Consequences of Tariff Reforms

Several tariff liberalisation simulations have been conducted to examine their distributional consequences and macro economic impacts. These include:

TM: Reduction of nominal tariff rates as implemented during the fiscal year 1996-97. In this experiment, no adjustments are made in domestic indirect or direct tax rates to bridge the deficit generated in government revenue as a consequence of reduction of tariff rates.

TM1: Reduction of nominal tariff rates along with adjustment of manufacturing value-added tax rate to maintain neutrality of government revenue.

TM2: Reduction of nominal tariff rates along with introduction of lower value-added tax rate (i.e. than the standard rate applicable to manufacturing value added and imports) for construction, miscellaneous service sector and trade sector to maintain neutrality of government revenue.

Macroeconomic Impacts of Tariff Liberalisation

The macroeconomic impacts of tariff liberlisation are reported in Table 1. It is observed that there are gains from tariff liberalisation as liberlisation allows resources to move from protective and inefficient sectors to less protective and more efficient sectors. It is also observed that macroeconomic impacts are more pronounced in the first experiment compared to the other two experiments where neutrality of government has been ensured with adjustment in the domestic production and consumption taxes.

Table 1: Macroeconomic Impacts of Tariff Liberalisation

	TM	*TM1*	*TM2*
Real GDP	0.78	0.63	0.65
GDP Value-added	1.36	0.94	1.10
Current Account Deficit	-11.36	-11.12	-11.10
Exports	-7.81	-7.74	-7.71
Imports	2.46	2.35	2.38
Budget Deficit	-9.30	-	-
Revenue	-4.55	-	-
Tariff	-6.02	-6.13	-6.16
Consumption-Production Taxes	-2.57	1.53	1.81
Income Tax	1.92	1.25	1.26
Corporate Tax	1.92	1.07	1.09
Savings	0.06	0.38	1.07
Investment	0.06	0.38	1.07

Welfare and Income Distribution Effects of Tariff Liberalisation

The concept of efficiency or welfare is the starting point for any policy analysis. Unlike a pure theoretical approach where only an ordinal measure of alternative states are examined, in applied policy analysis some measures of welfare are employed to compare movement from one state to another.

Therefore, in applied policy analysis, generally some monetary representations of individual utility functions are used. This is defined as the amount of money required to attain a level of utility at a reference price vector. This is termed as money metric, and its value is derived from the expenditure function. The expenditure function, which is the inverse of the indirect utility function, is a vital tool for welfare analysis and allows 'measurement of utility'. Since the value of expenditure function depends on the set of prices used, there are different money metrics one can use. The most widely used ones are compensating variation (CV) and equivalent variation (EV). These are generally used because they have easy interpretation in terms of the compensated demand curves. In the EV approach, the idea is to measure in money terms, how much income needs to be given to the consumer at the 'pre-policy change' level of prices (P_0) in order to enable him to enjoy the utility level which arises after the policy change is effected ('post-policy change level of utility'). The CV comes from the opposite direction. It measures the change in 'post-policy change' level of prices (P_1) that brings the consumer to the 'pre-policy change' level of utility.

In a many consumer economy, the use of aggregate EV or CV as a measure of welfare changes, although avoiding any explicit Social Welfare Function (SWF), has an implicit SWF because of the adding up approach. Boadway and Bruce (1984) show that there are some well-known problems in interpreting the aggregate EVs or CVs and one needs to be careful in interpreting the result of such measures. Social ordering requires more data and judgement than do household ordering and it may not be possible to measure changes in welfare simply on the basis of household orderings of social status drawn from their market behaviour[4]. When EV is used as a measure of welfare, it is implicitly assumed that aggregate market behaviour is generated by a single household whose preferences coincide with the social ordering[5]. In this exercise the Equivalent Variation is used as a measure of welfare to examine welfare impacts of tariff liberalisation.

Table 2: Equivalent Variations under Different Simulations

Household Groups	**TM**	*TM1*	*TM2*
Professional	1.419	1.561	1.568
Services	2.110	1.572	1.584
Agricultural Labour	0.641	0.370	0.396
Small Farm	0.709	0.448	0.479
Large Farm	2.640	1.875	1.966
Skilled Worker	0.566	0.389	0.395
Semi-skilled Worker	0.175	0.107	0.116
Unskilled Worker	0.687	0.490	0.560

[4] Social ordering requires more information than household preference orderings as its information base. It also requires some degree of household welfare comparability and measurability. It also requires a method for aggregating individual welfare. Thus the social ordering requires information on comparability and measurability of household welfare as well as a method for aggregating the household welfare. On the other hand, household orderings are based on their market behaviour i.e household's income and market prices.

[5] The aggregate EV 'measures' utilities by the money metric and simply adds the utilities together, assuming the constancy of the marginal utility of income. The aggregate EV is like a classical utilitarian social welfare function applied to individuals with constant marginal utility of income. Thus pure redistributive changes do not affect it (Boadway and Bruce, 1984).

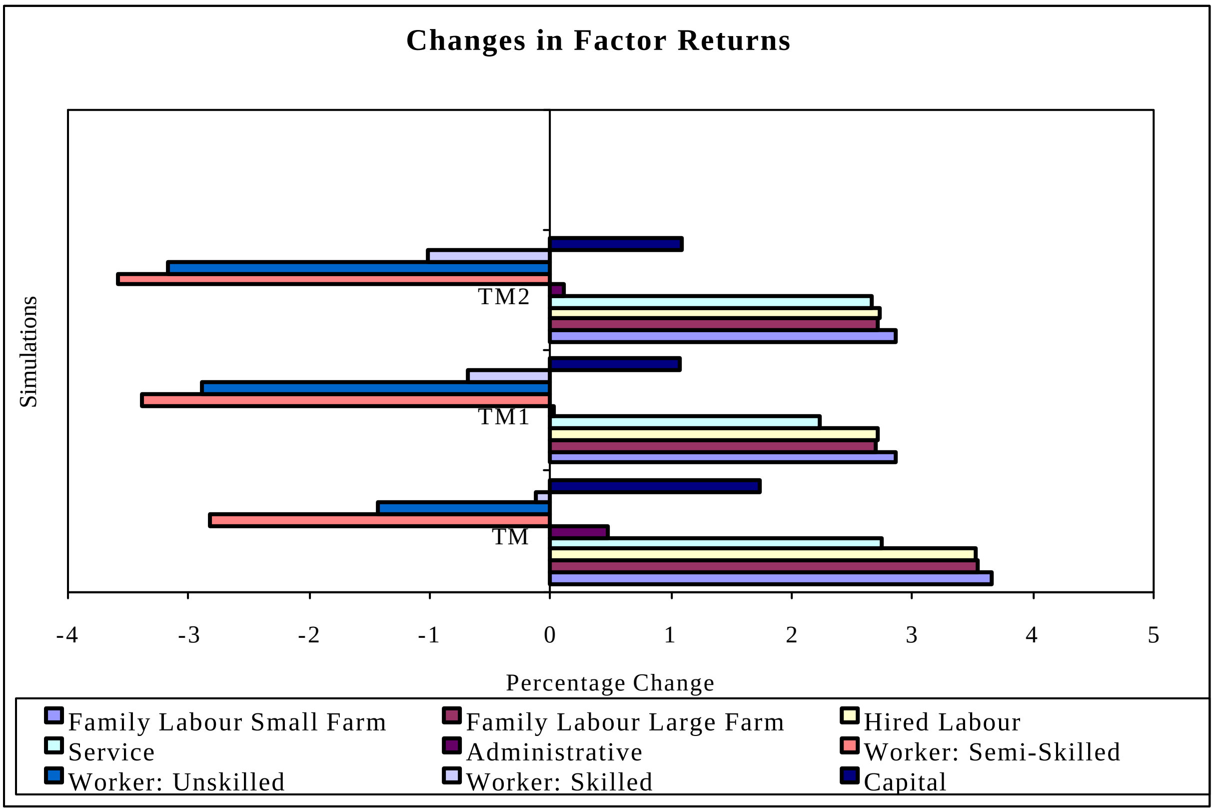
It is observed from Table 2 that in the *first experiment*, Equivalent Variation are positive for all household groups. The observed EV is, however, larger for the high-income household groups (e.g. professional, services, and large farm) compared with low income household groups (agricultural labour, semi-skilled and unskilled workers). Contrary to the first experiment, in the *second experiment* observed EVs are lower for all household groups because of lower GDP growth observed in this case. Again the distribution of income appears to favour the high-income household groups (e.g. professional, services, and large farm) compared with low income household groups (agricultural labour, semi-skilled and unskilled workers). The distribution of income also appears to favour the high-income households in the *third experiment*. There is, however, no significant difference in the level of EVs observed between this and the second experiment. This is because changes in GDP growth and price movements are almost similar in these two experiments.

The observed EVs are, however, substantially lower for the worker household groups compared to the rural based agricultural household groups. This is perhaps due to the fact that as a result of tariff reforms, resources move from protected sectors (e.g manufacturing) to non-protected sectors such as agricultural activities.

Factors Returns under Different Tariff Liberalisation Simulations

The impact of tariff liberalisation experiments on wages of different types of labour and rental rate of capital is reported in Figure 2. It is observed that impacts of tariff liberalisation on factor returns are mixed. In all the three experiments it is found that workers engaged in manufacturing activities are the losers as a result of decline in manufacturing GDP. On the other hand, laborers engaged in rural based agricultural activities are the gainers. One can also observe the degree of changes of factor returns under the three different tariff liberalisation experiments. In all the experiments, wage changes are negative for the workers engaged in the manufacturing sectors. It is also observed that decline in wages is more prominent in the revenue neutral tariff experiments where manufacturing and services sectors bear the burden of generating extra revenue to bridge the deficit in government revenue. On the other hand, increase in wage of labourers engaged in agricultural activity is relatively low in revenue experiments compared to the first experiment.

Figure 2: Changes in Factors Returns under Different Tariff Liberalisation Experiments



Analysis of Revenue Potential and Incidence by Sector: Introduction of Supplementary Tax

The mobilisation of additional domestic resources has always been a difficult task in Bangladesh. Recently, the government has introduced a new type of tax known as the supplementary tax. The tax is levied on domestic production and consumption bases in addition to the existing indirect taxes. The revenue potential and incidence of introducing the new tax system in some selected sectors have been analysed. More specifically, the model analysed the issue: what is the effective tax rate of a given sector that would raise a net additional real domestic indirect tax revenue of 1 percent (i.e. Tk. 217 million at 1992/93 prices). The efficiency and distributional effects of such a change were examined. The results are summarised in Table 3.

Table 3: Effects of Introducing Supplementary Taxes on Some Selected Sectors

Sectors	*Tax Rate*	*Change in Real Income Change*	*Change in CPI*	*Change in Trade Gap*	*Change in Tariff Revenue*	*Distribution Effect*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Edible Oil	0.12	-0.395	0.18	-0.23	-0.048	?
Processed Food	0.075	0.072	0.15	-0.03	-0.024	?
Tobacco Products	0.13	-0.533	0.25	-0.16	-0.020	+
Cotton Yarn	0.33	-2.770	0.16	-1.36	-0.024	-
Cloth	0.06	-0.39	0.11	-0.59	-0.056	+
Jute-textile	0.10	-1.075	-0.97	-0.03	-0.464	-
Chemical	0.035	-0.572	0.21	-0.152	-0.064	+
Basic Metal	0.185	-1.834	0.10	-1.294	-0.50	+
Machinery	0.145	-3.400	0.07	-1.55	-1.299	+
Trade	0.010	-0.382	0.12	-0.191	-0.026	+
Services	0.0225	-0.467	0.14	-0.159	-0.024	+
Construction	0.015	-0.107	0.10	-0.50	-0.018	+/?

Column (1) shows the supplementary tax rate that would raise the net indirect tax revenue by 1 percentage point. Column (2) reports the changes in real income due to the introduction of the new tax. The change in real income is the change in income which, at pre-tax prices, would leave the household as well off as in the post-tax situation. Thus a negative number implies a worsening of household’s circumstances as a result of the new tax. Column (3) depicts the resulting change in the consumer price index. The CPI is a consumption-weighted price index. Column (4) records the movement in trade gap induced by the effects of new taxation on imports and exports. Column (5) shows resulting changes in tariff revenue. Finally, column (6) captures distribution effects of new tax system. A plus (+) means progressive, whereas a minus (-) indicates regressive incidence. A question mark (?) envisages that the various incidence measures conflict with each other.

From the above it clear that the services sectors are relatively more effective in raising the required revenue while capital supplying sectors (e.g. machinery and basic metal) and cotton yarn sector are relatively less effective. Here efficiency is measured in terms of the sectoral rates of supplementary duty that would raise the targeted revenue. It is observed that for services and construction sectors the required rate of supplementary duty are between 1 to 2.5 percent while for capital goods sectors (e.g. machinery, basic metal etc.) it is around 15 percent. However, effectiveness does not necessarily indicate that these sectors should be preferred over other sectors to raise additional revenue. One has to examine the inherent welfare cost of or the distributional consequences of introduction of the new tax by each of the taxable sectors. The results suggest that the preferred sectors for the introduction and subsequent expansion of the supplementary taxation could be the service sectors (such as miscellaneous service, trade and construction sectors). These sectors (i) have favourable distributional effects and (ii) are effective in raising the required revenue with lower supplementary duty rates.

3.2 Tariff Liberalisation

In all experiments, the tariff rates on imported products are reduced by 50 percent with an upward adjustment of existing domestic production tax rates, so as to maintain the neutrality of government revenue. The results of simulations using different variants of model are presented.

***EXPT-I*: tariff liberalisation under perfect competition**

The simulation reports the results of tariff reduction under perfect competition and constant returns to scale. In this case all sectors are assumed to behave in competitive manner and production takes place under constant returns to scale. The factors are fully mobile across sectors and full employment of factors is assured through the equality of factor demand and supply. Finally, the equality of savings and investment closes the model.

***EXPT-II*: tariff liberalisation under imperfect competition**

The simulation refers to the outcomes of tariff liberalisation under imperfect competition. Seven manufacturing sectors are characterised as non-competitive while other seven production sectors are assumed to behave in a competitive manner.

***EXPT-III*: tariff liberalisation under imperfect competition and entry and exits of domestic firms**

In this experiment, the consequences of tariff liberalisation are examined when the number of domestic firms in each non-competitive sector is allowed to adjust freely in response to policy changes. The present scenario does not necessarily denote a long-run scenario or outcome since full mobility of labour and capital are also allowed in the previous experiments. Instead the simulation depicts a situation where there are no barriers in the industrial structure to prevent entry and exit of firms. However, the accepted terminology in empirical research is to refer to this scenario as a long run scenario where all primary factors of production are mobile and domestic firms can enter and exit without impediments. The usual (e.g. Cox and Harris, 1985 and Gunasekera and Tyres, 1988) way to proceed is to set the level of excess profits to zero and then allow the number of domestic firms to adjust endogenously in response to policy reforms. In our case, since base scenario allows for excess profits, the zero profit condition is not directly comparable to the base scenario. In that case, one would be comparing a long-run equilibrium under free trade with a short-run equilibrium under trade protection.

To overcome this problem, de Melo and Holst (1990) and Devarajan and Rodrik's (1991) approach assumed that the 'observed' level of excess profits describes a long-run solution to start with. Therefore, the level of firm's profits is fixed to the benchmark level of excess profits and then the number of domestic firms are allowed to adjust endogenously in response to policy changes.

EXPT-IV **: tariff liberalisation with increasing returns to scale**

To perform this experiment, a uniform scale elasticity of 10 percent is assumed for all non-competitive sectors. However, the scale elasticity changes as relative price, input price and firm output change with tariff liberalisation. It is expected that the overall welfare gains are enhanced to the extent that scale elasticity is reduced that is to the extent that firms move down their average cost curves.

Results of Tariff Liberalisation

EXPT I*:* Resource allocation of revenue neutral tariff liberalisation is provided in Table 4. In the competitive case, due to tariff liberalisation, resources move from highly protected sectors to less protected or non-protected sectors. In this case, tariff liberalisation mainly favours the less protected sectors such as subsistence and commercial agriculture, forestry and trade and transport sectors. On the other hand, the highly protected manufacturing sector is the major loser. Except for the garments, outputs decline in all other manufacturing sectors. Such a movement of resources is expected given the initial levels of protection provided to domestic industries. Protection (such as tariffs and non-tariff barriers) permits domestic industries to operate with value added higher than that which prevails under free trade thereby providing incentives for movement of resources into protected industries. Thus, when such protection is removed, resources tend to move from protected (e.g. manufacturing) to less protected sectors.

Table 4: Resource Allocation Impacts of Tariff Liberalisation under Different Scenarios

(percentage changes)

Sectors	*Tariff Rate*	*EXPT-I*	*EXPT-II*	*EXPT-III*	*EXPT-IV*
Competitive Sectors					
Food Crops	8.25	0.91	-0.22	0.03	-1.66
Cash Crops	8.18	3.90	0.49	1.08	1.19
Forestry		1.21	5.56	4.92	6.33
Exports Oriented	61.50	2.41	1.57	1.61	3.17
Construction		-2.33	14.29	14.55	24.42
Services		-0.35	-0.83	-0.84	0.63
Trade-Transport		-0.22	5..35	6.13	7.14
Non-competitive Sectors					
Processed Food	33.23	-1.48	2.62	3.56	3.72
Textiles	25.59	-0.01	-1.98	-1.44	1.58
Chemical	18.23	-0.51	1.12	4.11	2.77
Cement	23.39	-4.19	10.00	9.79	26.21
Heavy Industry	22.12	-7.30	16.14	17.91	34.17
Other Industries	30.15	-3.22	1.73	4.15	7.44
Energy	11.00	-4.43	9.15	10.19	14.74
Sub-Total		-1.30	4.30	5.2	9.1
All Sectors		-0.23	3.06	3.32	5.22

* Tariff rates refer to effective tariff rates. Note: In experiment II, the excess profits are allowed to adjust, holding number of domestic firms fixed. In experiment III, the number of domestic firm is allowed to adjust, keeping the excess profits fixed.

***EXPT II**:* In the non-competitive case, the pattern of resource allocation is reversed with the manufacturing sectors turning out to be the main beneficiary of liberalisation. Almost all the manufacturing sectors show moderate output growth with largest output growth noted for the machinery sector. Cement and energy closely follow. The expansion of construction sector is perhaps due to strong inter-industry linkages with machinery and cement sectors. In particular, total manufacturing output increases by 4.3 percent compared to the previous case where manufacturing output as whole declines by 1.3 percent.

It is interesting to note the simultaneous expansion of output and contraction of excess profits of the manufacturing sectors. It is observed that the excess profits decline in all non-competitive sectors. The reduction of excess profits in these sectors is an expected outcome of intensified import competition. But what explains the growth of manufacturing sector ? It depends to what extent import competition alters the slope of the domestic firm's demand curve (and hence marginal revenue curve). Outputs of domestic firms increase when import competition sufficiently flattens the demand and the marginal revenue curves faced by domestic firms[6]. That is, by allowing flow of imports in the domestic markets, tariff liberalisation reduces the market power of domestic firms and compels them to behave competitively-it reduces the gap between prices and marginal cost and expands output. Changes in producer prices and marginal costs are shown in Appendix Table A.3.

To understand the mechanism at work it is useful to consider an economy where a domestic monopolist competes with a single foreign firm. The domestic monopolist has a downward sloping demand curve d_o and a marginal revenue curve mr_o. For simplicity, it is assumed that the marginal cost (c) is constant and is equal to the average cost. The domestic monopolist is in equilibrium when marginal cost curve (c) intersects the marginal revenue curve mr_o. The equilibrium price and quantity demanded are p_o and x_0 respectively. The domestic monopolist realises excess profits equal to the area cp_0ta. The initial equilibrium is denoted by point a in Figures 3 and 4.

Consider the consequences of import tariff liberalisation on the domestic monopolist's price, quantity produced and excess profits. Because of tariff liberalisation the domestic monopolist's demand curve shifts inward. In this regard two cases may be considered:

- In the first case, consider a parallel inward shift of domestic monopolist's demand curve to d_1 from d_o. The corresponding new marginal revenue curve is mr_1 which is also parallel to original marginal revenue curve mr_o. The new equilibrium of domestic monopolist is defined by point b, at which the new marginal revenue curve mr_1 intersects the marginal cost curve (c). The price is p_1 which is less than the initial price p_o. Analogously, quantity demanded x_1, is less than the initial quantity demanded x_o. The excess profit of the domestic monopolist is also reduced (since $cp_1sb < cp_0ta$). Therefore, the domestic monopolist responds to

[6] Almost all trade policy changes market demand curves. But such changes are much more significant for non-competitive behaviour than for perfect competition, where demand curves of firm remain invariantly flat (Richardson, 1989). Mere pivoting of the market demand curves around an equilibrium point will alter the perceived elasticities and equilibrium even if no conventional "shift" occurs (Bresnahan, 1987). Changes in tariff rates generally cause the elasticity of market demand to alter and hence change the size of marks-up and price distortions (which are invariant at zero under perfect competition).

intensified import competition by shifting its demand curve inward and thereby reducing output, price and profits when such shift does not affect the slope of the demand curve. This situation is illustrated in Figure 3.

- On the other hand, intensified import competition can have a second effect on the demand curve of the domestic monopolist. Beyond shifting the demand curve inward, tariff liberalisation can change its slope and make it flatter. This case is illustrated in Figure 4. The new demand curve is d_1 which is more elastic than the demand curve d_o. The corresponding new marginal revenue curve is mr_1. Given the marginal cost (c) of the monopolist, the new equilibrium position is b where the new price p_1 is smaller than the initial price p_o. Contrary to the first case, the quantity produced is larger in this ($ox_1 > ox_0$). The effect on monopolist's profits is not that straightforward. Monopolist's profits may increase or decline in the new equilibrium. It depends on how the tariff liberalisation shifts the demand curve. This can not be determined a priori. In Figure 4, the shift in the demand curve is drawn so that the profit levels are lower in the new equilibrium. In the initial equilibrium (i.e. at point a) the excess profit of the domestic monopolist is

$$\boldsymbol{p}_o = cp_0ta = cp_1va + p_1p_0tv \qquad (50)$$

5 In the new equilibrium (i.e. at point b) the domestic monopolist's excess profit is

$$\boldsymbol{p}_1 = cp_0sb = cp_1va + vasb \qquad (51)$$

Subtracting (50) from (51), we find

$$\boldsymbol{p}_1 - \boldsymbol{p}_0 = [cp_1va + vasb] - [cp_1va + p_1p_0tv] \qquad (52)$$

$$\boldsymbol{p}_1 - \boldsymbol{p}_0 = vasb - p_1p_0tv \qquad (53)$$

From Figure 4 it is observed that area p_1p_0tv is larger than area $vasb$. Hence it appears that $\boldsymbol{p}_1 < \boldsymbol{p}_0$. Thus, the domestic monopolist realises less profits in the new equilibrium compared to the initial equilibrium. Similar approach is used by Koutsoyiannis (1979) to show that the level of profits is higher for a discriminating monopolist compared to a simple monopolist.

This is what happens in this case as tariff liberalisation renders the demand faced by domestic firms more elastic. Although the demand curve shifts inward due to tariff liberalisation, the change in the slope of the demand curve in the new equilibrium is large enough to offset the deleterious effect on firm's output. Domestic firms now perceive themselves as having less control over their prices, and hence increase output. This is known as the pro-competitive effects of trade liberalisation.

Devarajan and Rodrik (1989, 1991) also report an expansion of manufacturing output due to the pro-competitive effects of tariff liberalisation. They report a larger expansion of manufacturing output compared with the present experiment. This may be because (i) they consider a complete elimination of tariffs while in our experiments tariff rates are halved leading to much smaller degree of import competition; (ii) to keep government revenue at the pre-reform level a lump-sum tax is levied on household's income in their experiment, whereas in our case production tax rates are raised. Consequences of higher production taxes on non-competitive firm behaviour are well established in micro-theory (Koutsoyiannis, 1979). Higher production taxes affect the price of composite goods. As a result, the marginal cost curve shifts upward (c_2) to establish a new equilibrium (f) where output is lower ($x_2 < x_1$) and price is higher ($p_2 > p_1$) compared with the equilibrium (i.e. b) in which production taxes are not raised but tariff rates are reduced.

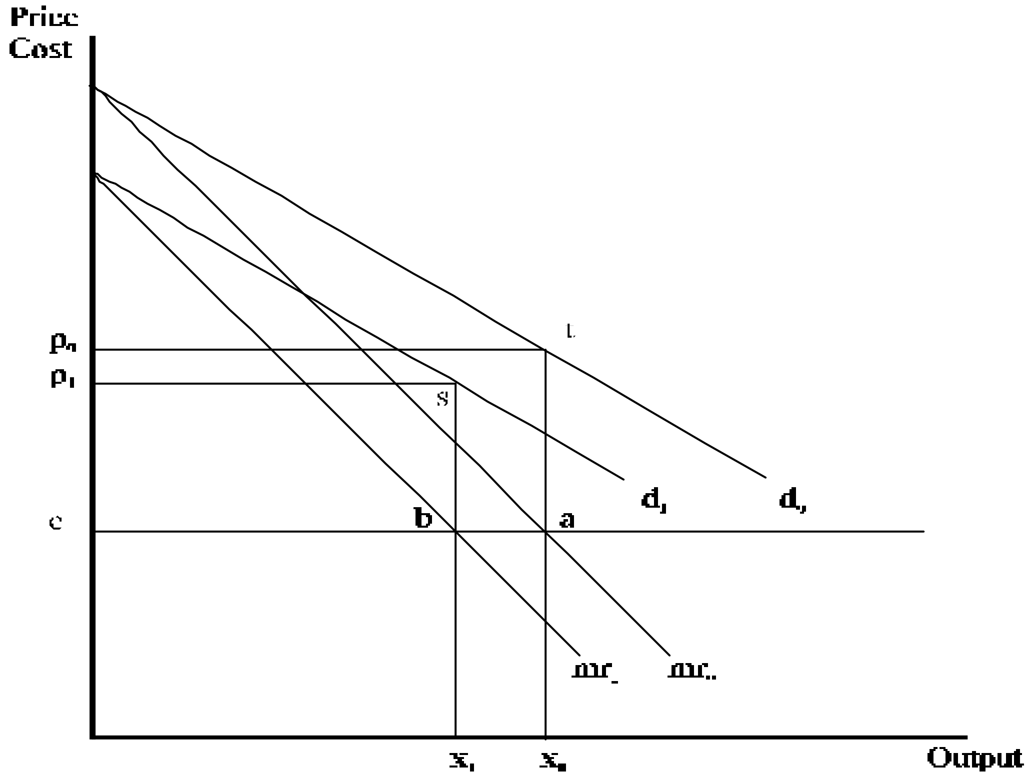


Figure 1: Inward Shift in Monopolist's Demand Curve

Figure 3: Inward Shift in Monopolist's Demand Curve

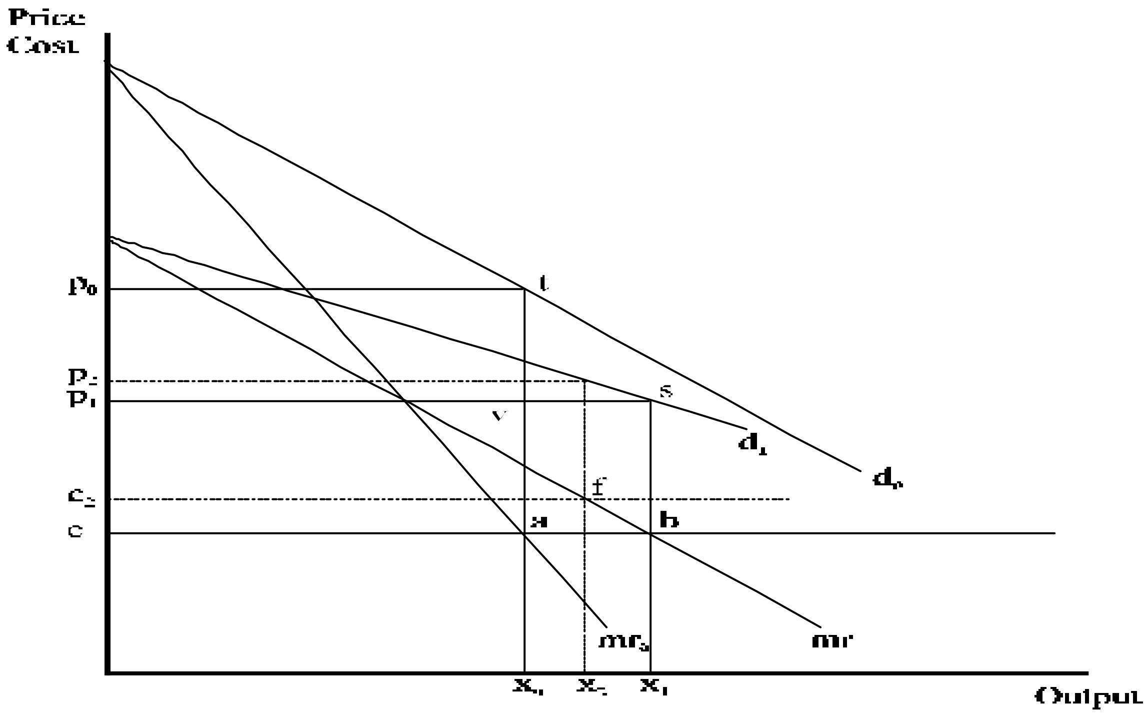


Figure 2: Changes in the Slope of Monopist's Demand Curve

Figure 4: Changes in the Slope of Monopolist's Demand Curve

***EXPT III**:* The pattern of sectoral output change is also similar between experiments two and three. As in the previous experiment, except for clothing all manufacturing sectors show moderate growth in output when firms are allowed to exit and enter domestic industries. Moreover, total manufacturing output growth observed in the two experiments is also very close. Total manufacturing output growth is 5.2 percent in the present case compared with output growth of 4.3 percent in the previous case.

The apparently similar resource-allocation effects of tariff liberalisation between these two experiments may be due to small entry and exit of domestic firms and observed high sensitivity between firm-level profits and entry and exit of domestic firms. It is noticed that the number of firms declines in all six sectors that experience reduction in profits in the previous experiment. It appears that firm-level profits are sensitive to changes in competitive environment generated by exit and entry of domestic firms.

***EXPT IV**:* The most significant difference of this experiment is the much larger expansion of output of the manufacturing sectors. Almost all the manufacturing sectors show a much larger output growth. The largest output growth is observed for the machinery sector which expands by 34 percent (previously 18 percent). Cement sector expands by 27 percent (previously 10 percent). The increases in output of construction and energy sectors are 25 and 15 percent respectively in this experiment, whereas previously the corresponding output increases for construction and energy sectors are 14 and 10 percent. On the other hand, the other industry sector expands by 7 percent compared to an output expansion of 4 percent previously. The output expansions of food and tobacco and chemical sectors are not significantly different from the previous experiment. Total manufacturing output as a whole expands by 9.1 percent (previously 5.2 percent). Clearly the larger expansion of the machinery, cement, energy and other industry sectors is due to moderate reduction in unrealised scale economies in these sectors. This is reflected by the decline of the scale elasticity (q) in these sectors. The fall in scale elasticity implies a reduction in unit cost as the scale of production increases.

Devarajan and Rodrik (1991) reported a doubling of manufacturing output for intermediate goods and food processing sector with 3 to 4 percent reduction in unrealised scale economies respectively for CAmeroon. The output expansion of cement and basic metal sector is very large (109 percent) due to large reduction (12 percent) in unrealised economies of scale.

The exit rates of domestic firms are larger in this experiment compared to the previous experiments; perhaps the moderate benefits from scale economies now compel more inefficient firms to leave the industry. The exit rates of domestic firms are, however, moderate at around 2-6 percent. On the other hand, the entry rate in the other remaining sector is also moderate (3.5%). These rates are similar to the exit rates reported by Devarajan and Rodrik (1991) in the case of Cameroon. Our estimates of exit of domestic firms are significantly smaller than the exit of domestic firms reported by Gunasekera and Tyres (1988). They report high exit rates of 25-47 percent for domestic firms in the case of Korea in response to trade liberalisation[7].

[7] No estimates are available for entry and exit of domestic firms in the manufacturing sectors of Bangladesh. Tybout (1989) and Roberts (1988) report some estimates of net exit rates for Chile and Columbia, albeit in the absence of policy shocks. On average the net exit rates were around -3 and 6 percent per year in three- digit industries in Chile and Columbia respectively.

3.3 Estimates of Income and Price Elasticity

The summary results of the estimates of income elasticity by eight household groups and price elasticity by major food items are presented.

Demand Responsiveness Due to Changes in Income

The income elasticity of demand is usually interpreted as the percentage change in the quantity demanded of a particular product due to change in income, other factors remaining constant. Own and cross price elasticity and the income elasticity of various food items by occupational groups are given in Appendix Tables A4 to A11. A summary of the results for important food and non-food items is given in Table 5.

Table 5: Income Elasticity of Selected Items

Group	*Rice*	*Wheat*	*Fish*	*Pulses*	*Beef*	*Vegetables*	*Milk*	*Non-food*
Professional	-0.14	-0.59	1.98	1.33	2.08	0.92	1.86	1.36
Services	-0.06	-0.13	1.37	0.33	1.54	1.58	1.27	1.05
Large Farmers	-0.05	-0.27	1.70	0.72	1.83	1.28	1.58	1.23
Small Farmers	-0.04	-0.25	1.71	0.61	0.40	1.11	1.54	1.27
Skilled Workers	-0.05	-0.24	1.61	0.81	1.76	1.54	1.30	1.17
Semi-skilled Workers	-0.06	-0.21	1.65	0.84	1.77	1.68	1.44	1.22
Unskilled Workers	-0.03	-0.30	1.67	0.81	1.85	1.98	1.59	1.24
Agricultural Labourers	-0.07	-0.23	1.87	0.87	2.07	1.05	1.79	1.37

Source: Appendix Tables A4-A11.

A striking feature of the results is that, for all groups the income elasticity of rice and wheat are negative. This would imply that these two staple foods are, in fact, inferior goods. While other studies have found wheat to be an `inferior' good, positive income elasticity is reported for rice. At the outset, it may be difficult to interpret such negative income elasticity for rice and one may like to attribute the result to methodological differences. A closer look at Table 5 reveals that the absolute value of income elasticity for wheat is much higher than that of rice and the magnitude of income elasticity of rice is very low. In fact, if income rises by 10 percent, the demand for rice by agricultural labourers and by professionals falls by 0.7 and 1.4 percent respectively.

For most of the occupational groups, income elasticity of rice is essentially, zero which may be attributable to the fact that increased calorie consumption may not be a priority goal for the consumers. The present consumption bundle is overwhelmingly dominated by rice that makes the diet monotonous for most of the households. As a result, it seems that with increase in income, the households try to add variety to the diet or opt for expensive or `superior' foods such as, fish, meat, milk and similar items.

Yet another possibility is that, with increase in income the households may not decrease their consumption of rice but may reduce the proportion of expenditure on rice. For example, let a household spend 75 percent of its income on rice. Now if the household's income rises by 20 percent and the per capita consumption of rice remains the same, the expenditure on rice may decrease below 75 percent if the household spends the additional income on other food items. Now if the proportions are compared, it may suggest that rice consumption has declined although this is not the case. The relative consumption share of rice may thus decrease without any decline in absolute terms.

The estimated negative income elasticity for wheat conforms to the findings of several other studies in Bangladesh. Out of 10 estimates that are available, eight reports negative income elasticity for wheat in rural Bangladesh. According to the present estimate, a 10 percent rise in income results in 2.3 percent decline in wheat consumption by agricultural labourers while the comparable magnitude for others would range between 1.3 percent for services group to 5.9 percent in the case of professionals.

Table 5 also makes it clear that relatively expensive sources of calories have high income elasticities and items like fish, beef, vegetables, and milk fall in this category. However, it is difficult to interpret why the income elasticity for pulses for the professional group is so high or the income elasticity of beef for small farmers is so low.

Own and Cross Price Elasticity of Demand

Tables 6 gives the own price elasticity for some selected items.

Table 6: Own Price Elasticity of Selected Food Items

Groups						***Own Price Elasticity's***	
	Rice	*Wheat*	*Fish*	*Pulses*	*Beef*	*Vegetables*	*Milk*
Professional	-0.48	-1.48	-0.91	-1.38	-1.01	-1.17	-1.11
Services	-0.14	-0.79	-1.01	-1.09	-1.01	-1.34	-1.16
Large Farmers	-0.20	-0.79	-1.00	-1.07	-1.02	-1.37	-1.09
Small Farmers	-0.23	-0.83	-1.01	-1.09	-1.02	-1.93	-1.11
Skilled	-0.27	-0.83	-1.01	-1.08	-1.01	-1.64	-1.16
Semi-skilled	-0.28	-0.83	-1.00	-1.07	-1.03	-1.56	-1.15
Unskilled	-0.24	-0.83	-1.01	-1.07	-1.01	-1.82	-1.09
Agri-labourers	-0.25	-0.84	-0.98	-1.06	-1.02	-1.65	-1.08

Source: Appendix Tables A4-A11

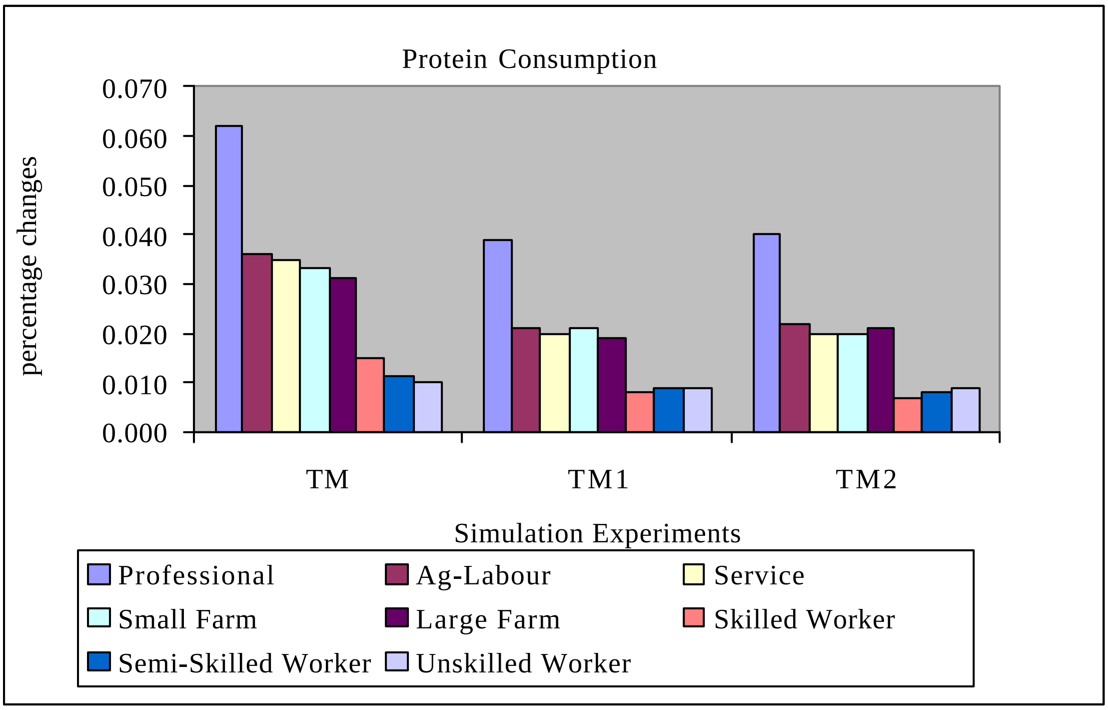
The estimated own-price elasticity indicates that if, for example, the rice price falls by 10 percent the demand for rice would increase by 4.8 percent for the professional group whilst for other groups the rise will range between 1.4 percent to 2.8 percent. The expensive sources of calories also have higher own price elasticity. The results indicate a positive cross price elasticity between rice and wheat (Appendix Tables A4-A11). This would imply that as price of rice rises so is the demand for wheat. On the other hand, the present study finds some complementary relationship between the demand for rice and potato. However, no significant relationship between the price of fish and the demand for beef is reported which is presumed to be prominent a priori.

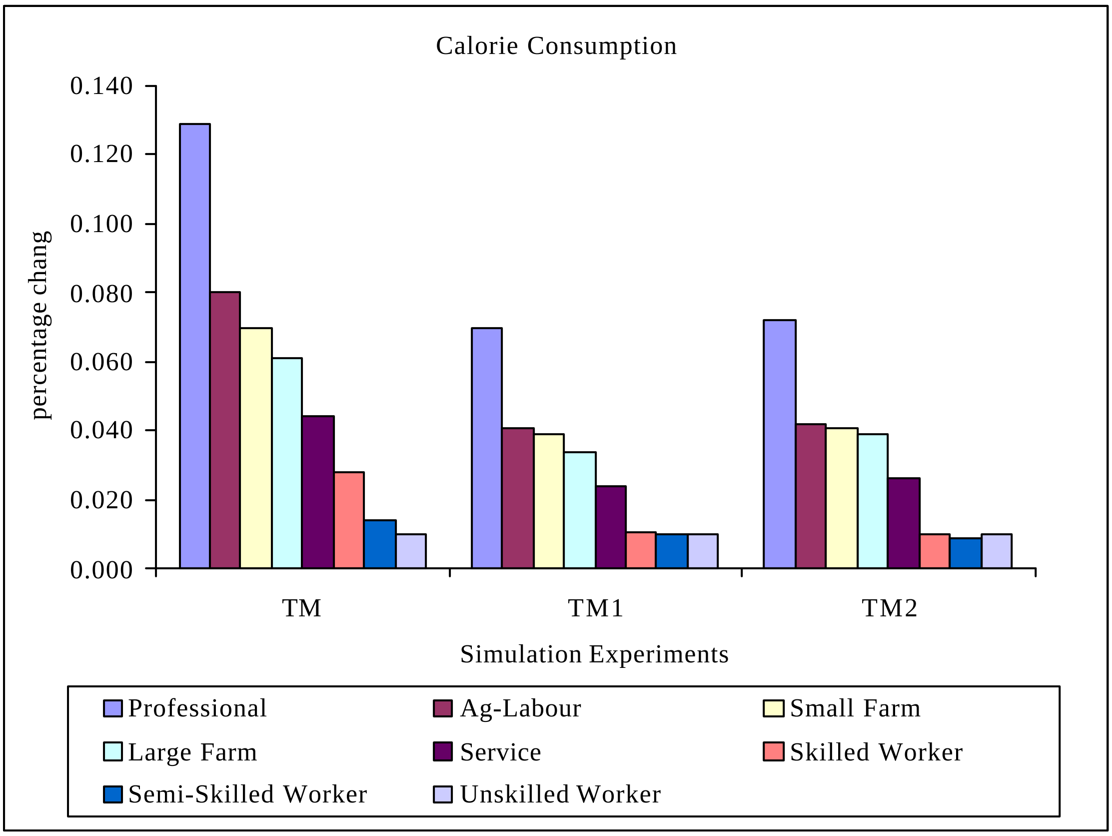
3.4 Simulating Nutrition Effects of Price and Income Changes

A macro policy change usually affects household groups through its impacts on commodity prices and income levels. Within the purview of the MAP project, the impact of macro economic policy changes on the nutrition status of eight household groups has been simulated using the linked model. The linked model employs estimates of elasticity from the elasticity model and changes in sectoral prices and household income to generate impacts on nutrition status of household groups.

The impacts of tariff liberalisation experiments on the availability of protein and calorie availability to the households are shown in Figure 5. In particular, Figure 5 shows the changes in protein and calorie availability by eight household groups under tariff liberalisation experiments. It is observed that, the tariff liberalisation experiments appear to be regressive in terms of nutrient availability in household groups. That is percentage change in protein and calorie availability is large for high-income groups compared to the low-income groups. Except for the agricultural labour household group, both calorie and protein availability are greater for the higher income household groups. Another important observation is that, nutrient availability is significantly lower for the workers household groups compared to other five household groups. This is because changes in income are lower for the worker household groups. Another observation is that percentage change in protein and calorie availability is relatively larger in the first experiment compared to the other two experiments since income effects are high and price affects are low in the first experiment.

Figure 5: Changes in Protein and Calorie Consumption





3.5 Analysis of Simulation Results: Growth and Poverty

In Bangladesh, the extent of overall poverty is usually analysed without explicit consideration of poverty levels for households classified either by income groups or by occupational classes. We have estimated the extent for poverty by eight household groups classified by their main occupations. Unpublished tables obtained from the "Household Expenditure Survey, 1991/92" of the BBS were used to estimate poverty level for each of the eight household groups using the FGT measure of poverty. The HES tables provide the profiles of 16 income groups by 31 occupational categories. These 31 categories are aggregated into eight household groups following a mapping procedure (CIRDAP 1997). Poverty lines for each of the eight household groups are calculated using the information of per day per capita poverty line expenditure (in Taka) on food (Ravallion and Sen 1996), number of days in a month, and size of household of each household group. The estimated poverty line for food for each household group is presented below:

$$PL_i = PDFE \cdot DM \cdot HS_i$$

where, $PDFE$ denotes per day per capita expenditure on food (in Taka), DM depicts number of days in a month (30 days), and HS_i size of each household group.

The estimated poverty line for food is then augmented for non-food basic items by an adjustment factor that is assumed to be 30 percent of the poverty line expenditure for food. The incidence of poverty is then estimated using the household specific poverty lines (the estimated poverty lines for eight household groups are reported in Appendix Table A12).

Table 7: Measurement of Household Poverty in Bangladesh

Household Groups	*Poverty Measure*			*Group Poverty Share out of Total Poverty*			*Elasticity of Poverty with Respect to Mean Income Change*		
	Head Count	*Poverty Gap*	*Squared Poverty Gap*	*Head Count*	*Poverty Gap*	*Squared Poverty Gap*	*Head Count*	*Poverty Gap*	*Squared Poverty Gap*
Professional	0.188	0.038	0.012	0.024	0.016	0.013	-3.47	-2.00	-2.00
Service	0.479	0.157	0.065	0.156	0.209	0.253	-1.21	-1.75	-2.00
Agricultural Labour	0.717	0.251	0.107	0.298	0.291	0.248	-0.60	-0.97	-1.47
Small Farmer	0.565	0.155	0.061	0.137	0.120	0.107	-0.99	-1.21	-1.57
Large Farmer	0.401	0.100	0.038	0.214	0.206	0.216	-1.39	-1.45	-1.67
Workers-Skilled	0.431	0.152	0.071	0.037	0.047	0.058	-1.08	-1.63	-2.09
Semi-Skilled	0.492	0.125	0.049	0.021	0.017	0.015	-0.94	-1.52	-2.18

Unskilled	0.591	0.160	0.072	0.114	0.093	0.091	-0.53	-1.04	-1.78
All Household	0.483	0.142	0.059	1.00	1.00	1.00	-	-	-

The extent of household poverty under three alternative measures; head-count ratio, poverty gap, and squared poverty gap, are provided in Table 7. It is observed that, under all three measures, the extent of poverty is the highest for agricultural labour households, followed closely by unskilled workers households and small farmer households. The poverty level is the lowest for the professional households. The Poverty Monitoring Surveys under the MAP project reports poverty levels by six household groups. The household classification, however, is somewhat different from our classification. What is relevant is, in line with our findings, the lowest poverty level is reported for professional households and the highest for the petty traders or labour household groups (Hossain 1997). Table 7 also reports the elasticity of poverty reduction with respect to changes in mean income. Since such elasticity estimates are not available for Bangladesh, these values are obtained from Kakwani (1993) with some adjustment. The elasticity values are reported for the eight household groups under three poverty measures.

A 10 percent increase in output of each of the eleven sectors has been taken to analyse the impact of sectoral changes in output on incidence of poverty. More specifically, the simulation is conducted to find out relative strengths of the eleven sectors in terms of five effects; *effective distributional effects, interdependence effects, fixed priced or accounting multipliers, poverty sensitive effects, and the poverty alleviation effects.* The simulation results are presented in Table 8. It shows the impact of a ten percent increase in sectoral outputs on five effects under three measures of poverty.

The *effective distributional effects* show the distributional consequences on household income through changes in returns of primary factors and participation of household groups in the production process. The effective distributional effects appear to be the largest for the social sectors (e.g. education and health) followed by services sector and the two agricultural sectors.

The *interdependence effects* which capture the first round effects of spending and subsequent rounds of responding are, on the other hand, the largest for the two agricultural sectors and the food processing sector. These sectors are followed by manufacturing, construction and services sector. The interdependence effect is, however, the lowest for the social sectors. The observed interdependence effects and their inclination towards the food and agricultural sector is a reflection of the household expenditure patterns where the largest share of household resources are spent. Since household expenditures on education and health sectors are low, the implied interdependence effects are also small.

The *accounting multipliers* depict the ultimate impact on household income distribution taking into consideration all the first round and subsequent rounds (i.e. general equilibrium impacts) of interaction among economic factors, institutions, and production sectors due to the initial intervention on sectoral output. The accounting multipliers are also observed to be the largest for the social sectors, followed by service sector and the agricultural sectors. This suggests that, out of an initial equivalent intervention on these eleven sectors, relatively more income would accrue to households from the social sectors, service sector and agricultural sectors.

Poverty sensitive effects which take into account changes in income of the households and the corresponding elasticity of poverty reduction with respect to mean-income change, are also found to be the largest for the social sectors, followed by service sector, and the agricultural sectors.

Table 8: Decomposition of Multipliers and Poverty Reduction Effects by Major Sectors: The Bangladesh Case

	Food grain	*Other Agriculture*	*Processed Food*	*Clothing*	*Exports Industries*	*Other Industries*	*Machinery*	*Construction*	*Education*	*Health*	*Services*
Head Count Measure											
Effective Distributional effects	0.126	0.134	0.086	0.049	0.098	0.076	0.027	0.105	0.205	0.152	0.144
Interdependence effects	3.350	3.290	3.236	3.151	3.225	3.168	3.139	3.215	2.808	2.969	3.069
Accounting Multipliers	0.422	0.441	0.277	0.156	0.316	0.239	0.084	0.339	0.575	0.451	0.441
Poverty sensitive Effects	2.452	2.470	2.485	2.522	2.497	2.518	2.525	2.499	2.702	2.609	2.551
Poverty Alleviation Effects	1.036	1.090	0.689	0.393	0.789	0.602	0.211	0.846	1.554	1.177	1.124
Poverty Gap Measure											
Effective Distributional Effects	0.127	0.136	0.087	0.050	0.099	0.077	0.027	0.108	0.207	0.154	0.147
Interdependence effects	3.364	3.290	3.246	3.159	3.238	3.160	3.141	3.201	2.817	2.967	3.056
Accounting Multipliers	0.428	0.448	0.281	0.158	0.320	0.243	0.085	0.344	0.583	0.458	0.448
Poverty sensitive Effects	2.813	2.810	2.776	2.777	2.784	2.822	2.804	2.807	3.019	2.933	2.856
Poverty Alleviation Effects	1.204	1.259	0.780	0.439	0.892	0.686	0.238	0.967	1.760	1.344	1.280
Squared Poverty Gap Measure											
Effective Distributional effects	0.129	0.140	0.090	0.052	0.103	0.081	0.028	0.112	0.223	0.164	0.155
Interdependence Effects	3.413	3.307	3.245	3.135	3.228	3.136	3.113	3.186	2.749	2.915	3.016
Accounting Multipliers	0.441	0.463	0.291	0.164	0.332	0.253	0.088	0.358	0.612	0.479	0.467
Poverty sensitive Effects	3.598	3.590	3.519	3.506	3.528	3.594	3.555	3.580	3.831	3.740	3.641
Poverty Alleviation Effects	1.586	1.663	1.024	0.576	1.172	0.909	0.314	1.280	2.345	1.792	1.702

Finally *the poverty alleviation effects* of an initial equivalent intervention on the eleven production sectors are also estimated. Like most of the other effects, the poverty alleviation effects are also observed to be the largest for the education sector, followed closely by the health sector. Other sectors, which are significant in terms of poverty alleviation effects, are service sectors, and the two agricultural sectors. Relatively less poverty alleviation effects of the agricultural sectors tend to indicate that scope of growth of output and factor incomes are limited in these sectors compared to the social sectors. The extent of poverty alleviation is small in the remaining sectors that are predominantly manufacturing industries. The effective distribution effects of the manufacturing sectors are small which may have unfavourable implications on poverty alleviation effects. The ranking of the poverty alleviating sectors along with the intensity of the effects are shown in Table 9.

Table 9: Ranking of the Poverty Alleviating Sectors

Sectors	*Poverty Measures*		
	Head-Count Ratio	**Poverty Gap**	*Squared Poverty Gap*
Education	1.554	1.760	2.345
Health	1.177	1.344	1.792
Service	1.124	1.280	1.702
Other Agriculture	1.090	1.259	1.663
Food Grain	1.036	1.204	1.586
Construction	0.846	0.967	1.280
Export Industries	0.789	0.892	1.172
Processed Food	0.689	0.780	1.024
Other Industries	0.602	0.686	0.909
Clothing	0.393	0.439	0.576
Machinery	0.211	0.238	0.314

It is observed from Table 9 that education sector has the highest poverty alleviation effects and the extent of poverty alleviation ranges from 2.345 under poverty sensitive measure to 1.554 under the head-count measure. The domain of poverty alleviating effects under the health sector ranges from 1.792 to 1.117. In the case of service, the range is between 1.702 to 1.124. The poverty alleviation effects ranges from 1.663 to 1.090 and 1.586 to 1.036 under other agriculture and food grain sector respectively. These results tend to suggest that the poverty alleviation effects under different sectors as well as under alternative poverty measures may be significantly varied.

This analysis suggests a strong option for the policy makers in Bangladesh that the social sectors deserve priority to eradicate poverty. The results aptly reiterate the perceptions and demands for human resources development interventions in poverty alleviation programmes through increased investments in the social sectors to create conditions under which the poor can participate and take advantage of the growth process.

In this regard it is relevant to note the quality aspects of social sector development (e.g., education and health programmes) as well as their sustainability. For instance, in the case primary education, a high enrolment rate is not enough. What is needed is to ensure its sustainability and development of linkages of education with productive activities in order to enhance the capabilities of the poor to exploit opportunities to increase their access to employment and income.

4. Future Research Areas

It has been a common practice in the social accounting matrix (SAM) construction to consolidate the financial transactions between major institutions and production sectors of the economy. There is, therefore, virtually no information on flow-of-funds among institutions; behaviour of the money market, financial market and relationship between financial and non-financial institutions such as households, firms, government and the rest of the world. Aggregation of such information in one consolidated account conceals vital information and reduces the scope for analysing the impact of financial sector reforms involving major financial instruments such as rate of interest, bank rate and credit control.

Since a real SAM with a consolidated capital account conceals vital financial transactions, a financial SAM is needed in Bangladesh. This can then be integrated into the real part of the SAM. The financial SAM will include a flow-of-funds; and opening and closing balances of assets. Consequently, it will encompass a detailed and consistent description of the disaggregated acquisition and ownership of real and the financial assets. It will also include capital account transactions between major institutional agents: the central bank, the commercial banks, other financial institutions, insurance companies, households, government, non-financial enterprises, and the rest of the world.

A Financial CGE Model for Bangladesh

One of the main objectives of the present computable general equilibrium (CGE) model is to explore the consequences of various adjustment policies adopted by the government on the economy. More specifically, the consequences of the adjustment policies are examined in terms of allocation of resources, household income, distribution of income and extent of poverty. Incorporation of a disaggregated financial sector and its linkages with the supply side of the economy and with major institutions would produce different implications on the above mentioned indicators. This will also help to understand the causality of the impacts on household income distribution, flow-of-funds, and the poverty level of the household groups. The incorporation of financial SAM with important financial instruments e.g. interest rate, bank rate, and credit control will broaden the scope of the analysis of financial sectors along with the reforms adopted in the real sector of the economy. The analysis of the implications of the financial sector reforms also appears to be pertinent in view of the present emphasis to liberalise financial markets.

The CGE model would be expended to incorporate characteristics of the financial sectors. The financial SAM would provide the data-base for the financial CGE model. The introduction of financial markets along with different financial assets, e.g., currency, and interest-bearing deposits on loans, would provide alternative stores of wealth to the wealth holders. The primary participants in the financial sector would include firms, households, the central bank, the banking system, and other financial institutions. Incorporation of these financial assets would expand the scope of the model by additional markets, e.g., for currency and credit. The behaviour of the suppliers and demanders in each of these markets will be specified considering the equilibrium conditions of the financial markets (the balance sheets of the actors involved in the sector would provide the conditions of equilibrium). More specifically, the behaviour of the *households* through their preferences for transaction demand and liquidity preference may be incorporated. The role of the central bank may be specified in terms of (i) financing of government debt, (ii) accommodating increase in foreign reserves, and (iii) responding to changes in money supply, required reserved of the banking sector, and foreign and domestic borrowing. The behaviour of the banking sector may be specified through their operation as financial intermediary between the savers and the borrowers. The other financial sector may provide alternative sources of financing in addition to the banking sector. The behaviour of the firms may be taken as demands for loanable funds for two distinct purposes: (i) to finance the acquisition of new capital stock when the purchase price exceeds the firm's retained profits, and (ii) to finance fraction of the advanced purchase of working capital in the production process. This latter motive reflects the fact that a substantial portion of the credit available from capital market is devoted not to finance capital accumulation but instead to finance the production process. Van Wijnberger (1982) and Taylor (1983) incorporate the cost of working capital finance in empirical models applied to the less developed countries.

Finally, assets markets equilibrium conditions will be specified. In the credit market, the equilibrium condition is that total assets equal the liabilities of the banking sector and the other financial sector. Equilibrium in the currency market requires the equality between supply of and demand for currency.

Dynamic Extension of the CGE Model

While the current framework of the CGE model has been useful to evaluate the consequences of tax and tariff policies, the integration of several dynamic features into the model would make it more suitable to analyse the poverty consequences of macro policies. Such dynamic aspects, following Mann (1977) and Fullerton (1983), are likely to include imperfect mobility of capital and other long term dynamic issues, involving generations (Goulder, 1985). The existence of overlapping generations, in different stages of their life cycles and with different resources and constraints, is a key aspect in many long term policy issues and would prove useful to evaluate the efficiency and sustainability of alternative poverty reduction programmes of the government. This would also help to set a target to reach the members of the poor groups in the future considering the first and second round effects. For the planners, this could help to validate the programmes using simulation results.

Within the state-of the-art of dynamic CGE modelling, possible options would be explored to incorporate the relevant aspects. This may involve updating of exogenous variables such as population growth, productivity gains, international prices, and stocks of assets. Some mechanisms for incorporating total factor productivity growth in each sector and the impact of expectations may also be explored.

A Macro Econometric Model to Supplement the CGE Framework

Like CGE models, macro econometric models have also been widely used for simulation and forecasting purposes. A macro econometric model specifies the structural aspects of the economy through behavioural equations and establishes the linkages among these equations. It uses time-series information as the data-base. The model tends to be aggregated and the relationships are validated through formal statistical tests. The proposed macro econometric model will be used to generate (annual/half-yearly) forecasts on major macro-aggregates and to simulate impacts of various government policies (especially demand driven policies). The model will supplement the present CGE model in providing the required information to the policy makers. The specification of the model may include, among others, the following equations: demand for money, imports, exports, inflation, real output, capacity output, money supply, balance of payments, domestic credit to the public sector, and expected inflation.

Estimates of Elasticity, Market Structure Variables and Benefit Pattern of Public Expenditure

It is envisaged that the results of the CGE models are sensitive to elasticity values. In the present version of the model, most of the elasticity values are taken from other studies with appropriate adjustments. At this point it may be pertinent to undertake studies to generate consistent estimates for such elasticity values. Some of the elasticity values involve export demand elasticity, substitution elasticity between imports and domestic goods, substitution elasticity between labour factors and others. It may also be important to undertake studies to estimate market structure variables such as marginal costs, and minimum efficient scale. A study may be undertaken to estimate the benefit patterns of public expenditure programmes in Bangladesh. These information may then be used in the model to examine the incidence of public expenditure programme in the event of changes in sectoral prices, government revenue constraint, and changes in government subsidy policy. The public expenditure incidence may then be added with indirect tax incidence to analyse overall fiscal incidence.

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APPENDIX: A1: A General Equilibrium Model of Bangladesh Economy (The Core Model)

The Model Structure

Production and Supply

The production structure is represented by a set of nested functions. Domestic output is a Cobb-Douglas function of value added and composite intermediate inputs. The production technology is described by the following equation:

$$X_i = AX_i \prod_i V_i^{\lambda_i} \cdot IN_i^{(1-\lambda_i)} \qquad (1.1)$$

where, X_i is sectoral output. AX_i and λ_i are the production function shift and share parameters respectively. V_i is sectoral value added and IN_i is aggregation index of intermediate inputs. The composite intermediate input demand function is derived from the first order condition of equation (1.1);

$$IN_i = V_i \cdot [\frac{PV_i \cdot (1-\lambda_i)}{PN_i \cdot \lambda_i}] \qquad (1.2)$$

where, PV_i and PN_i are the value added and composite intermediate input prices respectively.

The value added is a CES aggregate of nine factor inputs which includes capital and eight different categories of labour inputs. The value added function is therefore specified as;

$$V_i = AV_i \cdot [\sum_f \alpha_{if} \cdot FD_{if}^{-\mu_i}]^{\frac{-1}{\mu_i}} \qquad (1.3)$$

where, AV_i and α_{if} are value added function shift and share parameters respectively. μ_i denotes the elasticities of substitution between factors. FD_{if} shows sectoral factors. By profit maximisation with respect to (1.3), the factor demand function is derived as:

$$FD_{if} = V_i \cdot [\frac{\alpha_{if} \cdot PV_i}{AV_i^{\mu_i} \cdot W_f \cdot \nu_{if}}]^{\frac{1}{1+\mu_i}} \qquad (1.4)$$

where, W_f is the average return of factor f and ν_{if} is a sector-specific parameter derived from base year data which captures the fact that in a developing economy factor returns generally differ across sectors.

Prices

Domestic price of imports

On the import side we retain the price-taker small-country assumption of classical trade theory. This implies that the domestic price of import, PM_i is determined exogenously and is linked to the world price in dollars, $\overline{PWM_i}$ by:

$$PM_i = \overline{PWM_i} \cdot ER \cdot (1 + tm_i + st_i) \qquad (1.5)$$

where tm_i and st_i are the tariff and sales tax rates on sector i and ER is the nominal exchange rate between US dollars and Bangladesh currency, taka.

Domestic price of exports

On the export side, Bangladesh is assumed to have some market power. In such a situation both the domestic price of exports and the world price of Bangladeshi exports are endogenous. The domestic price of exports is defined as a function of world price of exports PWE_i, and the nominal exchange rate, ER:

$$PE_i = PWE_i \cdot ER \qquad (1.6)$$

The world prices of Bangladeshi exports are determined by domestic production costs of exports, and the exchange rate policy.

Composite price

The composite or unit price is defined by the following equation:

$$P_i = \frac{PD_i \cdot D_i + PM_i \cdot M_i}{Q_i} \qquad (1.7)$$

where, D_i and M_i are the domestic and imported goods respectively. PD_i is the price of domestic goods.

Sales or Activity prices

The sales or activity price is composed of domestic price of domestic sales and domestic price of exports activities;

$$PX_i = \frac{PD_i \cdot (1 - td_i) \cdot D_i + PE_i \cdot E_i}{X_i} \qquad (1.8)$$

where, td_i is the production or excise tax on sector i.

Composite intermediate input price

The composite intermediate input price is specified by the following equation:

$$PN_i = \sum_j \boldsymbol{t}_{ji} \cdot P_j \tag{1.9}$$

where, $\boldsymbol{t}_{ij}$ are the input-output coefficients.

Value-added price

The value-added price is defined as:

$$PV_i = \frac{PX_i \cdot X_i - PN_i \cdot IN_i}{V_i} \tag{1.10}$$

Composite capital good price

The composite capital good price is defined as:

$$PK_i = \sum_j \boldsymbol{k}_{ji} \cdot P_j \tag{1.11}$$

where, $\boldsymbol{k}_{ij}$ is a capital composition matrix.

Imports and Exports

Imports

In this model the Armington specification is adopted because the perfect substitution assumption seems unrealistic for two reasons. First, in Bangladesh there are quality differences between imports and domestic substitutes for most products. Second, at a high level of aggregation in the model, each sector represents a bundle of different goods. For example the machinery sector includes goods which are produced in Bangladesh (i.e. machine tools) and others (i.e. heavy machinery) which are not domestically produced. It is therefore reasonable to suggest that these two goods are not perfect substitutes; rather they are imperfect substitutes.

Thus for each commodity category an "aggregate" or composite commodity Q_i is defined, which is a CES function of imports M_i and domestic good D_i. Domestic consumers are assumed to have a CES utility function over these two goods:

$$Q_i = AQ_i \cdot [\boldsymbol{d}_i \cdot M_i^{-r_i} + (1-\boldsymbol{d}_i) \cdot D_i^{-r_i}]^{-1/r_i} \tag{1.12}$$

where, AQ_i and $\boldsymbol{d}_i$ are shift and share parameters respectively and $\boldsymbol{s}_i$, elasticity of substitution is given by $\boldsymbol{s}_i = \frac{1}{1+\boldsymbol{r}_i}$. This formulation implies that consumers will choose a mix of M_i and D_i depending on their relative prices. Minimising the cost of obtaining a 'unit of utility', subject to (1.12) yields the following import demand function;

$$M_i = D_i \cdot [\frac{PD_i \cdot d_i}{PM_i \cdot (1-d_i)}]^{s_i} \qquad (1.13)$$

As a result of this specification, PD_i is no longer equal to PM_i and PD_i is endogenously determined in the model.

Exports

As mentioned earlier, on the export side Bangladesh is assumed have some market power for exports. This assumption is particularly relevant for traditional exports, such as jute and jute products, where Bangladeshi exports are significant and where Bangladesh has some market power. For other sectors, Bangladesh may not have such market power. However, given such a high level sectoral aggregation it is difficult to identify sectors with and without market power. Thus, a downward sloping world demand curve for all exports is assumed. The export demand function can be shown as:

$$E_i = E_i^0 \cdot [\frac{PWE_i}{\overline{PWSE_i}}]^{h_i} \qquad (1.14)$$

where, E_i^0 is a constant, h_i is the price elasticity of export demand and $\overline{PWSE_i}$ is world price of goods which are close substitutes of Bangladeshi exports.

We postulate a constant elasticity of transformation (CET) function between domestically consumed goods D_i and exported goods E_i for total supply:

$$X_i = AT_i \cdot [g_i \cdot E_i^{f_i} + (1-g_i) \cdot D_i^{f_i}]^{1/f_i} \qquad (1.15)$$

where X_i is domestic output, AT_i and g_i are constant and the elasticity of transformation is given by $y_i = \frac{1}{1-f_i}$. Maximising revenue from given a output, subject to equation (2.15) yields the export supply function as:

$$E_i = D_i \cdot [\frac{PE_i \cdot (1-g_i)}{PD_i \cdot (1-td_i) \cdot g_i}]^{y_i} \qquad (1.16)$$

The treatment of imports and exports allows two-way trade (that is simultaneous exports and imports, known as cross-hauling) at the sectoral level, again reflecting empirical realities in developing countries. Similar reasons were put forward by Condon et al (1986) to model the foreign trade regime of Cameroon based on CES and CET specifications.

Incomes

Household Income

The household income from factors is specified as;

$$YF_h = \sum_f \Phi_{hf} \cdot Y_f \qquad (1.17)$$

where, YF_h, Φ_{hf} and Y_f define household income from factors, the factors to households allocation matrix, and income by factors, respectively. The following equation is used to calculate factor income:

$$Y_f = \prod_i W_f \cdot \nu_{if} \cdot FD_{if} \qquad (1.18)$$

Besides factor incomes, the households also receive remittances from abroad, dividend income from corporations, direct transfers from government and net transfer of resources from other households. The shares from all these sources are fixed in the benchmark level and thus relative shares do not change across experiments. Spendable income equation of household is specified as;

$$Y_h = [YF_h + \overline{RM}_h \cdot ER + \overline{DV_h} + \overline{GTR_h} + \overline{NHTR_h}] \cdot (1 - th_h - s_h) \qquad (1.19)$$

where, $\overline{RM}_h$, $\overline{DV_h}$ and $\overline{GTR_h}$ are the shares of household income from remittances, dividends and government transfers respectively. $\overline{NHTR_h}$ is the net transfer of resources among households. This is calculated as $\overline{NHTR_h} = \overline{HTR_h} - \overline{HYP}_h$, where $\overline{HTR_h}$ and $\overline{HPY_h}$ are transfer receipts and transfer payments by the same household groups. Income tax rates and savings rates for different household groups are denoted by th_h and s_h respectively.

Government Income

Government derives income from all indirect and direct taxes and part of capital income to reflect the income generated from public sector corporations. The income equation has the form:

$$\begin{aligned} YG = & \sum_h th_h \cdot Y_h + \sum_i tm_i \cdot \overline{PWM}_i \cdot M_i \cdot ER + \sum_i st_i \cdot \overline{PWM}_i \cdot M_i \cdot ER \\ & + \sum_i td_i \cdot X_i \cdot PD_i + tc \cdot YC + YFG \end{aligned} \qquad (1.20)$$

where, t_c denotes the corporate tax rate. YFG shows government income from capital. This is endogenously derived as $YFG = z_f \cdot Y_f$. Where, z_f is a scalar showing government share of income from the capital factor only.

Corporation Income

Corporations generate all their income from capital only. There are no other sources of income for the corporate institutions in the model. Corporation income is represented by the following equation:

$$YC = c_f \cdot Y_f \qquad (1.21)$$

where, c_f is a scalar showing corporation share of income from the capital factor only.

Product Demand

Consumption Demand

Total consumption demand is composed of private and government consumption. Consumption behaviour of each household is specified in the form of a representative household (for each household group), maximising a Stone-Geary utility function subject to the budget constraint of the household:

$$U_h = \prod_i (CD_{ih} - \varphi_{ih})^{\beta_{ih}} \qquad (1.22)$$

Maximisation of utility function subject to the household income yields a linear expenditure system of the form:

$$CD_{ih} = \varphi_{ih} + (\beta_{ih} / P_i) \cdot (Y_h - \sum_i \varphi_{ih} \cdot P_i) \qquad (1.23)$$

where, CD_{ih} is consumption of good i by household group h, φ_{ih} denotes floor or committed consumption of good i by household h and β_{ih} depicts the marginal budget

share of good i by household h and $Y_h - \sum_i \varphi_{ih} \cdot P_i$ denotes supernumerary income of each household .

Government Demand

The government is assumed to keep the real level of expenditure on each commodity fixed. Hence, government demand for commodity i is:

$$\overline{GD_i} = \beta_i^g \cdot \overline{GTOT} \qquad (1.24)$$

where, $\overline{GTOT}$ is total fixed government expenditure. In the application model β_i^g is zero for all sector except services, for which $\beta_i^g = 1$.

Intermediate Demand

Since the shares among different intermediate inputs in a sector and the ratios of intermediate inputs to total outputs are fixed, one can write the demand for intermediate inputs as:

$$INT_i = \sum_j \tau_{ij} \cdot IN_j \qquad (1.25)$$

where, τ_{ij} are input-output coefficients and IN_j are sectoral intermediate inputs.

Investment Demand

Total investment is always equal to savings in equilibrium. Total investment is composed of fixed capital formation only (i.e. no inventory investments as stock change is not modelled due to the lack of data). Capital investment by sector of destination is given by:

$$PK_i \cdot DK_i = x_i \cdot I \qquad (1.26)$$

where, DK_i is capital investment by sector i, PK_i is the composite price of capital installed sector i and x_i is the proportion of total capital investment accounted for by sector i. Investment by sector of destinations is then translated into demand for capital goods by sector of origin (ID_i), using a capital composition matrix k_{ij}:

$$ID_i = \sum_j k_{ij} \cdot DK_j \qquad (1.27)$$

Savings

Total savings is the sum of household, government, corporate and foreign savings. Households save a fixed proportion of their income. Following equation specify the savings behaviour of the households:

$$SH_h = s_h \cdot Y_h \qquad (1.28)$$

The government savings is the difference between the endogenous government income and exogenous government expenditure and transfers to the household groups. The government savings is thus:

$$SG = YG - \sum_i \overline{GD_i} - \sum_h \overline{GTR_h} \qquad (1.29)$$

Corporate savings is the difference between endogenous corporate income and corporate tax and dividend payment to household groups. The corporate savings is thus:

$$SC = YC - \sum_h \overline{DV_h} - tc \cdot YC \qquad (1.30)$$

The last component of aggregate savings is the foreign savings. Foreign savings is the difference between the value of imports and the value of exports, at world prices. The dollar value of foreign savings is then converted into domestic currency value using the relevant exchange rate. The aggregate or total savings is thus:

$$S = \sum_h SH_h + SG + SC + SF \cdot ER \qquad (1.31)$$

Equilibrium Conditions

Factor Market Equilibrium

The labour market is particularly simple and full employment of factors (i.e. labour and capital) is assumed. Thus, the factor market clearing requires that total factor demands equal exogenously fixed factor supplies and the equilibrating variables are the average factor prices (W_f) .

$$\sum_i FD_{if} - FS_f = 0 \tag{1.32}$$

Product Market Equilibrium

$$Q_i = INT_i + \sum_h CD_{hi} + GD_i + ID_i \tag{1.33}$$

> **Equation (1.33) is the material balance equation for each sector, requiring that total composite supply (Q) is equal to the sum of composite demands.**

Balance of Payments

We impose the balance of payment (BOP) equation to clear the foreign exchange market. The inflows are exogenous but imports and exports are determined endogenously in the model. Since nominal exchange rate is fixed in this model, foreign savings are allowed to vary to clear the foreign exchange market.

$$[\sum_i \overline{PWM_i} \cdot M_i] - [\sum_i PWE_i \cdot E_i + \sum_h \overline{RM_h} + SF] = 0 \tag{1.34}$$

Savings-Investment Balance

The final macro closure is achieved through the equality of endogenously determined aggregate savings and exogenously fixed total investment. Thus, this closure is "Savings driven", in which total investment is fixed and the saving components are endogenous:

$$I = S = \sum_h SH_h + SG + SC + SF \cdot ER \tag{1.35}$$

In the model only relative prices are determined. Thus it is necessary to normalise the price system. We make the nominal exchange rate the numeraire against which all relative prices will be determined. One can virtually normalise around any nominal magnitude because it has no effect on real variables. On the other hand, normalisation basically closes the system and allows one to solve the model for prices as a function of exogenous parameters and policy variables.

APPENDIX A2 : Competitive and Non-competitive Variants of the CGE Model

The Competitive Case

This section presents the equations of the model assuming perfect competition and constant returns to scale. The model specifications are similar to the specifications of the core model. The equations, variables and parameters of the model are presented in Box A1. The presentation is brief because the model specification is similar to that already discussed and elaborated in Appendix A1.

Box A_1 Equations of the CGE Model: Competitive Variant

Prices

2.1 $PM_i = \overline{PWM_i} \cdot ER \cdot (1 + tm_i + st_i)$

2.2 $PE_i = PWE_i \cdot ER$

2.3 $P_i = \dfrac{PD_i \cdot D_i + PM_i \cdot M_i}{Q_i}$

2.4 $PV_i = PD_i - \sum_j \tau_{ji} \cdot P_j - td_i$

2.5 $PK_i = \sum_j K_{ji} \cdot P_j$

2.6 $PX_i = \dfrac{PD_i \cdot D_i + PE_i \cdot E_i}{X_i}$

Production and Supply

2.7 $X_i = A_i \prod_l LD_{il}^{\alpha_{il}} \cdot K_i^{\alpha_{ki}}$

2.8 $W_l \cdot \nu_{il} = PV_i \cdot \alpha_{il} \dfrac{\partial X_i}{\partial LD_{il}}$

2.9 $INT_{ij} = \tau_{ji} \cdot X_j$

2.10 $R_i = PV_i \cdot \alpha_{ki} \cdot \dfrac{\partial X_i}{\partial K_i}$

Exports and Imports

2.11 $X_i = AT_i \cdot [\gamma_i \cdot E_i^{\phi_i} + (1-\gamma_i) \cdot D_i^{\phi_i}]^{1/\phi_i}$

2.12 $E_i = D_i \cdot [\dfrac{PE_i \cdot (1-\gamma_i)}{PD_i \cdot \gamma_i}]^{\psi_i}$

2.13 $E_i = E_i^0 \cdot [\dfrac{PWE_i}{PWSE_i}]^{\eta_i}$

2.14 $Q_i = AQ_i \cdot [\delta_i \cdot M_i^{-\rho_i} + (1-\delta_i) \cdot D_i^{-\rho_i}]^{-1/\rho_i}$

2.15 $M_i = D_i \cdot [\dfrac{PD_i \cdot \delta_i}{PM_i \cdot (1-\delta_i)}]^{\sigma_i}$

Incomes

2.16 $Y_l = \prod_i W_l \cdot \nu_{il} \cdot LD_{il}$

2.17 $YL_h = \sum_l \Phi_{hl} \cdot Y_l$

2.18 $Y_h = [YL_h + YK_h + \overline{RM_h} \cdot ER + \overline{DV_h} + \overline{GTR_h} + \overline{NHTR_h}] \cdot (1 - th_h - s_h)$

2.19 $YKG = \zeta_k \cdot Y_k.$

2.20 $Y_k = \sum_i R_i \cdot K_i$

2.21 $YK_h = \Phi_{hk} \cdot Y_k$

2.22 $YG = \sum_h th_h \cdot Y_h + \sum_i td_i \cdot X_i \cdot PX_i + tc \cdot YC + \sum_i tm_i \cdot \overline{PWM_i} \cdot M_i \cdot ER + \sum_i st_i \cdot \overline{PWM_i} \cdot M_i \cdot ER + YKG$

2.23 $YC = \chi_k \cdot Y_k$

Final Demand

2.24 $CD_{ih} = \varphi_{ih} + (\beta_{ih}/P_i) \cdot (Y_h - \sum_{i=1}^{14} \varphi_{ih} \cdot P_i)$

2.25 $INT_i = \sum_j INT_{ij}$

2.26 $PK_i \cdot DK_i = \xi_i \cdot I$

2.27 $\overline{GD_i} = \beta_i^g \cdot \overline{GTOT}$

2.28 $ID_i = \sum_j \kappa_{ij} \cdot DK_j$

Savings

2.29 $SH_h = s_h \cdot Y_h$

2.30 $SC = YC - \sum_h \overline{DV_h} - t_c \cdot YC$

2.31 $SG = YG - \sum_i \overline{GD_i} - \sum_h \overline{GTR_h}$

2.32 $S = \sum_h SH_h + SG + SC + SF \cdot \overline{ER}$

Equilibrium Conditions

2.33 $\sum_i LD_{il} = LS_l$

2.34 $Q_i = INT_i + \sum_h CD_{ih} + GD_i + ID_i$

2.35 $\sum_i K_i = KS$

2.36 $\sum_i \overline{PWM_i} \cdot M_i = \sum_i PWE_i \cdot E_i + \sum_h \overline{RM_h} + SF$

2.37 $I = S = \sum_h SH_h + SG + SC + FS \cdot \overline{ER}$

Box A$_2$: Variables and Parameters of the CGE Model

Variables

CD_{hi}	Household demand for good i	R_i	Returns to capital in sector i
D_i	Domestic sales of domestic output	$\overline{RM_h}$	Remittances
DK_i	Investment by sector of destinations	S	Total savings
$\overline{DV_h}$	Dividend payments to households	SH_h	Household savings
E_i	Exports from sector i.	SG	Government savings
ER	Nominal exchange rate.	SC	Corporate savings
$\overline{GD_i}$	Government final demand	SF	Foreign savings
$\overline{GTR_h}$	Government transfers to households	Q_i	Composite goods supply
I	Investment	$\overline{NHTR_h}$	Net transfers among households
ID_i	Final demand for investment goods	W_l	Average wage of labour category l
INT_i	Intermediate demand	X_i	Domestic output,
K_i	Capital demand	YC	Corporation income
LD_{il}	Labour demand	Y_l	Labour income
M_i	Imports	Y_k	Capital income
PD_i	Domestic sales price	YL_h	Household income from labour
PE_i	Domestic price of exports	YK_h	Household income from capital
PK_i	Composite price of capital	YKG	Government income from capital
PM_i	Domestic price of imports	YG	Government income
PWE_i	World price of exports	Y_h	Household income

Parameters

A_i	Production function shift parameter	Φ_{hk}	Capital to household matrix
a_{il}	Share parameters for labour	z_f	Government income from capital
a_k	Share parameters for capital	c_f	Corporation income from capital
v_{il}	Sector-specific parameter	b_i^g	Government expenditure shares
t_{ij}	Input-output coefficients.	b_{hi}	Household expenditure shares
tm_i	Tariff rates on imports	x_i	Investment destination shares
st_i	Sales tax rates on imports	k_{ij}:	Capital composition matrix
td_i	Indirect tax rates	t_c	Corporate tax rate
AQ_i	CES function share parameter	th_h	Household income tax rate
d_i	CES function shift parameter	s_h	Household savings rate
s_i	Elasticity of substitution.	$\overline{GTOT}$	Real government expenditure

AT_i	CET function shift parameters	E_i^0	Export demand shift parameter
g_i	CET function share parameters	h_i	Price elasticity of export demand
y_i	Elasticity of transformation	$\overline{PWM_i}$	World price of imports
Φ_{hl}	Labour to household matrix	$\overline{PWSE_i}$	World price of export substitutes

Model Variant with Non-Competitive Behaviour The specification of various market structure variables involves the estimation of marginal costs, the number of firms in each industry, the excess profit condition and the market demand elasticity for the domestic goods. This information is essential in order to simulate the effects of trade liberalisation in Bangladesh in the presence of non-competitive structure. Since econometric estimates of market structure variables such as marginal cost and the market demand elasticities are not available for the manufacturing sectors in Bangladesh, a calibration procedure is used to estimate them.

The marginal cost is derived from the solution of the minimisation of total cost subject to a given output level . For sector i this yields:

$$MC_i = \frac{1}{A_i}\prod_{l=1}^{7}(v_{il}\cdot W_l / a_{li})^{a_{li}} \cdot (R_i / a_{ki})^{a_{ki}} + \sum_j t_{ji}\cdot P_j \qquad (2.38)$$

The market demand elasticity for the domestic goods is calculated, using the information from the Armington specification. The calculated market demand elasticity takes the following form:

$$e_i = -s_i + (1-s_i)\cdot \frac{d_i^{s_i}\cdot PD_i^{(1-s_i)}}{(1-d_i)^{s_i}\cdot PM_i^{(1-s_i)} + d_i^{s_i}\cdot PD_i^{(1-s_i)}} \qquad (2.39)$$

The inverse relationship between market demand elasticity and the relative price of imports is depicted by the following equation:

$$\frac{\P e_i}{\P \frac{PM_i}{PD_i}} = (1-s_i)\cdot \frac{-(1-s_i)\cdot(1-d_i/d_i)^{s_i}\cdot(PM_i/PD_i)^{-s_i}}{\left[(1-d_i/d_i)^{s_i}\cdot(PM_i/PD_i)^{1-s_i}+1\right]^2} < 0 \qquad (2.39a)$$

Contrary to this elasticity specification, in some models (e.g. Cox-Harris, 1985 and Gunasekera and Tyres, 1988) the firms perceived demand elasticity is assumed constant in the short-run. The elasticity of aggregate sectoral demand is also endogenous in de Melo and Holst (1990).

The number of domestic firms is endogenous in this model. The Lerner symmetry condition is used to derive the number of domestic firms. The Lerner condition states that:

$$\frac{PD_i\cdot(1-td_i)-MC_i}{PD_i\cdot(1-td_i)} = \frac{-1}{N_i\cdot e_i} \qquad (2.40)$$

Further manipulation of equation (2.40) yields the number of domestic firms:

$$N_i = \frac{PD_i \cdot (1-td_i)}{\varepsilon_i \cdot [PD_i \cdot (1-td_i) - MC_i]} \tag{2.41}$$

For export sales, the Lerner symmetry condition takes the following form:

$$\frac{PE_i \cdot (1-td_i) - MC_i}{PE_i \cdot (1-td_i)} = \frac{-1}{N_i \cdot \eta_i} \tag{2.42}$$

where, η_i is the price elasticity of export demand. The export demand elasticities are exogenous and are different from the endogenously determined market demand elasticities. It is observed that the right hand side and the left hand side of equation 2.42 are conceptually different because the number of firms is already derived, and export demand elasticities are exogenous. However, the two sides of the above equation should be equal and the equality between two sides is not attained unless either η_i or PE_i are allowed to adjust. To satisfy the equality condition PE_i is allowed to adjust while keeping η_i constant. In this case PE_i will be marginally less than unity. Alternatively, export demand elasticities, η_is may be allowed to adjust setting PE_i equal to unity. In this case, η_i would always be equal to ε_i and therefore the developments in the domestic economy would directly influence the world market which appears to be a highly unrealistic assumption.

The level of excess profits is an important dimension of imperfect competition. The level of excess profits is defined to be those profits above the normal amount necessary to keep entrepreneurial resources committed (Richardson, 1989). The excess profit function for the non-competitive sector i is specified as;

$$\pi_i = [PX_i \cdot (1-td_i) - AC_i] \cdot (N_i \cdot XF_i) \tag{2.43}$$

where, XF_i is the output per firm. No information is available regarding the amount of excess profits in the non-competitive sectors. In previous studies, part of the return from capital has been treated as pure or excess profits. To generate amount of excess profits, sectoral rental rates of capital (R_i) observed in the SAM are reduced by 30 percent across all sectors, so that the total excess profits amount to 15 percent of total corporate capital income. This implies that in the non-competitive variant the sectoral rental rates (R_i) are different for each of the production sectors but are less than the sectoral rental rates observed in the SAM data base. Therefore, in the non-competitive sectors any excess of revenues over wage, capital and intermediate costs is treated as excess profits. While in the competitive sector, this excess revenue is denoted as if it is a return to specific factors, although no sector-specific factor is used in the model.

It is relevant to note that, de Melo and Holst (1990) also used the information of observed price-cost margin to specify an excess profit rate of 10 percent in their model for Korea. On the other hand Devarajan and Rodrik (1991) assumed a uniform five percent rental rate for capital for all sectors to generate amount of excess profits.

The first order conditions (for labour and capital) for non-competitive sectors are modified to capture the effects of imperfect competition, while the first order conditions for the competitive sectors remain as before. The first order conditions for non-competitive sectors are re-specified as:

$$W_l \cdot \nu_{il} = (MC_i - \sum_j \tau_{ji} \cdot P_j) \cdot \alpha_{il} \frac{\partial X_i}{\partial LD_{il}} \tag{2.44}$$

or $W_l \cdot \nu_{il} \cdot LD_i = X_i \cdot (MC_i - \sum_j \tau_{ji} \cdot P_j) \cdot \alpha_{il}$

$$R_i = (MC_i - \sum_j \tau_{ji} \cdot P_j) \cdot \alpha_{ki} \cdot \frac{\partial X_i}{\partial K_i} \tag{2.45}$$

or $R_i \cdot K_i = X_i \cdot (MC_i - \sum_j \tau_{ji} \cdot P_j) \cdot \alpha_{ki}$

In the non-competitive variant, since the gross return to capital is now decomposed into returns to capital; excess profits; and returns to sector-specific factor, the distribution of capital income among institutions needs to be re-specified.

Equation (2.20) is re-specified to show to income from capital and profits:

$$Y_k = \sum_i (R_i \cdot K_i + \pi_i) \tag{2.46}$$

The following equation is used to derive income from sector-specific factor:

$$Y_s = \sum_i (PV_i \cdot X_i + \pi_i) - Y_k - \sum_l Y_l \quad . \tag{2.47}$$

To distribute incomes from capital and sector-specific factor among institutions, the same capital factor to institution allocation matrix is used, so that an institution's income from these factors exactly conforms to the institution's income from capital observed in the SAM data base.

Household income from capital is thus specified as:

$$YK_h = \Phi_{hk} \cdot Y_k \tag{2.48}$$

The distribution of income from the sector-specific factor is specified as:

$$YS_h = \Phi_{hs} \cdot Y_s \tag{2.49}$$

where, YS_h, Φ_{hs} and Y_s is household's income from sector-specific factors, sector-specific factor to households allocation matrix and income from specific factor respectively. Finally household disposable income equation is re-specified as:

$$Y_h = \left[YL_h + YK_h + YS_h + \overline{RM}_h \cdot ER + \overline{DV}_h + \overline{GTR}_h + \overline{NHTR}_h \right] \cdot (1 - th_h - s_h) \tag{2.50}$$

The government income equation is modified to show the income from specific factor. The modified income equation has the form:

$$YG = \sum_h th_h \cdot Y_h + \sum_i tm_i \cdot \overline{PWM}_i \cdot M_i \cdot ER + \sum_i st_i \cdot \overline{PWM}_i \cdot M_i \cdot ER \tag{2.51}$$

$$+\sum_i td_i \cdot X_i \cdot PX_i + tc \cdot YC + YKG + YSG$$

where, YSG shows government's income from sector-specific factor. This is estimated as $YSG = z_s \cdot Y_s$.

Analogously the corporation income is represented by the following modified equation:

$$YC = YKC + YSC \qquad (2.52)$$

where, YKC and YSC denote corporation's income from capital and sector-specific factor respectively. These are computed as $YKC = c_k \cdot Y_k$ and $YSC = c_s \cdot Y_s$ respectively.

The results of the calibration procedure are provided in Table A1. Table A.1 shows the calibrated values of the relevant variables. The calibration procedure generates the base year of values of domestic output, the number of domestic firms, marginal cost and the amounts of excess profits that are consistent with the assumptions and observed data for Bangladesh.

Table A.1. Calibration of Market Structure Variables

Non-competitive Sectors	*Number of firms*	*Marginal Cost (taka)*	*Industry Profits (million taka)*	*Output per Firm (million taka)*
Processed Food	88	0.833	300	380
Textiles	9	0.896	1330	1530
Chemical	25	0.869	500	550
Cement	10	0.870	1740	2050
Heavy Industry	22	0.917	560	610
Other Industries	17	0.905	690	860
Energy	27	0.750	410	650

Note: Number of firms is rounded to the nearest whole number.

Calibration with imperfect competition and increasing returns to scale

To incorporate increasing returns to scale, in most models the total cost is separated into fixed and variable cost components. The increasing returns to scale is then assumed to stem from the fixed cost part of the total cost. The problem is to ascertain the split between fixed and variable costs. In Cox-Harris type models, fixed cost is calculated using available econometric estimates of the minimum efficient scale of production and cost saving achievable (cost disadvantage ratio). It shows the decline in cost when a firm increases its output from the actual level to the efficient level. Such specification requires information on minimum efficient scale and cost disadvantage ratio. Such estimates are not available for Bangladesh nor it is possible to estimate them as the required information is not available. Furthermore the extent of fixed cost by major industry groups is also not available. In the absence of such essential information, an alternative approach (in line with Devarajan and Rodrik, 1991) has been adopted to specify increasing returns to scale based on the following assumptions.

- ♦ Like other models, increasing returns are assumed to stem from the fixed cost element of the total cost. It is also assumed that the fixed cost consists of labour and capital costs in the same proportion as in total value added.

- ♦ Scale elasticity which depicts the extent of unrealised scale economies is defined as a ratio of the average and marginal cost (i.e. $q_i = AC_i / MC_i$). A uniform scale elasticity of 10 percent is assumed for all non-competitive sectors. This implies that average cost is assumed to be 10 percent higher than the marginal cost for each non-competitive sector. This parameterizes the degree of increasing returns to scale in the benchmark equilibrium. However, the scale elasticity is only fixed initially and it varies across simulation outcomes as firm output, factor costs and input prices change.

A similar approach has also been used by de Melo and Holst (1990) and Devarajan and Rodrik (1991). There is, however, some controversy as to how important and symmetric these scale effects are within given industries. Accordingly, some models such as Harrison et al (1995) and Francois et al (1994) adopted differential scale elasticity values for different sectors. In Harrison et al, the elasticity values ranged from 3 percent for food-beverage-tobacco products to 13 percent for processed rice. In Francois et al where the values are 'best guessed', the range is between 5 percent to 15 percent.

The scale elasticity is used to calculate the fixed cost from:

$$FC_i = (AC_i - MC_i) \cdot X_i \qquad (2.53)$$

or $$FC_i = MC_i \cdot (AC_i / MC_i - 1) \cdot X_i \qquad (2.54)$$

or $$FC_i = MC_i \cdot (\theta_i - 1) \cdot X_i \qquad (2.55)$$

where, FC_i denotes total fixed cost in sector i.

Given FC_i, the fixed amount of labour and capital inputs can then be estimated as:

$$\overline{LD}_{il} = \frac{\alpha_{il} \cdot FC_i}{W_l \cdot \nu_{il}} \qquad (2.56)$$

$$\overline{K}_i = \frac{\alpha_{ki} \cdot FC_i}{R_i} \qquad (2.57)$$

The production function is modified to incorporate the fixed amount of labour and capital inputs. The modified production function takes the following form:

$$X_i = A_i \prod_l (LD_{il} - \overline{LD}_{il})^{\alpha_{il}} \cdot (K_i - \overline{K}_i)^{\alpha_{ki}} \qquad (2.7^*)$$

The first order conditions (for labour and capital) for non-competitive sectors are also modified, while the first order conditions for the competitive sectors remain unchanged. The first order conditions for non-competitive sectors are specified as:

$$W_l \cdot \nu_{il} = (MC_i - \sum_j \tau_{ji} \cdot P_j) \cdot \alpha_{il} \frac{\partial X_i}{\partial LD_{il}} \quad \text{where } LD_{il} = (LD_{il} - \overline{LD}_{il}) \qquad (2.44^*)$$

or $$W_l \cdot \nu_{il} \cdot (LD_i - \overline{LD}_{il}) = X_i \cdot (MC_i - \sum_j \tau_{ji} \cdot P_j) \cdot \alpha_{il}$$

$$R_i = (MC_i - \sum_j \tau_{ji} \cdot P_j) \cdot \alpha_{ki} \cdot \frac{\partial X_i}{\partial K_i} \quad \text{where } K_i = (K_i - \overline{K}_i) \qquad (2.45^*)$$

or $R_i \cdot (K_i - \overline{K}_i) = X_i \cdot (MC_i - \sum_j t_{ji} \cdot P_j) \cdot a_{ki}$

The calibration results with increasing returns to scale are presented in Table A2. The calibration procedure generates the base year of value of domestic output, the number of domestic firms, marginal cost, and the amounts of excess profits that are consistent with the assumptions and observed data for Bangladesh. Notice that the numbers of firms are significantly smaller in this case since marginal costs are lower in the presence of fixed cost.

Table A2. Calibration Results with Increasing Returns to Scale

Non-competitive Sectors	*Number of firms*	*Marginal Cost (taka)*	*Industry Profits (million taka)*	*Output per Firm (million taka)*
Processed Food	9	0.767	300	3710
Textiles	5	0.814	1330	2860
Chemical	8	0.812	500	1720
Cement	6	0.808	1740	3420
Heavy Industry	6	0.833	560	2380
Other Industries	8	0.830	690	1830
Energy	7	0.698	400	2510

Note: Number of firms is rounded to the nearest whole number.

Appendix A3: Table A3 : Results of Trade Liberalization Under Imperfect Competition and Constant Returns to Scale

(Percentage Changes)

	Producer Price				*Marginal Cost*			*Profit*	*Number of Firms*		*Scale Elasticity*
Sectors	*Exp. I*	*Exp. II*	*Exp. III*	*Exp. IV*	*Exp-II*	*Exp-III*	*Exp-IV*	*Exp-II*	*Exp-III*	*Exp-IV*	*Exp-IV*
Food Crops	-0.63	0.01	-0.01	1.68	-	-	-	-	-	-	-
Cash Crops	-0.59	0.36	0.63	1.60	-	-	-	-	-	-	-
Forestry	-1.34	2.45	4.07	11.47	-	-	-	-	-	-	-
Processed Food	0.95	-1.60	-2.34	-4.24	-3.51	-4.35	-2.33	-9.40	-1.60	-3.25	-1.00
Textile	-2.49	-1.16	-1.48	-0.77	-1.62	-1.97	0.96	-0.15	2.50	3.45	-1.10
Export Oriented	-2.16	-1.17	-1.26	-2.31	-	-	-	-	-	-	-
Chemical	-1.17	-1.66	-4.82	-2.27	-2.66	-6.02	-1.21	-3.62	-1.52	-2.23	-1.00
Cement	-2.05	-2.72	-2.03	-10.04	-1.87	-1.72	-6.92	-6.45	-1.20	-3.75	-1.80
Heavy Industry	-1.41	-3.10	-4.23	-7.05	-3.31	-4.60	-4.51	-5.11	-3.45	-5.96	-1.70
Other Industries	-1.77	-2.44	-5.01	-4.86	-3.00	-5.68	-3.22	-2.29	-1.53	-2.25	-1.10
Construction	-3.27	1.17	1.35	1.70	-	-	-	-	-	-	-
Energy	2.25	-3.27	-5.85	-14.56	-4.88	-4.98	-6.99	-12.81	-3.21	-4.26	-1.30
Services	0.97	-1.60	-1.86	-0.32	-	-	-	-	-	-	-
Trade and Transport	-2.11	-7.62	-8.50	-6.73	-	-	-	-	-	-	-

Appendix A4: Estimates of Food and Income Elasticity

Table A4: Food Demand Elasticity Estimates for Professional Group

	Rice	*Wheat*	*Fish*	*Pulses*	*Beef*	*Mutton*	*Poultry*	*Fruits*	*Vegetables*	*Potato*	*Edible oil*	*Sugar*	*Gur*	*Milk*	*other food*	*Non-food*	*Income*
Rice	-0.48870	1.28522	0.01774	0.14936	-0.60960	0.05689	-0.01166	0.00580	0.01566	-0.16346	0.00338	0.00129	0.00011	0.00130	0.00098	0.00821	-0.14340
Wheat	0.11021	-1.48604	-0.23593	-0.53716	-0.04660	-0.00487	-0.01509	-0.05199	-0.15021	-0.18832	-1.02923	-0.60469	-0.77475	-0.13496	-0.00518	-0.28039	-0.59951
Fish	0.01049	1.27870	-0.91245	-0.03094	0.01018	0.00814	0.00938	0.01519	0.03062	-0.11532	-0.09155	-0.04838	-0.07049	0.01871	0.01413	0.03435	1.98373
Pulses	0.06383	0.06791	0.03147	-1.38880	-0.19923	-0.19605	-0.19773	-0.20452	-0.22413	-0.04314	-0.09070	-0.13641	0.00550	-0.21086	-0.20327	-0.15982	1.33202
Beef	-0.00185	-0.01089	0.06375	0.04110	-1.01897	-0.04070	-0.04029	-0.05617	-0.06902	-0.12958	-0.01794	-0.03139	-0.03260	-0.04122	-0.04246	-0.00633	2.08836
Mutton	0.00039	-0.00063	0.01040	-0.00023	0.01144	-1.04643	-0.05719	-0.05364	-0.00599	0.00220	-0.02515	-0.03762	-0.02951	-0.05776	-0.05790	-0.04364	2.12749
Poultry	-0.00142	0.00065	-0.03218	-0.02226	-0.03164	0.03159	-1.02933	0.00976	0.00753	-0.00210	-0.00481	-0.00728	-0.00568	-0.01040	-0.01152	-0.00613	2.12162
Fruits	0.00571	-0.00797	-0.01647	0.02759	0.02526	0.02650	-0.00134	-1.28143	-0.00274	0.00611	-0.00031	-0.00036	-0.00007	-0.00165	-0.00048	-0.00371	1.52888
Vegetbles	-0.04776	0.03227	0.15869	0.14417	0.08879	0.06893	0.00631	0.02936	-1.16772	-0.03826	0.00171	0.00201	0.00017	0.00975	0.00285	0.02231	0.92145
Potato	0.06323	-0.00970	-0.00946	0.04997	0.00076	-0.00109	-0.00280	-0.01056	-0.03111	-1.91698	-0.00920	-0.01100	-0.00341	-0.04733	-0.01391	-0.10428	1.60620
Edible oil	0.14816	0.02135	0.04029	0.02683	0.03429	0.03223	0.00079	0.00369	0.01023	-0.02072	-1.64815	0.00389	-0.00022	0.02014	0.00586	0.04703	0.81253
Sugar	0.04593	0.00109	0.01786	0.01852	0.02250	-0.00070	-0.00062	-0.00251	-0.00724	0.01773	-0.00084	-1.45133	-0.00030	-0.00595	-0.00175	-0.01313	1.22592
Gur	0.01077	0.00224	0.00585	0.00469	0.00429	0.00378	0.00017	0.00081	0.00224	-0.00451	0.00024	0.00030	-1.64120	0.00452	0.00132	0.01034	0.84012
Milk	0.01047	-0.01155	0.05625	0.05887	0.07085	0.07352	0.00188	-0.00776	-0.02220	0.05315	-0.00244	-0.00287	-0.00032	-1.11203	-0.00038	-0.00287	1.86099
oth food	-0.00524	0.00178	0.00357	0.02906	0.03796	0.03723	-0.00049	0.00220	0.00617	-0.01331	0.00069	0.00082	0.00019	0.00368	-1.42050	0.03128	2.07219
Nonfood	0.00022	-0.04370	0.37857	-0.54659	0.44582	0.46488	0.00581	-0.02570	-0.07201	0.15523	-0.00803	0.00957	-0.00225	-0.04292	-0.01261	-0.40208	1.36533

Table A5: Food Demand Elasticity Estimates for Services Group

	Rice	*Wheat*	*Fish*	*Pulses*	*Beef*	*Mutton*	*Poultry*	*Fruits*	*Vegetables*	*Potato*	*Edible oil*	*Sugar*	*Gur*	*Milk*	*other food*	*Non-food*	*Income*
Rice	-0.14328	0.70006	0.00019	0.00498	-0.59477	0.01714	-0.00363	0.00098	0.02200	-0.07564	-0.00017	-0.00009	-0.00260	0.00047	0.00010	0.00177	-0.05817
Wheat	0.02145	-0.79434	-0.25568	-0.64060	-0.14206	-0.11969	-0.12022	0.00147	0.23585	-0.17919	-0.90642	-0.58702	-0.00022	-0.10870	-0.07308	-0.20915	-0.13912
Fish	0.07196	0.00113	-1.01965	-0.01537	-0.00124	-0.00194	-0.00164	0.00399	0.07177	-0.02922	-0.02365	-0.01451	-0.61986	0.00214	0.00013	0.01074	1.37333
Pulses	0.03642	0.01881	-0.00081	-1.09793	-0.04833	-0.04783	-0.04836	-0.06676	-0.37442	-0.02098	0.02042	-0.00798	-0.13588	-0.05902	-0.05346	-0.04250	0.32777
Beef	0.01549	0.00294	0.01747	0.00407	-1.01375	-0.00362	-0.00384	-0.02225	-0.15395	-0.02765	0.03717	0.01902	0.96751	-0.01332	-0.00741	0.00360	1.54269
Mutton	0.00107	0.00086	0.00305	-0.00001	0.00351	-1.01515	-0.01722	-0.01920	-0.01063	-0.00349	0.00246	-0.00522	0.57183	-0.01795	-0.01836	-0.01373	1.59856
Poultry	0.00582	-0.00187	0.00714	0.00183	0.00755	0.00765	-1.01428	-0.00356	-0.01281	-0.00069	0.00048	-0.00107	0.12335	-0.00333	-0.00380	-0.00193	1.59267
Fruits	-0.01268	0.01177	0.00616	0.00925	0.00695	0.00693	-0.00020	-1.20194	-0.00366	0.00163	0.00001	-0.00002	0.00208	-0.00023	-0.00006	-0.00098	1.25611
Vegetables	-0.02660	-0.09951	0.23431	0.34515	0.15942	0.13293	0.00164	0.00895	-1.34762	-0.01004	-0.00010	0.00008	-0.01425	0.00141	0.00038	0.00596	3.58510
Potato	-0.00936	0.03104	0.00265	0.01066	0.00365	0.00253	-0.00052	-0.00236	-0.05604	-1.57073	-0.00070	-0.00175	0.05010	-0.01231	-0.00309	-0.04744	1.97298
Edible oil	0.09845	-0.00515	-0.00698	-0.04879	-0.00275	-0.00294	0.00014	0.00075	0.01560	-0.00660	-1.11333	0.00025	-0.03541	0.00357	0.00096	0.01534	0.12629
Sugar	0.01309	0.00385	0.00027	-0.00709	0.00172	-0.00017	-0.00006	-0.00026	-0.00616	0.00284	-0.00003	-1.05484	0.01566	-0.00100	-0.00028	-0.00396	0.47852
Gur	0.04513	-0.00218	0.00066	-0.02426	-0.01361	-0.01454	0.00006	0.00037	0.00721	-0.00283	-0.00015	-0.00004	-3.85367	0.00040	0.00010	0.00170	1.14050
Milk	-0.01294	0.01716	0.01047	0.01101	0.01225	0.01237	-0.00029	-0.00137	-0.03179	0.01450	0.00012	-0.00013	0.02016	-1.16009	-0.00013	-0.00175	1.27355
oth food	0.00595	-0.00350	0.00043	0.00402	0.00921	0.00920	0.00006	0.00029	0.00663	-0.00294	-0.00001	0.00004	-0.00351	0.00043	-1.07139	0.00861	1.64133
Non-food	0.15792	0.09077	0.56043	-0.46055	0.64387	0.67090	-0.00153	-0.00766	-0.16652	0.07147	0.00061	-0.00077	0.09245	-0.01081	-0.00287	-0.20100	1.05043

Table A6: Food Demand Elasticity Estimates for Large Farmers

	Rice	*Wheat*	*Fish*	*Pulses*	*Beef*	*Mutton*	*Poultry*	*Fruits*	*Vegetables*	*Potato*	*Edible oil*	*Sugar*	*Gur*	*Milk*	*other food*	*Non-food*	*Income*
Rice	-0.20366	0.82481	0.00241	0.03150	-0.55388	0.01172	-0.00268	0.00055	0.00596	-0.09545	0.00075	0.00007	0.00002	0.00046	0.00012	-0.00218	-0.05369
Wheat	0.03856	-0.79968	-0.18192	-0.52108	-0.05626	-0.03111	-0.03814	-0.07205	-0.31368	-0.11730	-0.59833	-0.38318	-0.66091	-0.10219	-0.02129	0.20481	-0.27253
Fish	0.01754	0.17379	-1.00061	-0.01258	0.00099	0.00096	0.00111	0.00130	0.01344	-0.03189	-0.01647	-0.00999	-0.01902	0.00212	0.00217	-0.01257	1.67776
Pulses	0.03381	0.02125	-0.00785	-1.07954	-0.05501	-0.05433	-0.05488	-0.07240	-0.17101	-0.04299	-0.02102	-0.03533	0.00144	-0.06391	-0.06065	0.04656	0.72295
Beef	0.00134	-0.00040	0.01178	0.00618	-1.01963	-0.00952	-0.00977	-0.02831	-0.07558	-0.04973	0.00291	-0.00404	-0.00255	-0.01673	-0.01457	-0.00268	1.83793
Mutton	0.00030	-0.00006	0.00237	-0.00003	0.00263	-1.01776	-0.01175	-0.01265	-0.00223	-0.00597	-0.00470	-0.00741	-0.00404	-0.01227	-0.01230	0.00921	1.90430
Poultry	0.00059	0.00016	0.00743	0.00382	0.00755	0.00763	-1.01744	-0.00248	-0.00392	-0.00051	-0.00101	-0.00163	-0.00075	-0.00251	-0.00271	0.00140	1.88415
Fruits	0.00186	-0.00093	0.00524	0.00797	0.00590	0.00548	-0.00016	-1.20019	-0.00118	0.00172	-0.00004	-0.00002	-0.00001	-0.00021	-0.00006	0.00103	1.26252
Vegetables	-0.00050	0.00993	0.12824	0.17114	0.08382	0.06448	0.00174	0.00677	-1.36740	-0.00900	0.00021	0.00011	0.00004	0.00105	0.00031	-0.00535	1.27963
Potato	0.02481	0.00254	-0.00963	0.02481	0.01027	0.00770	-0.00056	-0.00179	-0.02094	-1.33721	-0.00256	-0.00147	-0.00110	-0.01195	-0.00366	0.05801	1.77343
Edible oil	0.04520	-0.00230	0.00997	-0.00280	0.00978	0.00939	0.00012	0.00044	0.00462	-0.00658	-1.04110	0.00038	0.00012	0.00370	0.00109	-0.01894	0.67168
Sugar	0.00674	0.00002	-0.00277	0.00101	0.00329	-0.00006	-0.00004	-0.00013	-0.00149	0.00225	-0.00006	-1.04530	-0.00002	-0.00080	-0.00025	0.00396	1.06314
Gur	0.00990	0.00076	0.00081	0.00083	0.00180	0.00141	0.00007	0.00025	0.00266	-0.00380	0.00009	0.00005	-1.09344	0.00026	0.00008	-0.00134	0.30513
Milk	0.00450	0.00142	0.01384	0.01371	0.01565	0.01535	-0.00025	-0.00081	-0.00926	0.01391	-0.00033	-0.00017	-0.00006	-1.09985	-0.00014	0.00229	1.57652
other food	-0.00020	-0.00034	0.00053	0.00493	0.00674	0.00656	0.00006	0.00023	0.00251	-0.00363	0.00009	0.00005	0.00003	0.00044	-1.07524	-0.00828	1.79429
Non-food	-0.01321	0.01525	0.67977	-0.61538	0.76234	0.79242	-0.00162	-0.00605	-0.06210	0.08744	-0.00222	-0.00127	-0.00082	-0.01086	-0.00334	-0.13755	1.23507

Table A7: Food Demand Elasticity Estimates for Skilled Workers

	Rice	*Wheat*	*Fish*	*Pulses*	*Beef*	*Mutton*	*Poultry*	*Fruits*	*Vegetables*	*Potato*	*Edible oil*	*Sugar*	*Gur*	*Milk*	*other food*	*Non-food*	*Income*
Rice	-0.27339	0.83412	0.00288	-0.03570	-0.52768	0.01913	-0.00313	0.00093	0.00864	-0.08334	0.00081	0.00013	0.00003	0.00024	0.00015	0.00242	-0.05408
Wheat	0.06484	-0.83616	-0.15983	0.46232	-0.05402	-0.03412	-0.03012	-0.06175	-0.27211	-0.24281	-0.64116	-0.40381	-0.57926	-0.10293	-0.01727	-0.15213	-0.23684
Fish	0.02438	0.18686	-1.00605	-0.01569	0.00151	0.00084	0.00128	0.00206	0.01931	-0.04379	-0.02520	-0.01503	-0.02321	0.00034	0.00276	0.01556	1.61764
Pulses	0.03743	0.01967	0.00844	-1.08108	-0.05954	-0.05850	-0.05902	-0.07348	-0.20166	-0.04670	-0.01968	-0.03643	0.00144	-0.06741	-0.06381	-0.04920	0.81021
Beef	0.00285	-0.00050	0.01934	0.01077	-1.01421	-0.01027	-0.01025	-0.02260	-0.07066	-0.04415	0.00161	-0.00477	-0.00383	-0.01848	-0.01333	0.00081	1.76485
Mutton	0.00047	-0.00006	0.00277	-0.00003	0.00305	-1.02116	-0.01930	-0.01982	-0.00380	-0.00900	-0.00660	-0.01147	-0.00760	-0.01885	-0.01987	-0.01482	1.80090
Poultry	0.00064	0.00008	0.00667	0.00367	0.00685	0.00686	-1.01673	-0.00289	-0.00554	-0.00061	-0.00101	-0.00179	-0.00113	-0.00278	-0.00313	-0.00161	1.81699
Fruits	0.00236	-0.00095	0.00729	0.00963	0.00802	0.00799	-0.00016	-1.21186	-0.00102	0.00128	-0.00003	-0.00002	-0.00001	-0.00011	-0.00005	-0.00077	1.24789
Vegetables	0.00344	0.00721	0.14092	0.16970	0.09529	0.07988	0.00119	0.00805	-1.64459	-0.01118	0.00027	0.00020	0.00006	0.00090	0.00046	0.00663	1.54000
Potato	0.03613	-0.00121	0.01034	0.02541	0.00968	0.00853	-0.00046	-0.00255	-0.02540	-1.49545	-0.00241	-0.00191	-0.00116	-0.00791	-0.00380	-0.05115	1.01663
Edible oil	0.07126	0.00418	0.01006	-0.00146	0.00957	0.00905	0.00011	0.00068	0.00631	-0.00766	-1.05105	0.00059	0.00016	0.00263	0.00135	0.01974	0.54493
Sugar	0.01335	0.00032	0.00380	0.00183	0.00449	-0.00009	-0.00005	-0.00027	-0.00261	0.00336	-0.00009	-1.05502	-0.00003	-0.00067	-0.00034	-0.00462	0.95337
Gur	0.00955	0.00071	0.00061	0.00096	0.00174	0.00151	0.00004	0.00024	0.00224	-0.00272	0.00007	0.00005	-1.09205	0.00027	0.00014	0.00200	0.46559
Milk	0.00431	-0.00084	0.00819	0.00942	0.00912	0.00914	-0.00015	-0.00086	-0.00841	0.01085	-0.00026	-0.00020	-0.00006	-1.16527	-0.00012	-0.00164	1.29678
other food	-0.00013	0.00027	0.00060	0.00616	0.00885	0.00863	0.00006	0.00035	0.00327	-0.00402	0.00011	0.00008	0.00004	0.00035	-1.08128	0.00644	1.72682
Non-food	-0.01581	0.01622	0.66918	-0.54650	0.74621	0.76525	-0.00121	-0.00762	-0.06942	0.08248	-0.00221	-0.00175	-0.00090	-0.00755	-0.00371	-0.14732	1.17981

Table A8: Food Demand Elasticity Estimates for Semi-Skilled Workers

	Rice	*Wheat*	*Fish*	*Pulses*	*Beef*	*Mutton*	*Poultry*	*Fruits*	*Vegetables*	*Potato*	*Edible oil*	*Sugar*	*Gur*	*Milk*	*other food*	*Non-food*	*Income*
Rice	-0.28268	0.81323	0.00413	0.03922	-0.72246	0.00587	-0.00113	0.00036	0.00661	-0.10022	0.00094	0.00013	0.00002	0.00048	0.00007	0.00172	-0.06569
Wheat	0.08139	-0.83493	-0.18154	-0.46299	-0.05899	-0.02824	-0.03536	-0.07003	-0.34676	-0.23158	-0.60491	-0.38218	-0.61110	-0.12243	-0.01104	-0.18521	0.21521
Fish	0.02230	0.18666	-1.00367	-0.02062	0.00003	0.00102	0.00089	0.00079	0.03009	-0.06571	-0.03210	-0.01946	-0.03366	0.00261	0.00336	0.02320	1.65399
Pulses	0.04195	0.02374	0.01142	-1.07397	-0.06081	-0.06057	-0.06093	-0.07931	-0.19835	-0.04875	-0.02396	-0.03984	0.00157	-0.07372	-0.06534	-0.05308	0.84454
Beef	0.00092	0.00006	0.00613	0.00357	-1.03242	-0.01363	-0.01405	-0.03267	-0.07498	-0.06120	-0.00157	-0.00837	-0.00742	-0.02282	-0.01642	0.00158	1.77321
Mutton	0.00013	-0.00003	0.00100	-0.00001	0.00110	-1.01993	-0.00587	-0.00659	-0.00172	-0.00323	-0.00232	-0.00375	-0.00239	-0.00644	-0.00618	-0.00484	1.88493
Poultry	0.00030	0.00008	0.00330	0.00189	0.00327	0.00336	-1.02397	-0.00101	-0.00174	-0.00022	-0.00040	-0.00067	-0.00036	-0.00102	-0.00116	-0.00059	1.85238
Fruits	0.00176	-0.00081	0.00396	0.00571	0.00505	0.00431	-0.00006	-1.22585	-0.00071	0.00083	-0.00002	-0.00001	-0.00001	-0.00011	-0.00002	-0.00050	1.18318
Vegetables	0.00160	0.01056	0.14674	0.15981	0.10504	0.07740	0.00079	0.00503	-1.55904	-0.00788	0.00021	0.00012	0.00005	0.00105	0.00021	0.00470	1.68111
Potato	0.03173	-0.00182	0.00896	0.02363	0.01200	0.00631	-0.00027	-0.00153	-0.02913	-1.46340	-0.00285	-0.00163	-0.00086	-0.01383	-0.00272	-0.06045	1.77868
Edible oil	0.06528	0.00528	0.01322	0.00299	0.01201	0.01138	0.00007	0.00044	0.00770	-0.00901	-1.04078	0.00052	0.00020	0.00463	0.00091	0.02081	0.61087
Sugar	0.00953	0.00026	0.00349	0.00212	0.00422	-0.00007	-0.00002	-0.00013	-0.00252	0.00300	-0.00008	-1.04790	-0.00006	-0.00123	-0.00024	-0.00541	1.02597
Gur	0.00970	0.00103	0.00081	0.00159	0.00191	0.00149	0.00003	0.00017	0.00303	-0.00355	0.00010	0.00005	-1.09101	0.00040	0.00008	0.00179	0.38102
Milk	0.00678	-0.00181	0.01417	0.01535	0.01727	0.01599	-0.00014	-0.00084	-0.01578	0.01881	-0.00051	-0.00028	-0.00011	-1.14968	-0.00010	-0.00213	1.44271
other food	-0.00024	0.00023	0.00039	0.00469	0.00710	0.00713	0.00002	0.00014	0.00244	-0.00287	0.00008	0.00004	0.00002	0.00039	-1.06919	0.01123	1.85463
Non-food	-0.01697	-0.02018	0.66382	-0.58073	0.73375	0.78165	-0.00077	-0.00478	-0.08376	0.09771	-0.00273	-0.00155	-0.00076	-0.01338	-0.00265	-0.14986	1.22408

Table A9: Food Demand Elasticity Estimates for UnSkilled Workers

	Rice	*Wheat*	*Fish*	*Pulses*	*Beef*	*Mutton*	*Poultry*	*Fruits*	*Vegetables*	*Potato*	*Edible oil*	*Sugar*	*Gur*	*Milk*	*other food*	*non-food*	*Income*
Rice	-0.24795	0.86678	0.00439	0.03061	-0.54006	0.01075	-0.00379	0.00060	0.01066	-0.11552	0.00077	0.00007	0.00002	0.00010	0.00004	0.00148	-0.03640
Wheat	0.06850	-0.83146	-0.18020	-0.48377	-0.05321	-0.03368	-0.03122	-0.08950	-0.51951	-0.19682	-0.62344	-0.35847	-0.35466	-0.07970	-0.02740	-0.21576	-0.30006
Fish	0.01967	0.17046	-1.00679	-0.01619	0.00238	0.00245	0.00288	0.00161	0.03329	-0.05809	-0.02513	-0.01295	-0.01285	0.00225	0.00312	0.02307	1.67634
Pulses	0.03501	0.01880	0.00914	-1.07366	-0.05502	-0.05513	-0.05558	-0.06224	-0.20714	-0.02195	-0.01856	-0.03530	0.00081	-0.05717	-0.05829	-0.04930	0.80856
Beef	0.00132	-0.00082	0.01043	0.00545	-1.01821	-0.01141	-0.01141	-0.02414	-0.08028	-0.04363	-0.00010	-0.00631	-0.00677	-0.01535	-0.01601	0.00209	1.85985
Mutton	0.00040	-0.00007	0.00327	-0.00003	0.00368	-1.01586	-0.01083	-0.00966	-0.00289	-0.00206	-0.00359	-0.00668	-0.00669	-0.01019	0.01055	-0.00853	1.91755
Poultry	0.00054	0.00001	0.00716	0.00369	0.00754	0.00769	-1.01191	-0.00298	-0.00651	-0.00072	-0.00119	-0.00228	-0.00228	-0.00338	-0.00358	-0.00197	1.92916
Fruits	0.00195	-0.00061	0.00433	0.00593	0.00523	0.00501	-0.00013	-1.24332	-0.00141	0.00144	-0.00003	-0.00001	-0.00001	-0.00007	-0.00003	-0.00086	1.16548
Vegetables	0.01598	0.00670	0.16283	0.18848	0.10883	0.09084	0.00137	0.00789	-1.81977	-0.01115	0.00020	0.00011	0.00009	0.00053	0.00018	0.00663	1.98224
Potato	0.03250	-0.00077	0.00629	0.01922	0.00714	0.00516	-0.00049	-0.00201	-0.04005	-1.49088	-0.00260	-0.00152	-0.00142	-0.00640	-0.00257	-0.07085	1.70588
Edible oil	0.05080	0.00311	0.00959	0.00082	0.00909	0.00886	0.00009	0.00047	0.00803	-0.00793	-1.03863	0.00040	0.00034	0.00198	0.00066	0.02511	0.57453
Sugar	0.00609	0.00015	0.00281	0.00137	0.00334	-0.00004	-0.00003	-0.00011	-0.00214	0.00223	-0.00005	-1.04096	-0.00006	-0.00041	-0.00016	-0.00478	1.11360
Gur	0.00459	0.00033	0.00036	0.00136	0.00275	0.00271	0.00002	0.00011	0.00198	-0.00198	0.00004	0.00002	-1.04664	0.00011	0.00004	0.00133	1.10090
Milk	0.00204	-0.00043	0.00669	0.00540	0.00784	0.00787	-0.00009	-0.00037	-0.00714	0.00742	-0.00014	-0.00007	-0.00006	-1.09497	-0.00004	-0.00119	1.59829
other food	0.00006	0.00011	0.00034	0.00223	0.00308	0.00302	0.00003	0.00014	0.00247	-0.00246	0.00005	0.00003	0.00002	0.00012	-1.08931	0.00442	1.70253
non-food	-0.00828	-0.01780	0.65709	-0.59910	0.74924	0.77453	-0.00137	-0.00678	-0.11570	0.11419	-0.00227	-0.00128	-0.00116	-0.00591	-0.00224	-0.16537	1.24282

Table A10: Food Demand Elasticity Estimates for Small Farmers

	Rice	*Wheat*	*Fish*	*Pulses*	*Beef*	*Mutton*	*Poultry*	*Fruits*	*Vegetables*	*Potato*	*Edible oil*	*Sugar*	*Gur*	*Milk*	*other food*	*Non-food*	*Income*
Rice	-0.23019	0.87486	0.00478	0.01984	-0.10603	0.00249	-0.00216	0.00093	0.01515	-0.12033	0.00071	0.00003	0.00001	0.00033	0.00004	0.00148	-0.037
Wheat	0.06421	-0.83591	-0.17861	-0.56703	-0.01212	-0.03559	-0.03493	-0.10122	-0.64174	-0.08160	-0.58062	-0.38701	-0.60866	-0.10369	-0.02388	-0.24132	-0.249
Fish	0.01601	0.15553	-1.00690	-0.01488	0.00049	0.00195	0.00224	0.00218	0.03766	-0.04971	-0.01684	-0.01064	-0.01866	0.00277	0.00295	0.02279	1.71927
Pulses	0.03347	0.01487	0.00468	-1.09081	-0.01066	-0.05029	-0.05060	-0.05280	-0.20896	-0.00933	-0.01732	-0.02862	0.00084	-0.05080	-0.05202	-0.04540	0.60586
Beef	0.00012	-0.00026	0.00283	0.00105	-1.02180	-0.00730	-0.00736	-0.02048	-0.09160	-0.03375	0.00533	-0.00048	0.00245	-0.01144	-0.01111	0.00461	0.4016
Mutton	0.00024	-0.00004	0.00188	-0.00002	0.00045	-1.01765	-0.00251	-0.00229	-0.00362	0.00236	-0.00099	-0.00144	-0.00075	-0.00249	-0.00249	-0.00360	1.94411
Poultry	0.00038	0.00004	0.00474	0.00185	0.00106	0.00505	-1.01594	-0.00161	-0.00425	-0.00045	-0.00079	-0.00122	-0.00059	-0.00185	-0.00207	-0.00112	1.94699
Fruits	0.00247	-0.00090	0.00450	0.00714	0.00121	0.00560	-0.00013	-1.26575	-0.00119	0.00111	-0.00002	-0.00001	-0.00001	-0.00008	-0.00002	-0.00066	1.09789
Vegetables	0.01796	0.00764	0.16948	0.23608	0.02510	0.09878	0.00109	0.00900	-1.93133	-0.01433	0.00030	0.00009	0.00010	0.00104	0.00025	0.00855	1.11297
Potato	0.02193	-0.00135	0.00285	0.01185	0.00102	0.00413	-0.00029	-0.00206	-0.03483	-1.41366	-0.00283	-0.00105	-0.00143	-0.00943	-0.00247	-0.07296	0.79068
Edible oil	0.04236	0.00205	0.00918	-0.00609	0.00208	0.00977	0.00006	0.00049	0.00787	-0.00722	-1.03793	0.00021	0.00024	0.00239	0.00058	0.01974	0.71836
Sugar	0.00392	0.00003	0.00154	0.00004	0.00041	-0.00003	-0.00001	-0.00010	-0.00162	0.00153	-0.00004	-1.04232	-0.00004	-0.00054	-0.00014	-0.00433	1.06682
Gur	0.00967	0.00065	0.00072	-0.00049	0.00038	0.00160	0.00004	0.00029	0.00474	-0.00435	0.00009	0.00003	-1.08146	0.00011	0.00003	0.00092	0.44095
Milk	0.00311	-0.00074	0.00819	0.00646	0.00208	0.00994	-0.00010	-0.00073	-0.01222	0.01152	-0.00025	-0.00007	-0.00008	-1.11363	-0.00008	-0.00261	1.54336
other food	0.00000	0.00013	0.00032	0.00198	0.00072	0.00333	0.00002	0.00016	0.00266	-0.00246	0.00005	0.00002	0.00002	0.00018	-1.08194	0.00688	1.77519
Non-food	-0.00780	-0.01568	0.67590	-0.57644	0.16162	0.78506	-0.00104	-0.00774	-0.12343	0.11288	-0.00246	-0.00081	-0.00099	-0.00852	-0.00216	-0.15384	1.26932

Table A11: Food Demand Elasticity Estimates for Agricultural labourers

	Rice	*Wheat*	*Fish*	*Pulses*	*Beef*	*Mutton*	*Poultry*	*Fruits*	*Vegetables*	*Potato*	*Edible oil*	*Sugar*	*Gur*	*Milk*	*other food*	*Non-food*	*Income*
Rice	-0.25005	0.84083	0.00570	0.03797	-0.51075	-0.01297	0.00138	0.00771	0.03807	-0.17041	0.00085	0.00018	0.00006	0.00045	0.00005	0.00185	-0.07457
Wheat	0.06214	-0.84163	-0.19628	-0.50579	-0.04156	0.04821	-0.02547	-0.18306	-0.75382	0.06802	-0.53564	-0.28023	-0.58566	-0.11036	-0.01288	-0.33699	-0.22922
Fish	0.01246	0.21717	-0.97979	-0.01448	0.00192	-0.00447	0.00246	0.00803	0.03633	-0.06428	-0.01841	-0.00740	-0.02122	0.00294	0.00365	0.02961	1.87759
Pulses	0.03120	0.01630	0.01142	-1.06012	-0.06944	0.14689	-0.07039	-0.08022	-0.18060	-0.01569	-0.03218	-0.05215	0.00143	-0.07096	-0.07263	-0.06311	0.87271
Beef	0.00026	-0.00033	0.00596	0.00302	-1.01753	0.02945	-0.01405	-0.02147	-0.05636	-0.04831	-0.00612	-0.01062	-0.00890	-0.01750	-0.01564	0.00373	2.06895
Mutton	-0.00005	-0.00001	-0.00126	-0.00001	-0.00135	2.13503	-0.00620	-0.00612	-0.00152	-0.00106	-0.00272	-0.00449	-0.00219	-0.00581	-0.00629	-0.00493	1.45681
Poultry	0.00011	0.00011	0.00569	0.00286	0.00596	-0.01274	-1.01216	0.00125	0.00209	-0.00013	0.00059	0.00098	0.00045	0.00124	0.00138	0.00095	2.12382
Fruits	0.00902	-0.00471	0.02027	0.02101	0.02548	-0.05260	-0.00030	-1.18101	-0.00114	0.00128	-0.00002	-0.00003	-0.00001	-0.00008	-0.00002	-0.00077	1.66097
Vegetables	0.01050	0.01941	0.14978	0.15894	0.10291	-0.19111	0.00118	0.03038	-1.64767	-0.04257	0.00082	0.00090	0.00045	0.00282	0.00071	0.02553	1.05236
Potato	0.02386	-0.00411	0.00473	0.01554	0.00784	-0.01392	-0.00031	-0.00808	-0.03973	-1.30151	-0.00316	-0.00351	-0.00152	-0.01101	-0.00277	-0.10168	0.81313
Edible oil	0.03307	0.00243	0.01477	0.00735	0.01413	-0.02950	0.00006	0.00156	0.00765	-0.00866	-1.01972	0.00094	0.00047	0.00295	0.00074	0.02661	0.86206
Sugar	0.00965	-0.00029	0.01051	0.00591	0.01204	0.00015	-0.00004	-0.00101	-0.00497	0.00556	-0.00011	-1.02090	-0.00009	-0.00056	-0.00014	-0.00518	1.47936
Gur	0.00971	0.00121	0.00106	0.00301	0.00323	-0.00633	0.00005	0.00122	0.00603	-0.00682	0.00013	0.00014	-1.06852	0.00037	0.00009	0.00333	0.57644
Milk	0.00380	-0.00159	0.01155	0.00887	0.01392	-0.02931	-0.00010	-0.00261	-0.01284	0.01437	-0.00028	-0.00030	-0.00015	-1.08308	-0.00011	-0.00408	1.79187
other food	-0.00030	0.00029	0.00026	0.00390	0.00722	-0.01531	0.00002	0.00056	0.00274	-0.00308	0.00006	0.00006	0.00003	0.00020	-1.03089	0.00861	2.10481
Non-food	-0.00657	-0.02512	0.61632	-0.66035	0.70706	-1.52619	-0.00118	-0.03085	-0.15186	0.17147	-0.00324	-0.00358	-0.00166	-0.01121	-0.00281	-0.23231	1.36947

APPENDIX A5 : DERIVATION OF SAM MULTIPLIERS

A SAM multiplier model is an extension of the input-output type fixed price demand driven model with the addition that the SAM model takes into account the structure of factor income and its distribution across institutions along with production structure of the economy. The degree of linearity assumptions increases with the extension of input-output table into a SAM. In the SAM model, the average tax rate, savings rate, investment expenditure, the distribution of value added among factors, and the sectoral compositions of consumption are assumed to be fixed. A SAM model is very much a general equilibrium model satisfying the "Walras Law" (e.g., the excess demand is zero) along with maintaining the major macro balances and allowing a "Keynesian" closure.

To move from a SAM to a model structure requires that each account should be designated as an endogenous or exogenous account. Generally, the government, the capital, and the rest of the world accounts are treated as exogenous on the assumption that spending decisions of the government, investment decisions of the firms, exports and inflows of foreign capital are externally determined. The model thus becomes " Keynesian" as supplies are assumed to adjust to demand. The treatment of some accounts as exogenous basically closes the model.

For the purpose of derivation of SAM multipliers, the data SAM is presented schematically separating the endogenous accounts and consolidating the exogenous accounts into one aggregate.

Step 1: Schematic Presentation of SAM

	Factor	Household	Activities	Others A/C	Total
Factor	0	0	S_{13}	0	Y_1
Household	S_{21}	0	0	S_{24}	Y_2
Activities	0	S_{32}	S_{33}	S_{34}	Y_3
Others A/C	0	S_{42}	S_{43}	S_{44}	Y_4
Total	Y_1	Y_2	Y_3	Y_4	

Matrix S_{13} shows generation of value added for nine factors by eleven production sectors. S_{21} depicts the distribution of household income from factors. Matrix S_{32} reveals the expenditure patterns of household groups. S_{33} shows the interdependence among sectors i.e. the input-output transactions matrix. The remaining accounts e.g. government, corporate, rest of the world, and capital accounts are treated as exogenous and are consolidated into one account classified here as the "other" account. Rest of the accounts is called leakage. The next step is to obtain coefficient matrices A_{ij}, dividing each elements of the SAM, S_{ij} by the corresponding column total Y_j.

Step 2: Derivation of SAM Coefficient Matrix

$$A_{ij} = \frac{S_{ij}}{Y_i}$$

$$\begin{vmatrix} Y_1 \\ Y_2 \\ Y_3 \\ Y_4 \end{vmatrix} = \begin{vmatrix} 0 & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & A_{33} \\ 0 & A_{42} & A_{43} \end{vmatrix} * \begin{vmatrix} Y_1 \\ Y_2 \\ Y_3 \\ Y_4 \end{vmatrix} + \begin{vmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{vmatrix}$$

Step 3: Separation of Endogenous for Leakage

$$\begin{vmatrix} Y_1 \\ Y_2 \\ Y_3 \end{vmatrix} = \begin{vmatrix} 0 & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & A_{33} \end{vmatrix} * \begin{vmatrix} Y_1 \\ Y_2 \\ Y_3 \end{vmatrix} + \begin{vmatrix} X_1 \\ X_2 \\ X_3 \end{vmatrix}$$

and $Y_4 = A_{42}Y_2+A_{43}Y_3+X_4$

Step 4: Further Breakdown of Endogenous Accounts

$$\begin{vmatrix} Y_1 \\ Y_2 \\ Y_3 \end{vmatrix} = \begin{vmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & A_{33} \end{vmatrix} * \begin{vmatrix} Y_1 \\ Y_2 \\ Y_3 \end{vmatrix} + \begin{vmatrix} 0 & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & 0 \end{vmatrix} * \begin{vmatrix} Y_1 \\ Y_2 \\ Y_3 \end{vmatrix} + \begin{vmatrix} X_1 \\ X_2 \\ X_3 \end{vmatrix}$$

Step 5: Derivation M_1 Matrix

$$\begin{vmatrix} Y_1 \\ Y_2 \\ Y_3 \end{vmatrix} = \begin{vmatrix} I & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & (I-A_{33})^{-1} \end{vmatrix} * \begin{vmatrix} 0 & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & 0 \end{vmatrix} + \begin{vmatrix} X_1 \\ X_2 \\ X_3 \end{vmatrix}$$

First Term of the RHS is M_1 Matrix

i.e. $$\begin{vmatrix} I & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & (I-A_{33})^{-1} \end{vmatrix}$$

Step 6: Derivation of M_2 Matrix

M_2 is defined as $M_2 = (I + A^0 + A^{02})$

$$A^0 = \begin{vmatrix} 0 & 0 & A_{13}* \\ A_{21}* & 0 & 0 \\ 0 & A_{32}* & 0 \end{vmatrix}$$

Where,

$$\mathbf{A_{13}^* = A_{13},\ A_{21}^* = A_{21},\ A_{32}^* = (I-A_{33})^{-1}.\ A_{32}}$$

$$A^{02} = \begin{vmatrix} 0 & 0 & A_{13}* \\ A_{21}* & 0 & 0 \\ 0 & A_{32}* & 0 \end{vmatrix} * \begin{vmatrix} 0 & 0 & A_{13}* \\ A_{21}* & 0 & 0 \\ 0 & A_{32}* & 0 \end{vmatrix}$$

$$A^{02} = \begin{vmatrix} 0 & A_{13}* A_{32}* & 0 \\ 0 & 0 & A_{21}* A_{13}* \\ A_{32}* A_{21}* & 0 & 0 \end{vmatrix}$$

So that M_2 can be written as

$$M_2 = \begin{vmatrix} I & A_{13}* A_{32}* & A_{13}* \\ A_{21}* & I & A_{21}* A_{13}* \\ A_{32}* A_{21}* & A_{32}* & I \end{vmatrix}$$

Step 7: Derivation of M_3 Matrix

$$M_3 = (I-A^{03})^{-1}$$

Where,

$$\mathbf{A^{03} = A^{02} * A^0}$$

$$A^{03} = \begin{vmatrix} A_{13}* A_{32}* A_{21}* & 0 & 0 \\ 0 & A_{21}* A_{13}* A_{32}* & 0 \\ 0 & 0 & A_{32}* A_{21}* A_{13}* \end{vmatrix}$$

$$M_3 = \begin{vmatrix} (I-A_{11}^*)^{-1} & 0 & 0 \\ 0 & (I-A_{22}^*)^{-1} & 0 \\ 0 & 0 & (I-A_{33}^*)^{-1} \end{vmatrix}$$

Where,

$\mathbf{A_{11}^* = A_{13}^* A_{32}^* A_{21}^*}$

$\mathbf{A_{22}^* = A_{21}^* A_{13}^* A_{32}^*}$

$\mathbf{A_{33}^* = A_{32}^* A_{21}^* A_{13}^*}$

Step 8: Aggregate Multiplier

$M = M_3 . M_2 . M_1$

$= I + (M_1 - I) + (M_2 - I) . M_1 + (M_3 - I) . M_2 . M_1$

Where,

I = Initial singular matrix/ identity matrix

$(M_1 - I)$ = Transfer matrix

$(M_2 - I) . M_1$ = Open loop matrix

$(M_3 - I) . M_2 . M_1$ = Closed loop matrix

Table A12: Profiles of the Household Groups

Household Groups	*Household Size*	*Mean Income*	*No. of Households*	*% of Household*	*Estimated Poverty Line*
Professional	5.61	4543	1161926	6.37	2744
Services	5.74	3632	3030949	16.60	2810
Agricultural Labour	4.51	1667	3858512	21.13	1921
Small Farmer	5.15	2337	2255505	12.36	2193
Large Farmer	6.22	3544	4974600	27.25	2649
Skilled Workers	5.16	2935	786929	4.31	2522
Semi-Skilled Workers	5.11	2561	398146	2.18	2177
Unskilled Workers	4.88	2271	1788247	9.80	2080
All Household	**5.4**	**2902**	**18254814**	**100.00**	**2387**