ESTIMATING THE IMPACTS OF THE JAMUNA BRIDGE ON POVERTY LEVELS IN BANGLADESH USING SAM AND CGE MODELS: A COMPARATIVE STUDY

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1) INTRODUCTION

Construction of the Jamuna Bridge, now the 11th longest bridge in the world, began in October 1994 and finished in June of 1998. With the Jamuna River physically dividing Bangladesh into two halves, the Bridge was built in order to provide the first road and rail link between the relatively less-developed Northwest region of the country and the more-developed eastern half that includes the capital of Dhaka and the port of Chittagong.

By facilitating transportation across the river, the Bridge has lead to the greater integration of regional markets within the Bangladeshi national economy. Given the interdependence of economic activities/sectors, the direct impacts of the Jamuna Bridge on individual sectors (primarily transportation) and factor markets are likely to induce a chain of changes in the rest of the sectors of the economy. This in turn is expected to result in subsequent feedback effects. This paper investigates and attempts to quantify these indirect and induced impacts utilizing Computable General Equilibrium (CGE) and Social Accounting Matrix (SAM) models. Particularly, we take the results of our model simulations and feed them into poverty modules to estimate the impact of the bridge investment on national poverty levels.

In addition, it is expected that the Jamuna Bridge will have the most significant economic and poverty impacts in Rajshahi Division - the northwest region of Bangladesh (see **Figure 1-1**). Therefore, we also conducted simulations of the Bridge's impact at the regional level utilizing an input-output table for the Northwest and a restructured SAM model that takes into account region-specific households. We were unable to run similar regional simulations with our CGE model as it is currently structured. Incorporation of unemployment specifications and regional trade flows within a CGE framework would surely provide additional avenues for a more comprehensive simulation of the impact of the Bridge on economic growth, household income-consumption and, hence, on the poverty situation at the regional level.

In section two of this paper, we give a brief overview of both of the models utilized for our analysis. Section three gives greater detail on the CGE model, the assumptions that underlay our simulation of the national impact of the Jamuna Bridge, and the simulation's results. Section four does the same for the SAM model. Section five explains how the SAM model was modified to conduct simulations of the Bridge's impact on the Northwest economy and briefly highlights what measures would be necessary in order to conduct a similar regional analysis using the CGE model. Section six concludes by comparing the results derived from the two models and by highlighting the strengths and weaknesses of each model for this type of policy analysis.

Figure 1-1
Political Map of Bangladesh with Approximate Location of the Jamuna Bridge

2) General Methodology

In order to asses the indirect and induced effects of the Jamuna Bridge on the economy of Bangladesh, we utilize conventional macroeconomic tools, making use of a standard CGE model and an improved version of Bangladesh's Social Accounting Matrix (SAM) model. In undertaking this study, we estimate the partial effects of the Bridge on directly relevant factor and sector markets – such as for labor and transportation – in order to approximate the economic impact of the Bridge within the context of each model.

CGE analysis allows for the assessment of the impacts of exogenous shocks - such as the completion of the Jamuna Bridge – within a constrained optimization framework (i.e. changes in quantity are restricted). At the core of the CGE model is a set of equations describing the behavior of various economic agents (such as industries and households) when faced with changes in relative prices.

On the other hand, a SAM model's key use is to assess the direct and indirect income effects of a particular exogenous impact that leads to different expenditure patterns. The SAM is a square matrix with columns for expenditure and rows covering income accounts. It combines input-output data with national accounts data to reflect the circular flow of income at a particular point in time.

Both models are based on national input-output tables, which severely restrict our ability to assess the impacts of the Jamuna Bridge at the regional level even after accounting for region-specific households groups. This is because the size of partial effects observed at the regional level need to be scaled down when represented within a national model. Additionally within each model, the estimated national effects of the Bridge are distributed across households in all regions. Therefore, we attempt to supplement our findings at the national level by utilizing an input-output table for the Northwest. True region-specific input-output tables for Bangladesh are not readily available and generating such tables from primary surveys would be very costly. However, non-survey techniques are often considered good substitutes for constructing a regional input-output table. Given data limitations, we use a simple Location Quotient (LQ) method to generate this table from the national SAM. A regional input-output table thus constructed provides the basis for our regional impact analysis, which strictly utilizes the SAM model. As mentioned previously, time and resources did not permit sufficient modifications to the CGE model needed to conduct this form of regional analysis.

3) Computable General Equilibrium Analysis

In an increasingly market oriented economy, variations in prices may be the most important sources of re-allocation of resources among competing activities which then may alter the factoral income and hence personal income distribution. Changes in personal income distribution of household groups and consumer price indices may have different implications on the welfare and poverty situations of distinct household groups. Application of computable general equilibrium analysis allows us to assess the impacts of exogenous shocks primarily through changing prices. This form of analysis is appropriate for looking at the impact of the Jamuna Bridge, as this investment is expected to have significantly reduced transport margin rates.

A CGE model examines the consequences of policy reforms within a constrained optimization framework. In order to capture the effects of changes in transport margins on sector prices and volumes of output, as well as on household welfare and the poverty situation, transport margins paid by each of the producing activities within the SAM are deducted from their transaction values valued at purchaser prices. The derived sector-based transport margins are then added as a component in the formation of domestic sales prices. Within the context of the CGE model, variations in the transport margins first affect the domestic sales price and subsequently the changed domestic sales price will influence all other prices due to their interdependence.

Variations in sectoral prices will reallocate resources across producing activities, thereby altering factoral income generation. As a consequence, the personal income of individual household groups will also be altered. Implied price, income and consumption effects will have implications for household welfare and the national incidence of poverty. For the purposes of this exercise, welfare is measured by the well-known equivalent variation and poverty incidence is estimated by the FGT (Foster, Greer, and Thorbecke, 1984) poverty measures.

The CGE model is numerically calibrated to a 1995/96 SAM. The main sources of information for the 1995-96 SAM are:

- 1993/94 Input-output table prepared by the Bangladesh Institute of Development Studies (BIDS 1998);
- Household Expenditure and Income Survey (HEIS) 1995/96 by the Bangladesh Bureau of Statistics (BBS), 1998;
- Labor Force Survey (LFS) by the BBS, 1998; and,
- National Income Estimates by the BBS.

The 1995/96 SAM identifies economic relations through *four types of accounts*: (i) production activity accounts for 6 producing sectors; (ii) 2 factors of production with one type of labor and one type of capital; (iii) current account transactions between 3 main institutional agents: households and unincorporated capital, government and the rest of the world; and (iv) one consolidated capital account to capture the flows of savings and investment by institutions and sectors respectively.

Detailed Overview of GGE Model

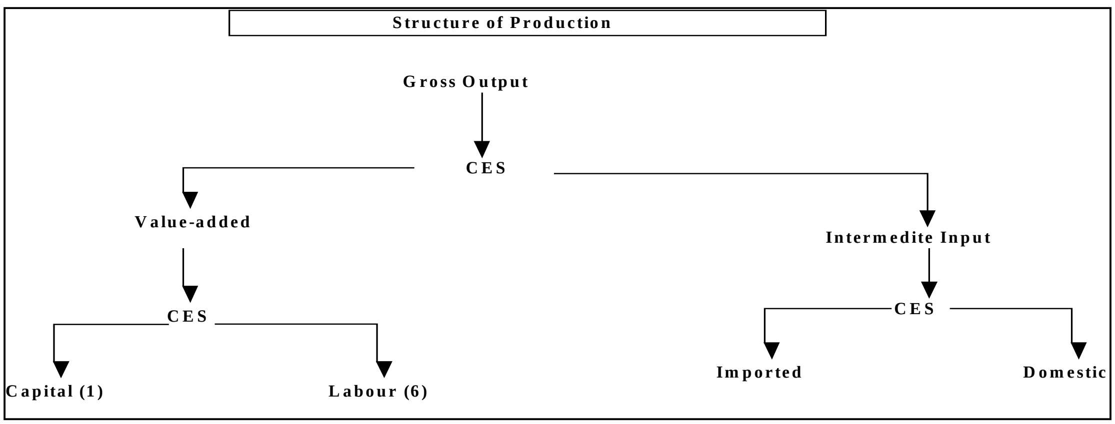
Computable general equilibrium models capture detailed accounts of the circular flows of receipts and outlays in an economy. It satisfies general equilibrium conditions in markets simultaneously. Such models are useful to analyze associations between various agents of the economy.

In line with most CGE models, the present model has been solved in comparative static mode and provides an instrument for controlled policy simulations and experiments. The solution of each simulation presents complete sets of socio-economic, meso and macro level indicators such as activity/commodity prices, household incomes and expenditures, factor demand and supplies, gross domestic products, exports and imports, and household poverty situation. The model is calibrated to the 1995/96 SAM to exactly reproduce the base year values[1]. The mathematical representation of the model is presented in **Appendix A**, while its general structure is described below.

a) Production Structure

The nested production structure in each sector is presented in **Figure 3-1**. At the top level, real value added and intermediate inputs are combined via a Constant Elasticity Substitution (CES) production function to produce gross output. At the bottom level, there are two CES functions: one for labor and capital to produce real value added and the other for imported and domestic intermediates to generate composite intermediate inputs.

Figure 3-1
Structure of Production

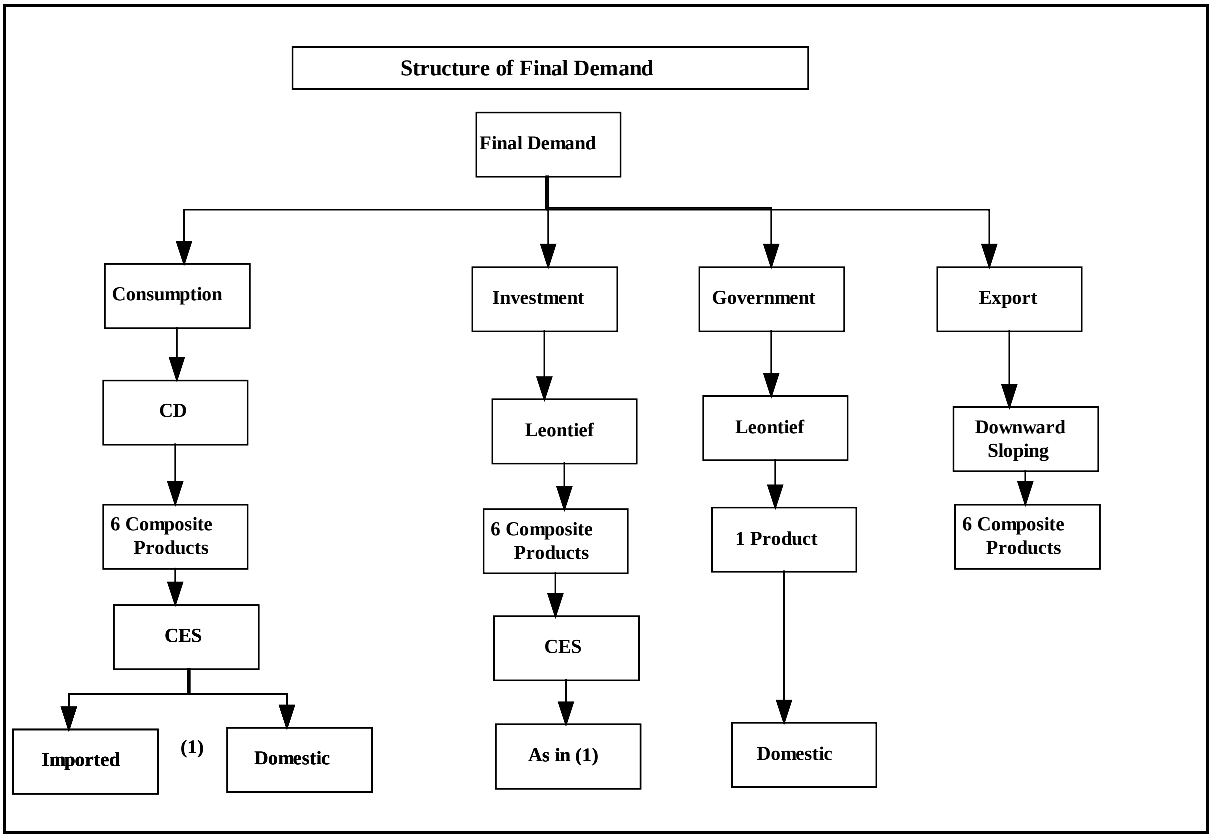


b) Demand Structure

Structure of demand is presented in **Figure 3-2**. This figure shows demand for private and public consumption expenditure, as well as investment and export demand. Private consumption demand is specified by a Cobb-Douglas function, which is combined with a nested CES function of composite products. The distribution of investment by sector is modeled using a fixed-coefficient specification. The Leontief specification applies to both domestically produced and imported investment. The formulation of investment is purely static: there is no link between increased savings today and additional investment in a subsequent time period. In a dynamic model, a policy that has a negative impact on welfare in the current period may yield substantial welfare gains in the long run. These inter-temporal features are not considered here. Total government expenditure is assumed to be exogenous. The distribution of government expenditure by sector is modeled using a fixed-coefficient specification. Export demand is specified by a downward sloping world demand for exports.

[1] In the calibration procedure, most of the model parameters are estimated endogenously keeping the various elasticity values fixed.

Figure 3-2
Structure of Final Demand



a) System Constraints and Equilibrium Conditions

There are four constraints in the system. The real constraint refers to the domestic commodity and factor market; the nominal constraint represents two macro balances: the current account balance with the rest of the world and the savings-investment balance.

Sectoral supply is a composite of imports and output sold in the domestic market. Composite demand, on the other hand, includes final demand (i.e., private and public consumption expenditure and investment) and intermediate input demand. Variations in sectoral prices assure equilibrium between sectoral supply and demand.

In the case of factor markets, it is generally assumed that total quantities of factor supply are fixed and hence variations in the factor returns (i.e., wages and rents) ensure equilibrium between factor demand and supply. This specification implies full mobility of factors across producing activities. However, given the comparative static and short-run nature of the analysis, the full mobility specification is adopted only for labor where variations in wages assure equilibrium in the labor market. Capital is considered to be immobile and sector specific.

Table 3-1
Summary of CGE Model Features

• Labor is mobile across producing activities. • Capital is immobile and sector specific. • Primary factor supplies are exogenous and fixed. • The world prices of imports and exports are exogenous, invoking the small country assumption. • The current account balance, or deficit, is fixed. • Imports and domestically produced goods are imperfect substitutes. • The output produced for domestic and export markets reflects differences in quality. • Savings of domestic institution adjust to equate given levels of investment. • The general price index acts as the numeraire. • Excess demand conditions are satisfied.

Inflows (transfers to and from domestic institutions) are fixed but imports and exports are determined endogenously in the model. Foreign savings is fixed in this model and the nominal exchange rate is allowed to vary to clear the foreign exchange market. In this case the equilibrating variable is the nominal exchange rate. Under this specification, fixing of foreign exchange is equivalent to keeping the trade deficit fixed.

Finally, for the savings-investment equilibrium, the model treats investment decisions as given and hence savings has to adjust to ensure the equality to the fixed value of investment. The basic approach is to allow the savings propensity of one of the domestic institution to vary.

Simulation Design

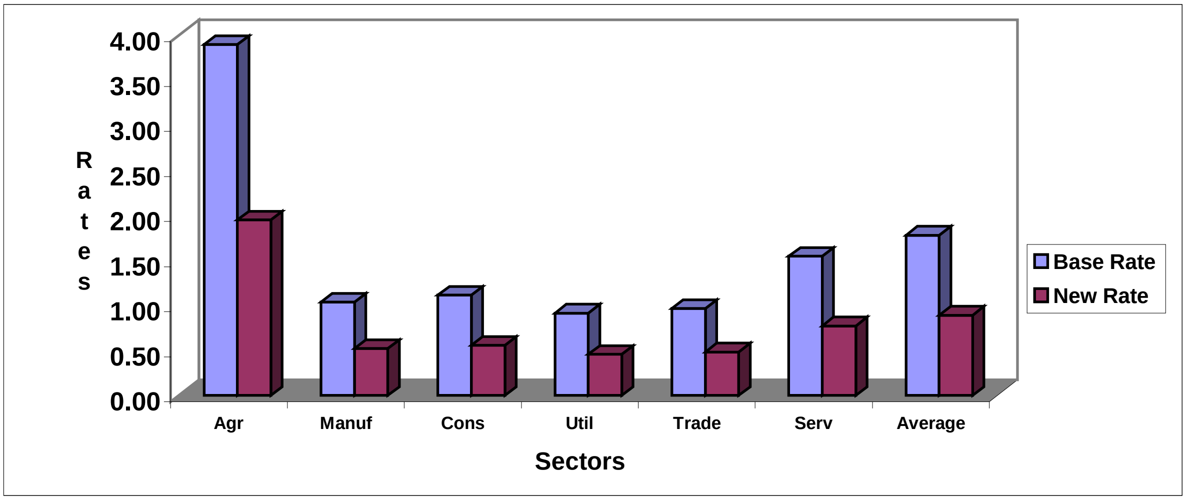
After undertaking extensive primary and secondary data analysis of transportation markets, we find that the cost of transporting cargo by truck between Dhaka and key markets in Rajshahi Division declined in nominal terms by over 30 percent within fives years after the completion of the Jamuna Bridge. Within the same time frame, average shipping times between these markets decreased by over 50 percent. Based on these findings we assume that the Bridge will lead to a 50 percent reduction in sectoral transport margin rates within a twenty-five year period[2].

We use our CGE model to simulate the impacts of reduced transport margins on resource re-allocation, sectoral output and consumption, as well as poverty levels and income distribution within and between rural and urban households. The base values of

[2] The sectoral transport rates are derived as proportions of sectoral total domestic sales values.

all other parameters are retained. The base and simulation values of transport margin rates are presented in **Figure 3-3**.

Figure 3-3
Rates of Transport Margin by Sectors Under Base and Simulation Scenarios



Simulation Results

We have divided our discussion into seven impact areas – price, volume, factor movements, the macro-economy, welfare and poverty incidence – and discuss each in turn below.

a) Price Effects

The fall of transport margin rates first affects sectoral domestic sales prices. Resulting changes in domestic sales prices then influence other prices, allocation of resources, incomes and consumption expenditures. The price effects of the 50 percent reduction in transport margin rates reduction attributed to the Jamuna Bridge are presented in **Table 3-2**.

The fall of domestic sales prices is highest for agriculture, followed by manufacturing and construction activities. This pattern of domestic price reductions is, however, expected given that agriculture has the highest base transport margin rates. As a result of the fall in domestic sales prices (which dominates consumer price formation), the prices faced by final consumers are also reduced. Except for manufacturing commodities, the pattern, as well as the magnitude of decline in consumer price, is similar to that observed for the prices of domestic sales. The reduction in the domestic price of manufacturing product imports led to a further decline of consumer prices of manufacturing commodities[3]. Due to the interdependence of price formation, imports/exports and producer prices have also been affected by the fall of domestic sales prices.

Table 3-2
Sectoral Price Effects
(Percentage change from base value)

	Domestic Sales	Consumer	Producers	Import	Export
Agriculture	-3.97	-3.97	-2.44	-2.89	-3.65
Manufacturing	-3.63	-3.47	-3.13	-2.89	-3.66
Construction	-3.14	-3.14	-2.49		
Utility	-2.67	-2.67	-2.05		
Trade-Transport	-2.71	-2.71	-2.05		
Services	-3.02	-3.02	-2.10		

b) Volume Effects

As a result of the decline in sectoral prices, sectoral domestic sales, consumption, imports, exports and outputs have all increased. In conformity with the price decline pattern, gains are found to be the highest for agriculture, followed by utilities and manufacturing. The higher gains of agriculture may have positive implications for the people of the Northwest where the predominant economic activity is agriculture[4]. Moreover, since agriculture accounts for a significant part of household consumption expenditure, higher availability of agricultural products should have beneficial effects on household welfare and the poverty situation.

Table 3-3
Sectoral Effects of Simulation
(Billion Taka)

	Output		Imports		Exports		Domestic Sales		Consumption	
	Base	Change (%)	Base	Change (%)	Base	Change (%)	Base	Change (%)	Base	Change (%)
Agriculture	550.73	1.79	15.15	-0.23	8.05	2.38	542.69	1.78	557.83	1.73
Manufacturing	718.45	1.32	172.96	0.41	90.69	1.28	627.75	1.33	800.72	1.13
Construction	229.91	0.12					229.91	0.12	229.91	0.12
Utility	46.8	1.44					46.8	1.44	46.8	1.44
Trade-Transport	475.97	1.27					475.97	1.27	475.97	1.27
Services	422.96	0.19					422.96	0.19	422.96	0.19

[3] The weight of imports to final manufacturing commodity consumption is 22 percent, influencing the formation of final consumer prices of manufacturing commodities. The corresponding weight for agriculture is only 3 percent which is too low to influence the consumer price of agriculture commodities.
[4] This pattern of positive growth of agriculture and negative growth of manufacturing is supported by our findings in the field.

c) Value-Added and Factor Return Effects

One of the important advantages of using a general equilibrium framework is that, as an outcome of any shock[5] into the system, labor reallocates from existing less productive sectors to relatively more productive sectors. In response to our simulated impact of the Jamuna Bridge, labor shifted out of manufacturing, construction and services and into agriculture, utility and trade-transport. The resulting changes in value-added and in primary factor returns are reported in **Table 3-4**. The manufacturing, construction and service sectors experienced negative value-added growth as the primary factor returns in these sectors declined. Conversely, the agriculture, utility and trade-transport sectors experienced positive value-added growth as the primary factor returns in these sectors increased.

Table 3-4
Effects on Value Added and Factor Returns
(Billion Taka)

	Value-Added		Capital Factor		Labor Factor		Structure (%)	
	Base	Change (%)	Base	Change (%)	Base	Change (%)	Base	Simulation
Agriculture	276.2	0.61	160.61	0.72	115.59	0.45	22.95	23.09
Manufacturing	157.42	-0.91	89.61	-0.80	67.81	-1.07	13.08	12.96
Construction	122.9	-1.05	102.26	-1.02	20.64	-1.27	10.21	10.10
Utility	29.35	0.92	23.33	0.94	6.02	0.71	2.44	2.46
Trade-Transport	331.96	0.63	117.27	0.79	214.69	0.53	27.58	27.76
Services	285.66	-0.45	167.96	-0.34	117.7	-0.61	23.74	23.63
							100.0	100.0

d) Macro-level Effects

The impacts of our simulated reduction in transport margin rates on major macro-level indicators are reported in **Table 3-5**. The effects of the transport margin rate reduction on these types of indicators are generally positive. Aggregate consumption expenditure, domestic sales, exports and imports increased by 1.05, 1.10, 1.37 and 0.89 percent compared to their base values. However, as expected, the most impressive gains have been found for the general price index, which declined by 3.4 percent. The positive growth of the economy and moderate fall of the general price index leads to the enhancement of national welfare by 0.51 percent.

[5] It is assumed here that the shock is to reduce the existing level of distortions in the economy.

Table 3-5
Effects on Major Macro Variables

	Base (Billion Taka)	Experiment (Billion Taka)	Change (%)
Real Gross Domestic Product	1316.61	1317.67	0.08
General Price Index	1.00	0.97	-3.35
Imports	158.85	160.27	0.89
Exports	98.74	100.09	1.37
Domestic Goods	2346.08	2371.9	1.1
Consumption Expenditure	2534.18	2560.67	1.05
Equivalent Variation			0.51

e) Welfare Effects

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 is examined, in applied policy analysis different 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 “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 the 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 an easy interpretation in terms of 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[6] In this exercise the EV is used as a measure of welfare to examine welfare impacts of our simulation of the impact of the Jamuna Bridge on transport margin rates.

[6] 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 judgment 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. 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.

Changes in nominal income, the consumer price index (CPI) and the EV values are reported in **Table 3-6**. Changes in nominal income for both rural and urban household groups are found to be negative. This is the reflection of reduced rental income from transport activity as well as reduced sectoral nominal wages and rental rate of capital, which manifested in the reduction of sectoral incomes. The nominal income decline is relatively higher for urban households compared to rural households mainly because the share of rental income is higher for them (see **Appendix B**). The decline in nominal income must be compared to the reduced consumer price index to arrive at the net beneficiaries of the transport margin rate reduction. The consumer price index for rural households fell more than for their urban counterpart. Taking into account both the income and price effects, the equivalent variation is a means of estimating the overall welfare impacts of the Bridge. We find a positive equivalent variation for rural households, reflecting positive consumption growth for this household group, which is the net effect of changes in nominal income and consumer price index. Conversely, we find a negative equivalent variation for urban households.

Table 3-6
Welfare Impacts by Household Groups
(Percentage Changes from Base Values)

	Rural Household	**Urban Household**
Changes in Nominal Income	-2.53	-4.05
Changes in Consumer Price Index	-3.40	-3.22
Changes in Consumption Expenditure	0.17	-0.10
Equivalent Variation	1.09	-0.67
Composition of household‘s income by sources		
Labor Income	52.63	31.63
Capital Income	44.14	57.80
Remittances	1.51	5.92
Rental Income	1.72	4.66
	100.00	100.00

Our main observations are that the welfare gains of the transport margin rate reduction are moderate and accrue mostly to rural households. Welfare gains are negative for the urban household group, suggesting a trade off between rural and urban household group with respect to the distribution of national welfare gains.

f) Poverty Incidence Effects

The head-count ratio of the FGT measurements of poverty has been used to evaluate the effects of the Jamuna Bridge on the poverty profiles of rural and urban households. The measurements of poverty profiles follow the method adopted by Decaluwe et al (1999). The methodology requires; (a) explicit proposition of income distribution formulation corresponding to each household group’s characteristics and (b) postulation of an unique and constant basket of a basic needs based poverty line whose monetary value is altered by endogenously determined commodity prices. Following this methodology the derivation of poverty profiles of the representative household groups is discussed below.

The income distribution formulation depends on the "minimum" and "maximum" income values and on the skewness of the distribution. The "Beta" distribution function (see equation 1) is used to represent these characteristics of the household groups. Implementation of the "Beta" distribution requires minimum (mny) and maximum (mxy) incomes within each of the six producing sectors and values of shape and skewness parameters (i.e. p and q) of the distribution. The derived intra-group distribution of rural and urban households, using HEIS 95/96, is used to estimate these parameters and values of minimum and maximum incomes. The reported minimum and maximum incomes and estimates of p and q parameters are reported in **Table 3-7**.

$$I^h(y^h, p^h, q^h) = \frac{1}{B^h(p^h, q^h)} \cdot \frac{(y^h - mny^h)^{p^h - 1} \cdot (mxy^h - y^h)^{q^h - 1}}{(mxy^h - mny^h)^{p^h + q^h - 1}}$$

$$B^h(p^h, q^h) = \int_{mn^h}^{mx^h} \frac{(y^h - mny^h)^{p^h - 1} \cdot (mxy^h - y^h)^{q^h - 1}}{(mxy^h - mny^h)^{p^h + q^h - 1}} dy \qquad (1)$$

The derived distribution will be employed to assess the poverty implication within each of the household groups. It is assumed that, following a policy change, intra-group distributions shift proportionally due to mean income changes, implying constancy of intra-group distributions. That is, if mean incomes change by k factor, the income of each household group is altered by k factor. Analogously, minimum and maximum income of each household group will also change. Income effects of this simulation are provided in **Table 3-7**.

The per capita incomes of each household group are contrasted with the poverty line to derive poverty profiles. Two poverty lines applicable for rural and urban locations have been defined to capture price and other characteristics. The poverty lines (i.e. z in equation 3) are determined endogenously within the CGE model. The poverty lines are determined by a basket of quantities of commodities reflecting basic needs (BN). Although, the basket (ω_i^l) remains invariant under different simulations, commodity price (P_i) changes alter the monetary values of poverty lines. Increases in commodity prices will shift the poverty line to the right (compared to the base case) and vice versa.

Monetary Poverty Line: $$z^l = \sum_i^l \omega_i^l \cdot P_i \qquad (2)$$

The above estimates (i.e. Beta distributions and poverty lines) are used in the FGT poverty measure to derive pre and post simulation poverty incidence for the rural and urban household groups. This class of measures satisfies the desirable axioms[7] and allows us to measure poverty incidence for different groups for which we can derive

[7] Any poverty measure is generally expected to satisfy the following three desirable axioms. (1) Focus axiom, which requires poverty measures to be insensitive to increases in income of a non-poor person. (2) Monotonocity axiom refers to the condition where a reduction in a poor persons' income should increase the value of the poverty measure; (3) Transfer axiom, which demands that, *ceteris paribus*, a transfer of income from a poor to a richer poor person should raise the value of the poverty index. For further details please see' Measurement of Inequality and Poverty (1997), in S. Subramanian.

national aggregates. The FGT ($P\alpha$) also allows us to estimate 3 measurements of poverty: Head Count (when $\alpha = 0$); poverty gap (when $\alpha = 1$) and severity (when $\alpha = 2$). The simplest measure of the <u>prevalence</u> of poverty, headcount ratio, is the proportion of population with a per capita income below the poverty line. The <u>depth</u> of poverty is measured by the poverty gap index, which estimates the average distance separating the income of the poor from the poverty line as a proportion of the income indicated by the line. The <u>severity</u> measure quantifies the aversion of the society towards poverty. This implies that the increase in "our measured poverty due to a fall in the standard of living will be greater the poorer you are "(Pavilion, 1994, page 48). All three measures for rural and urban persons may be computed using the following formula:

$$P_{\alpha}^{h} = \int_{mny^{h}}^{z^{l}} \left(\frac{z^{l} - y^{h}}{z^{l}} \right) \cdot I^{h}(y^{h}, p^{h}, q^{h}) dy^{h} \qquad (3)$$

where,
l $\in$ {rural, urban} refers to location;
h$\in$ {rural, urban} refers to 2 households considered;
P_{α}^{h} is the FGT index by household;

It is observed that in the base case, almost 53 percent of rural populations are poor while for urban areas it is around 29 percent. This suggests that the incidence of poverty in rural area is much higher than in urban area.

Table 3-7
Poverty Incidence by Location

	Income (Taka/person/month)				Population share (%)	Beta		Poverty incidence (%)		
	Min	Max	Mean	Poverty		q	p	Head-count (Po)	Poverty Gap (P1)	Severity Index (P2)
Rural										
Base	18	9140	697	650	78.65	2.9	37	53.454	19.679	9.636
Simulation	16.6	8908		628	78.65	2.9	37	(-2.127)	(-2.588)	(-2.883)
Urban										
Base	73	26533	1359	725	21.35	1.7	33	28.681	10.902	5.701
Simulation	70	25459		702	21.35	1.7	33	1.265	1.508	1.691
National										
Base	18	26533	831	666	100	2	56	48.078	17.775	9.007
Simulation	16.6	25459		644	100	2	56	(-1.688)	(-2.043)	(-2.254)

Note: Percent change from base to simulation are represented in brackets.

The above figures may be translated into estimates of poor and non-poor population by location, under different scenarios. **Table 3-8** summarizes the changes in the population sizes under different groups, which takes roughly 25 years to materialize. The estimates show that given a base population in 1995-96, a total of 0.97 million persons will graduate from poor to non-poor status given the reductions in transport margin rates attributed to the construction of the Jamuna Bridge.

Table 3-8
Poor and Non-Poor Population by Location Under Various Scenarios

	Base Case		Simulation Outcome		
	Million persons	Total (%)	Million persons	Total (%)	Million persons
Total Rural Population (78.65)	95.18	100.00	95.18	100.00	
Rural Poor	50.88	53.45	49.80	52.32	
Rural Non-Poor	44.30	46.55	45.38	47.68	1.08
Total urban Population (21.35)	25.83	100.00	25.83	100.00	
Urban Poor	7.41	28.68	7.50	29.04	
Urban Non-Poor	18.42	71.32	18.33	70.96	-0.09
Total Population	121.02	100.00	121.02	100.00	
Poor	58.17	48.07	57.21	47.27	
Non-Poor	62.85	51.93	63.81	52.73	0.97

Note: Base case refers to 1995-96.

In response to a reduction in transport margin rates, the incomes of the representative household groups and commodity prices change. These income and price changes will also change the minimum and maximum income within each household group and the monetary values of rural and urban poverty lines. The estimated post simulation values of the minimum and maximum incomes and the poverty lines are reported in **Table 3-8**. The changes in the values of minimum and maximum incomes and poverty lines are not significantly different under the base and simulated scenarios. The estimated income and price values are incorporated into the FGT formulation to derive the post simulation poverty profiles. The impacts are summarized below.

- The rural poverty situation is observed to improve significantly as a result of a positive consumption effect. The rural head-count ratio (P0), poverty gap (P1) and severity of poverty (P2) reduced respectively by 2.217 percent, 2.588 percent and 2.883 percent compared to their base values.
- As expected due to a negative consumption effect, the poverty situation of the urban household group deteriorates as measured by the FGT measures. The head-count ratio (P0), poverty gap (P1) and severity of poverty (P2) of the urban household group increased respectively by 1.265 percent, 1.508 percent and 1.691 percent compared to their corresponding base values.

Since almost 80 percent of the population of Bangladesh resides in rural areas, one would expect that the positive poverty impact in rural areas would outweigh the estimated negative impact in urban areas, leading to a reduction in poverty nationally. In line with the rural poverty incidence trend, the head-count ratio (P_0), poverty gap (P_1)

and severity of poverty (P_2) for all of Bangladesh reduced by 1.688 percent, 2.043 percent and 2.254 percent respectively compared to their corresponding base values.

Within our simulations of the Bridge's impact, both income and general price levels decline due to the reduction of transport margin rates. However, the decline in income from the transport sector is felt more by urban households. The decline in this income outweighs the decline in the general price level in urban areas, and therefore, urban poverty increased. In contrast, rural poverty is observed to decline due to the reduction in the transport margin since the latter promotes agriculture and, thus, the decline in rural income is only marginal and is outweighed by the decline in price level. Changes in real income are manifested in consumption; and subsequently show up in changes in the poverty level. The corresponding reduction in rural poverty led to an improvement of the poverty situation nationally.

In summary, given our supposition that the construction of the Jamuna Bridge and its subsequent usage have helped to reduce transport margins, the CGE model suggests that the reallocation of resources to more productive activities and the fall of general price indices and consumer price indices has led to improvements in rural and national welfare and in the poverty situation in Bangladesh.

4) Social Accounting Matrix Analysis

The SAM model utilized for this study is derived from the 1993/1994 input-output (I-O) table, which includes 79 sectors.[8] We updated this table with 1999-2000 prices and with available data on value added by sectors for that year[9]. Additionally, the 79 sectors were aggregated into 50, which are detailed in **Appendix C**. Other blocks in the SAM, including those on expenditure shares and flows in the external sector, have also been updated.[10] The major departure for this model has been in defining household groups; the recent Household Expenditure and Income Survey (HEIS) and the Labor Force Survey (LFS) have been extensively used to define household groups pertaining to the Northwest and to the rest of Bangladesh. Some basic statistics on the newly classified household groups are presented in **Appendix D**.

This form of modeling is appropriate for looking at the impact of the Jamuna Bridge, as this investment is expected to have significantly increased demand within a number of key sectors defined in the SAM.

Detailed Overview of SAM Model

In a narrower sense, a SAM is a systematic data and classification system. As a data framework, the SAM is a snapshot that explicitly incorporates various crucial transformations among variables, such as the mapping of factoral income distribution

[8] Very recently (early April 2002), a new input-output table, with 86 activities and 94 commodities, has been placed before a meeting at the Planning Commission. Since this is yet to be made available for public use and substantial changes may be made before that, we refrain from using it for the purpose of the present study.

[9] Earlier work by the Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP), as well as by Bazlul Khondker and the International Food Policy Research Institute (IFPRI), were relied upon to construct the 1999/2000 SAM.

[10] For example, the expenditure block showing budget shares of different household groups spent on different commodities was updated from HEIS 2000 data.

from the structure of production and the mapping of household income distribution from the distribution of factoral income.

In a broader sense, it can be conceived as embracing, in addition to the classification system, a modular analytical framework specifying, for a set of interconnected subsystems, the major relationships among variables within and among these systems (see Pyatt and Thorbeck, 1976). The move from a SAM data framework to a model framework requires decomposing the SAM accounts as “exogenous” and “endogenous”. Generally, accounts intended to be used as policy instruments are made exogenous and accounts *a priori* specified as objectives or targets must be made endogenous. Identification of the exogenous accounts within the model (i.e. those sectors directly impacted by the Jamuna Bridge) is detailed below, under the section title “Simulation Design.”

For any given injection into the exogenous accounts (i.e. instruments) of the SAM, influence is transmitted through the interdependent SAM system among the endogenous accounts. The interwoven nature of the system implies that the incomes of factors, institutions and production are all derived from exogenous injections into the economy via a multiplier process. This process is developed here based on the assumption that when an endogenous income account receives an exogenous expenditure injection, it spends it in the same proportions as shown in the matrix of average propensities to spend (APS). The elements of the APS matrix are calculated by dividing each cell by its corresponding column sum totals.

SAM based analysis helps us to further understand the linkages between the different sectors and the institutional agents at work within an economy. Accounting multipliers have been calculated according to the standard formula for accounting (impact) multipliers, as follows:

$$\boldsymbol{y = A\,y + x = (I - A)^{-1}\,x = M_a\;x}$$

where:

y is a vector of endogenous variables
x is a vector of exogenous variables
A is the matrix of average expenditures propensities for endogenous accounts, and
$M_a = (I - A)^{-1}$ is a matrix of aggregate accounting multipliers (generalized Leontief inverse).

The dimension of the M_a matrix is $_{70x70}$ (50 activities, 10 factors, and 10 households).

Table 4-1
Description of Elements of Endogenous and Exogenous Accounts

Types of Multipliers
1. **The activity or gross output multiplier**, which indicates the total effect on sectoral gross output of a unit-income increase in a given account *i* in the SAM is obtained by adding the activity elements in the matrix along the column for account *i*.
2. **The value added or GDP multiplier,** giving the total increase in GDP resulting from the same unit-income injection, is derived by summing up the factor-payment elements along account *i*'s column.
3. **Household expenditure multiplier** shows the total effect on household expenditure and is obtained by adding the elements for the household groups along the account *i* column.

The economy wide impacts of demand increases in particular sectors (which are attributed to the Jamuna Bridge) are examined by setting new demand targets for these activities. Within the SAM context given a positive exogenous shock into the system, the first effect will be to increase income in the corresponding account (i.e. activity). In turn, this increase will trigger effects in all other endogenous accounts, factors, and households. For each exogenous account in the SAM we can calculate multiplier measures for output, value added or GDP, and household consumption, which are explained in greater detail in **Table 4-1**.

Simulation Design

In order to simulate the impact of the Jamuna Bridge within the national SAM model, we treat three accounts as exogenous: "Transport", "Other crops", and "Electricity."

Travel across the Jamuna River has become easier with increased certainty regarding the time required to reach any destination on either side of the river. While the financial cost of traveling may not have declined, the certainty and the security in traveling may have induced demand for such services, which subsequently led to an increase in the size of the transport sector. Fieldwork suggests that reduced risk in transportation and faster delivery of cargo have led to increased demand for truck services across the Jamuna Bridge. Particularly, we estimate an almost 90 percent increase in inter-regional truck traffic as a result of the opening of the Bridge. Based on interviews with key informants, it is estimated that the Northwest accounts for 20 percent of national transport services. Applying this factor to an assumed 80 percent increase in the transport sector of Rajshahi Division, we consider a 16 percent increase in the final demand of national-level transport services.

More dependable cargo transportation has enabled northwest farmers and traders to fetch a better price for agricultural produce, which subsequently led to an increase in their supply. This trend has been strikingly visible in the case of vegetable production. Vegetables, potato and fruits are considered under "Other crop" in the input-output table. Our fieldwork suggests a 7.08 percent increase in leafy vegetables, a 74.1 percent increase in non-leafy vegetables and a 14.17 percent increase in potato production in the immediate period after the completion of the Jamuna Bridge. With the area allocated to each of these crops as weights, the average growth for the composite "Other crop" is estimated to be approximately 21.88 percent for the Northwest region[11]. In the case of a national-level SAM analysis, we consider a 5 percent increase in final demand for other crops, since one would expect producers in the eastern region to also benefit from the Jamuna Bridge for certain vegetables and fruits which are produced more efficiently there.

In addition to enabling transport between the Northwest and the rest of Bangladesh, the Bridge has also facilitated the transmission of gas to areas west of the Jamuna River. This, in turn, has had an effect on the supply of electricity in that region. Particularly, the conversion of the 71 MW power generation turbine in Baghabari to gas (in stead of furnace oil) has reportedly saved about Tk. 74 lakh per day for the Power Development Board. Moreover, construction of another 100 MW power station was made possible due to availability of gas, to be supplied to the Northwest over the Jamuna Bridge. Our findings at the consumer level suggest that this has led to a more stable supply of electricity in the Northwest. Particularly, we estimate an 10 percent increase in the supply of electricity in Rajshahi Division as a result of the completion of the Bridge. Likewise, we assume a 5 percent increase in the supply of electricity at the national level. The reason that we consider a 5 percent increase at the national level rather than a lower figure is because power generated in the Northwest has enabled more regular supply (through the national grid) to regions in the southwest as well.

In summary, within the context of the national SAM model we simulate the impact of the Jamuna Bridge as follows:

Table 4-2
Description of National SAM Simulation of Jamuna Bridge Impact

SAM Account	Increase in National Demand (%)
Transport	16
Other crops	5
Electricity	5

Simulation Results

The simulated impacts of our three demand shocks (attributed to the Jamuna Bridge) are presented in **Table 4-3**, which includes output effects by 50 activities, value added factor effects and consumption effects by household groups.

[11] In the base year, an average farm household allocated 1.13 decimals of land for leafy vegetables, 2.79 decimals for non-leafy vegetables and 16.73 decimals for the production of potatoes. We assume production per unit of land to remain constant and thereby assume land and production are synonymous for applying the weights.

Table 4-3
Output, Value Added and Consumption Effects Using National SAM Model

Activities	Base (Million Taka)	Simulation (Million Taka)	% Change
Paddy	287432.55	66305.43	23.07
Grains	28916.85	12335.04	42.66
Jute	13719.70	1556.91	11.35
Sugar Cane	16869.82	3299.71	19.56
Commercial Crop	7223.52	4519.30	62.56
Other Crop	195236.93	132181.35	67.70
Livestock	132169.47	49357.18	37.34
Poultry	26562.55	7509.62	28.27
Shrimp	42905.15	6305.67	14.70
Fish	143809.31	31864.58	22.16
Forest	100941.73	13245.69	13.12
Rice Mil	390456.51	84924.14	21.75
Ata and Flour	42420.67	11825.56	27.88
Edible Oil	29314.38	14492.34	49.44
Sugar	33208.41	7376.53	22.21
Other Food	43140.74	12259.39	28.42
Leather	33905.84	2415.06	7.12
Jute Textiles	20788.70	1274.50	6.13
Yarn	41121.66	15254.22	37.10
Mill Cloth	49970.77	8507.26	17.02
Cloth	85265.13	24627.28	28.88
Ready Made Garments	157150.77	5857.33	3.73
Knit wear	50128.63	1559.49	3.11
Other Textiles	19008.78	3176.01	16.71
Tobacco Products	22882.98	11269.90	49.25
Wood Products	59186.28	16682.16	28.19
Chemical	41269.46	18426.36	44.65
Fertilizer	13051.89	12225.85	93.67
Petroleum Products	30863.50	39607.40	128.33
Clay Products	17596.98	2176.37	12.37
Steel	103229.84	9155.62	8.87
Machinery	11387.14	32384.45	284.39
Miscellaneous Industry	23815.13	15189.68	63.78
Urban Buildings	99383.89	5311.46	5.34
Rural Buildings	331163.78	7319.65	2.21
Construction Electric	15489.83	0.01	0.00
Construction Road	10055.62	1.58	0.02
Construction Other	30694.56	360.03	1.17
Electricity	62447.14	23817.15	38.14
Gas	34643.67	7099.87	20.49
Trade Services	460336.51	129958.62	28.23
Transport Service	391183.14	300811.20	76.90

Activities	**Base (Million Taka)**	**Simulation (Million Taka)**	**% Change**
Housing	213866.63	59545.29	27.84
Health	33919.94	3408.50	10.05
Education	78824.29	13925.60	17.67
Public Administration	84650.39	8866.77	10.47
Financial Services	202138.05	57956.20	28.67
Hotel	39966.23	11841.48	29.63
Communication	22687.36	5602.21	24.69
Other Services	52278.88	16595.12	31.74
	4478681.65	**1331568.11**	**29.73**
Factors			
Labor: Unskilled Males	266103.23	114313.62	42.96
Labor: Low-skilled Males	230009.59	83727.66	36.40
Labor: Medium-skilled Males	199690.62	63672.48	31.89
Labor: Highly-skilled Males	300481.50	85485.11	28.45
Labor: Unskilled Females	37842.99	9976.59	26.36
Labor: Low-skilled Females	22271.94	5134.93	23.06
Labor: Medium-skilled Females	11801.56	2481.56	21.03
Labor: Highly-skilled Females	19592.92	3947.54	20.15
Capital	973136.30	215470.67	22.14
Land	226069.35	78235.44	34.61
	2287000.00	**662445.61**	**28.97**
Household			
Landless	15945.00	880.41	5.52
Marginal	229529.65	2886.99	1.26
Small	279780.65	13372.19	4.78
Large	183581.26	55516.62	30.24
Non-farm poor	210546.96	19611.69	9.31
Non-farm rich	153170.09	70473.22	46.01
Illiterate	155591.05	19335.67	12.43
Poorly-Educated	157597.91	62070.02	39.39
Medium-Educated	145416.90	12607.31	8.67
Highly-Educated	314219.08	55888.90	17.79
	1845378.55	**312643.01**	**16.94**

In response to the demand intervention, total output of the economy increased by 29.7 percent compared to the base year. In order to supply the increased outputs, demand for primary factors (i.e. labor, capital and land) increased and hence payments to primary factors also rose. Total factor payments or value-added increased by 28.9 percent. The growth of factor returns was highest for land (35 percent), followed by labor (34 percent) and capital (22 percent). Increases in factoral income envisage an increase in household income, part of which is saved and rest of which is spent on goods and services. Household consumption expenditures increased about 17 percent as a result of increases in household income.

Increases in household consumption expenditures are inputted into a poverty module to estimate the implications of the Jamuna Bridge on the poverty situation in Bangladesh.

Since the model does not recognize price effects, base poverty has been used along with changes in consumption to estimate poverty effects. We then compare derived poverty estimates with the base poverty estimates generated by the module. The base poverty scenario is summarized in **Table 4-4**.

Table 4-4
Poverty Status by Household Groups – Base Scenario

Household Groups	**Poverty measures (%) – Base Scenario**			
	Head-count (P0)	**Poverty Gap (P1)**	**Severity Index (P2)**	**Per capita expenditure (Taka)**
NORTHWEST				
Poor Non-Farm	77.63	30.52	13.43	492.54
Non-poor Non-Farm	58.19	16.50	5.90	684.23
Landless, agriculture	85.83	31.89	13.89	482.00
Marginal Farmers	78.04	26.78	11.10	545.78
Small Farmers	58.95	18.35	7.08	650.84
Large Farmers	28.59	6.69	1.97	891.54
Illiterate	80.57	28.23	12.65	656.37
Low education	47.33	13.10	4.92	1043.50
Medium Education	19.64	4.57	1.40	1531.92
High Education	0.00	0.00	0.00	2360.58
All NW Households	**61.50**	**19.85**	**7.99**	**724.49**
NATIONAL				
Poor Non-Farm	69.63	23.74	9.64	562.45
Non-poor Non-Farm	44.09	12.56	4.53	849.81
Landless, agriculture	75.70	26.15	10.88	549.04
Marginal Farmers	64.60	20.76	8.49	649.07
Small Farmers	46.58	13.95	5.10	766.88
Large Farmers	25.34	6.70	2.16	961.23
Illiterate	63.61	19.49	7.91	834.90
Low education	29.40	8.21	3.09	1266.97
Medium Education	7.41	1.71	0.60	1990.13
High Education	0.00	0.88	0.58	3058.77
All BD Households	**46.69**	**14.29**	**5.54**	**944.06**

The Bangladesh Bureau of Statistic's (BBS) estimates on national poverty for 2000, measured by headcount method with the upper poverty line, ranges between 44.2 and 49.8 depending on whether income or consumption is considered. The corresponding figures for Rajshahi Division are 51.5 and 61.0. The base scenario considered in our exercise generates a headcount national poverty of 46.69 percent nationally and 61.50 percent for the Northwest, which are both comparable with the BBS estimates.

The results of our simulation show that all the socio-economic groups benefit from the Bridge-initiated changes assumed in the national SAM exercise. However, the distribution of benefits is not equal across all groups, as can be seen in **Table 4-5**.

Table 4-5
Changes in Poverty and Expenditure in Bangladesh – Results of Simulation with National SAM

Household Groups	Percentage change (from base) in poverty measure			
	Head-count (P0)	Poverty Gap (P1)	Severity Index (P2)	Per capita expenditure
RURAL – NATIONAL				
Poor Non-Farm	-8.30	-22.52	-27.14	9.31
Non-poor Non-Farm	-66.47	-80.09	-84.53	46.01
Landless, agriculture	-3.70	-17.28	-23.40	5.52
Marginal Farmers	-3.41	-19.50	-28.48	1.26
Small Farmers	-7.85	-32.52	-40.23	4.78
Large Farmers	-54.59	-78.04	-86.32	30.24
URBAN – NATIONAL				
Illiterate	-18.71	-28.80	-33.78	12.43
Low education	-60.15	-77.20	-84.16	39.39
Medium Education	-31.19	-42.80	-48.87	8.67
High Education	0.00	0.00	0.00	17.79
All Bangladesh Households	**-30.17**	**-43.43**	**-47.93**	**24.21**

In generally, landowning non-poor rural households, whether they are engaged in farming or non-farming, benefit significantly more than poor rural households. In the case of the distribution of benefits among urban households, a larger involvement of the ‘low education’ group in transport activities ensured greater receipt of benefits for that group. Quite expectedly, this group registered the highest reduction in poverty, and obviously, the highest increase in household consumption expenditures. Very rich urban households (high education) also benefited more than the very poor or the semi-rich (medium education) groups. These findings are supported by the perceptions of respondents of different income-backgrounds that we interviewed in major urban and rural markets in the Northwest.

5) Region-specific Social Accounting Matrix Analysis

The Jamuna Bridge is expected to have a particularly large impact on the economy and poverty situation of Rajshahi Division, since the Bridge links this region to the generally more prosperous markets of the eastern part of Bangladesh. However, the previous exercises fail to capture the benefits that may potentially accrue to the people (households) in the Northwest. There are two simple accounting reasons for this. First, it is necessary to adjust downward the magnitude of the regional impacts of the Bridge within the national models that we utilized to account for the fractional share of the

Northwest in the whole of Bangladesh. Second, all benefits resulting from the simulations are distributed to households across all regions so that the pie received by the people in the Northwest is likely underestimated. Therefore, we also conducted simulations of the Bridge's impact at the regional level utilizing an input-output table for the Northwest and a restructured SAM model that takes into account region-specific households. We were unable to run similar regional simulations with our CGE model as it is currently structured.

Detailed Overview of Region-Specific SAM Model

Given data limitations, we use a simple Location Quotient (LQ) method to generate a Northwest-specific SAM from the national SAM. The location quotient is a measure comparing the relative importance of an industry in a region (in our case, the Northwest) and its relative importance in the nation. For industry i, it is expressed as,

$$LQ_i = (X^r_i / X^r) / (X^n_i / X^n);$$

where X represents output, or employment, and subscripts r and n are respectively for region and nation.

The most recent data on district/regional GDP by economic sectors, published by the Bangladesh Bureau of Statistics (BBS), is for 1991-92. This provided the first basis for estimation of LQs. However, this dataset only covers aggregate sectors, and direct correspondence may not always be made between these sectors with those defined in the national SAM. Therefore, we attempted to update this information with more recent data.

Particularly, we utilized employment data from the 2000 Labor Force Survey, and output shares of major sub-sectors within manufacturing from the 1995-96 Report on Bangladesh's Census of Manufacturing Industries (CMI)[12]. These three sets of information (see **Appendix E**) were pulled together to arrive at the location quotients utilized to adjust the input-output (I-O) coefficients of the national SAM to match the regional economic picture of Rajshahi Division. It is important to note this method only allows for the downward adjustment of I-O coefficients and, therefore, values of location quotients greater than one are treated as unity. After adjusting the I-O coefficients for the 50 sectors within the model, the regional SAM was appropriately balanced so that the base scenario reflected the current situation in Rajshahi Division as closely as possible.

Simulation Design

In order to simulate the impact of the Jamuna Bridge within the region-specific SAM model, we utilize the same three exogenous accounts as for the national model: "Transport", "Other crops", and "Electricity."

[12] The raw LFS data was analyzed for the purpose. The CMI data are from, BBS 2001, "Report on the Bangladesh Census of Manufacturing Industries (CMI) 1995-96", November, Dhaka.

Two alternative scenarios were projected, which differed only with regards to the extent of the increase in final demand within the transport sector. Both scenarios are summarized in **Table 5-1**.

Table 5-1
Description of Regional Simulations

Simulation	**SAM Account**	**Increase in Regional Demand (%)**
Simulation 1	Transport	50
	Other Crop	20
	Electricity	10
Simulation 2	Transport	100
	Other Crop	20
	Electricity	10

Simulation Results

Within the context of the Northwest region-specific SAM model, the impacts of our three demand shocks (attributed to the Jamuna Bridge) are presented in **Table 5-2**, which includes output effects by 50 activities, value added factor effects and consumption effects by household groups.

Table 5-2
Output, Value Added and Consumption Effects Using Region-Specific SAM Model
(In Million Taka)

Activities	*Base*	*Simulated 1*	*% Change*	*Simulation 2*	*% Change*
Paddy	117329.97	14244.53	12.14	17600.19	15.00
Grains	11803.86	3525.62	29.87	4375.95	37.07
Jute	5600.38	295.61	5.28	339.15	6.06
Sugar Cane	6886.26	541.59	7.86	671.37	9.75
Commercial Crop	2948.64	410.43	13.92	509.45	17.28
Other Crop	75790.98	22731.86	29.99	22731.86	29.99
Livestock	24215.45	9758.23	40.30	11732.88	48.45
Poultry	3847.66	1126.79	29.29	1394.90	36.25
Shrimp	2000.30	197.36	9.87	245.20	12.26
Fish	13519.31	3971.71	29.38	4914.07	36.35
Forest	9837.65	1009.75	10.26	1245.24	12.66
Rice Mil	23508.27	17149.54	72.95	21254.70	90.41
Ata and Flour	5900.20	3127.70	53.01	3873.88	65.66
Edible Oil	5122.85	2390.72	46.67	2951.66	57.62
Sugar	4688.67	1116.28	23.81	1384.39	29.53
Other Food	7062.48	1767.97	25.03	2186.43	30.96
Leather	6274.88	529.54	8.44	654.37	10.43
Jute Textiles	305.59	82.08	26.86	100.79	32.98
Yarn	604.49	28.58	4.73	35.34	5.85
Mill Cloth	9317.52	1273.45	13.67	1577.12	16.93
Cloth	7979.90	4428.98	55.50	5473.59	68.59
Ready Made Garments	2247.26	1297.72	57.75	1610.40	71.66
Knit wear	716.84	341.88	47.69	423.86	59.13
Other Textiles	5803.29	972.15	16.75	1205.16	20.77
Tobacco Products	2795.76	1400.84	50.11	1740.23	62.25
Wood Products	8750.71	2086.03	23.84	2574.80	29.42
Chemical	7184.09	2209.65	30.76	2673.80	37.22
Fertilizer	191.86	0.00	0.00	0.00	0.00
Petroleum Products	5613.33	586.15	10.44	728.55	12.98
Clay Products	2077.50	211.28	10.17	260.91	12.56
Steel	1517.48	63.44	4.18	79.05	5.21
Machinery	1290.96	839.58	65.04	1071.83	83.03
Miscellaneous Industry	3517.86	1848.81	52.55	2268.52	64.49
Urban Buildings	6907.18	535.95	7.76	662.84	9.60
Rural Buildings	16392.61	1023.50	6.24	1266.91	7.73
Construction Electric	1076.54	0.00	0.00	0.00	0.00
Construction Road	698.87	0.10	0.01	0.12	0.02
Construction Other	2133.27	52.67	2.47	63.68	2.99
Electricity	7574.77	3026.57	39.96	3026.57	39.96
Gas	1726.68	194.20	11.25	239.06	13.84
Trade Services	43778.00	21201.55	48.43	25698.92	58.70

Activities	***Base***	***Simulated 1***	***% Change***	***Simulation 2***	***% Change***
Transport Services	32216.42	51638.89	160.29	68743.39	213.38
Housing	18777.49	7735.49	41.20	9553.65	50.88
Health	1709.56	458.20	26.80	567.55	33.20
Education	3972.74	1424.19	35.85	1740.70	43.82
Public Administration	4266.38	535.26	12.55	680.04	15.94
Financial Services	10575.16	9934.56	93.94	12344.19	116.73
Hotel	4048.58	1730.88	42.75	2152.46	53.17
Communication	2523.91	817.16	32.38	1004.44	39.80
Other Services	5295.85	2686.35	50.73	3381.21	63.85
	549926.26	**204561.38**	**37.20**	***251015.35***	***45.65***
Factors					
Labor: Unskilled Males	34264.13	19493.69	56.89	25119.98	73.31
Labor: Low-skilled Males	29616.62	13811.51	46.63	17574.99	59.34
Labor: Medium-skilled Males	25712.67	10316.50	40.12	12956.59	50.39
Labor: Highly-skilled Males	38690.76	13085.70	33.82	16321.56	42.18
Labor: Unskilled Females	4872.76	1773.95	36.41	2150.54	44.13
Labor: Low-skilled Females	2867.79	951.32	33.17	1152.28	40.18
Labor: Medium-skilled Females	1519.60	445.05	29.29	535.52	35.24
Labor: Highly-skilled Females	2522.83	528.48	20.95	649.28	25.74
Capital	123357.23	30345.64	24.60	37683.62	30.55
Land	28657.13	13909.57	48.54	15209.18	53.07
	292081.52	**104661.39**	**35.83**	***129353.52***	***44.29***
Households					
Landless	3764.34	861.69	22.89	1099.34	29.20
Marginal	44597.53	13396.77	30.04	16884.47	37.86
Small	60961.52	19151.40	31.42	23568.98	38.66
Large	43617.49	18725.49	42.93	22175.80	50.84
Non-farm poor	38791.74	12639.84	32.58	15986.26	41.21
Non-farm rich	23831.39	8568.91	35.96	10447.69	43.84
Illiterate	19442.27	6664.93	34.28	8460.57	43.52
Poorly-Educated	18131.37	5858.74	32.31	7335.45	40.46
Medium-Educated	15912.90	6277.32	39.45	7827.74	49.19
Highly-Educated	23926.45	12512.43	52.30	15563.93	65.05
	292976.99	***104657.51***	***35.72***	***129350.24***	***44.15***

Simulation 1: Other Crop 20%, Electricity 10% and Transport 50%
Simulation 2: Other Crop 20%, Electricity 10% and Transport 100%

In response to the demand intervention, total output of the Northwest economy increased by 37 and 47 percent under simulations one and two respectively compared to the base scenario. In order to supply increased outputs, demand for primary factors (i.e. labor, capital and land) increased and, thus, payments to primary factors also rose. Total factor payments or value-added increased by 35 percent under simulation one. The growth of factor returns was highest for land (48.5 percent), followed by labor (43 percent) and capital (24.6 percent). Under simulation two, value added growth was 44 percent. However, in this case the highest growth was observed for labor (55 percent), which was followed by land (53 percent) and capital (31 percent)

Increases in factoral income envisage an increase in household incomes, part of which they save and the rest of which is spent on goods and services. As a result of increased household income, household consumption expenditures increased about 35.7 and 44 percent respectively under simulations one and two. Increases in household consumption expenditures under each simulation are inputted into a poverty model to estimate the implications of the Jamuna Bridge on the poverty situation in the Northwest. These results are presented in **Table 5-3** and **Table 5-4**.

Table 5-3
Percent Change in Poverty and Expenditure in the Northwest– Results of Simulation 1 with Regional SAM

Household Groups	**Percentage change in poverty measure**			
	Head-count (P0)	**Poverty Gap (P1)**	**Severity Index (P2)**	**Per capita expenditure**
RURAL – NORTHWEST				
Poor Non-Farm	-18.24	-45.86	-60.05	32.58
Non-poor Non-Farm	-50.52	-67.97	-73.59	35.96
Landless, agriculture	-15.48	-38.27	-48.37	22.89
Marginal Farmers	-37.35	-59.75	-70.06	30.04
Small Farmers	-54.46	-68.26	-72.94	31.42
Large Farmers	-84.82	-93.22	-96.51	42.93
URBAN – NORTHWEST				
Illiterate	-33.53	-49.41	-57.13	34.28
Low education	-43.55	-70.21	-82.78	32.31
Medium Education	-76.32	-79.65	-86.00	39.45
High Education	0.00	0.00	0.00	52.30
All Northwest Households	**-39.92**	**-56.72**	**-63.64**	**34.53**

Table 5-4
Percent Change in Poverty and Expenditure in the Northwest–
Results of Simulation 2 with Regional SAM

Household Groups	Percentage change in poverty measure			
	Head-count (P0)	**Poverty Gap (P1)**	**Severity Index (P2)**	**Per capita expenditure**
RURAL – NORTHWEST				
Poor Non-Farm	-21.18	-55.71	-69.75	41.21
Non-poor Non-Farm	-60.90	-75.13	-79.90	43.84
Landless, agriculture	-21.76	-46.29	-56.90	29.20
Marginal Farmers	-41.37	-67.82	-77.20	37.86
Small Farmers	-62.35	-73.70	-78.38	38.66
Large Farmers	-91.62	-95.74	-98.19	50.84
URBAN – NORTHWEST				
Illiterate	-40.88	-58.63	-65.64	43.52
Low education	-54.03	-79.78	-89.03	40.46
Medium Education	-76.32	-85.35	-92.27	49.19
High Education	0.00	0.00	0.00	65.05
All Northwest Households	**-47.47**	**-64.35**	**-70.98**	**42.64**

The extent of poverty reduction projected under the two simulations ranges between 40 and 48 percents, depending on the increase in the transport sector. More importantly, the distribution of benefits among the various household groups is found to be relatively more egalitarian in our regional SAM analysis compared to the national one. However, our general observation on the skewed distribution of benefits, with the rich benefiting more than the poor, still holds.

Region-specific Analysis within a CGE Framework

To assess the impacts of the Jamuna Bridge on the Northwest economy within a CGE framework would require a regional SAM that accounted for interregional trade flows and factor movements. This SAM would also have to include information on region-specific household groups. An advantage of the SAM model is that it allows us to perform a regional level of analysis without having to collect the extensive amount of additional data required to construct a regional GCE model. However, a regional CGE model would allow us to gather additional insights into the geo-spatial impacts of the Bridge Particularly, such a model would allow us to assess how an intervention, such as the Jamuna Bridge, affects:

(i) Allocation of resources (e.g. labor and capital) across regions;
(ii) Factor returns across regions;
(iii) Interregional trade flows;
(iv) Prices across regions;
(v) Income and consumption expenditure of household groups of different regions; and,
(vi) Welfare and the poverty situation within different regions.

6) Comparison of Findings from CGE and SAM Analyses

Table 6-1 summarizes the quantified poverty impacts of the Jamuna Bridge, simulated under both models. The exercise using the CGE flex price may be contrasted with the SAM based fixed price approach. The two exercises use SAM of two different years for reasons explained earlier. Both the exercises show a reduction in poverty in Bangladesh due to the opening of the Jamuna Bridge. However, the results suggest a higher magnitude of poverty reduction under the SAM approach than the CGE approach; and this would hold true even if a common social accounting matrix had been used for both models.

The reason for obtaining different magnitudes of poverty reduction under the two alternative approaches lays in the fact that the impact of the Jamuna Bridge intervention is explained differently within the two models. Under the SAM approach, the impact of the Bridge was demonstrated through enhancing the demand of other crops, electricity and transport services. Since this model assumes no capacity constraints, matching outputs are always supplied (as a result of demand interventions) which resulted in higher factoral incomes and household consumption expenditure.

On the other hand in the CGE case, the simulation was performed by reducing transport margin rates. The changes in transport rates alter the relative price situation in the economy, which then led to the reallocation of existing resources to various producing activities. The gains resulting from the Bridge are obtained by reducing existing distortions and hence they are small. Since supplies of primary factors are fixed in the CGE model there is no scope for generating extra income by employing additional factors (as was the case in the SAM approach).

It is important to bear in mind that all models, by their very nature, are limited in their ability to represent reality, given the great complexity of the inner workings of actual economies. Particularly, the SAM model does not allow for supply and demand interactions that could allow for substitution in both production and demand. The CGE model, on the other hand, assumes full employment, which is not technically possible in any economy, let alone those of developing countries (see Kraev 2003). In all likelihood, the Jamuna Bridge has had significant impacts on both quantities and prices within the economy of Bangladesh.

Since the ability to increase supply to Bangladeshi markets could be restricted by some capacity constraints, the actual poverty impact of the Jamuna Bridge will most likely be smaller than that projected by the SAM exercise, which assumes no capacity constraints. Conversely, the results of the CGE exercise most likely substantially under-represent the indirect and induced effects of the Bridge. Particularly, the CGE model assumes that the Bangladeshi economy is currently functioning at full capacity, which most likely is not the case. The results of the CGE model do not take into account that certain segments of the national economy have most likely become more productive as a result of the Bridge.

Table 6-1
Summary of the Estimated Quantified Poverty Impacts of the Jamuna Bridge

Type of Analysis	Level of Analysis	Type of Impact / Model Assumptions	Quantified Poverty Impact Findings			
			# Shifted Out of Poverty (thousands)	Estimated Change in Indicator by 2025 (%)		
				Head-count Ratio (P0)	Poverty Gap (P1)	Severity Index (P2)
Computable General Equilibrium (CGE) Analysis	National	Reduction in: Transport margins by 50%	970.00	-1.69	-2.04	-2.25
Social Accounting Matrix (SAM) Analysis	National	Increase in demand for: Other Crops by 5% Utilities (Electricity) by 5% Transport by 16%	19,300.00	-30.17	-43.43	-47.93
SAM Simulation 1	Northwest Region	Increase in demand for: Other Crops by 20% Electricity by 10% Transport by 50%	6,800.00	-39.92	-56.72	-63.64
SAM Simulation 2	Northwest Region	Increase in demand for: Other Crops by 20% Electricity by 10% Transport by 100%	8,100.00	-47.47	-64.35	-70.98

Models of this nature, and particularly the models that we utilize, do not generate measures of confidence for the outputs they produce. For this particular study, we argue that the results of the CGE and SAM national models can be viewed as generating approximate lower and upper bounds, respectively, of the likely impact of the Jamuna Bridge on poverty levels in Bangladesh. As such, we find that the results of these two modeling approaches offer complementary insights that ultimately enrich the quality and thoroughness of our overall investigation.

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APPENDIX A
CGE MODEL SPECIFICATION

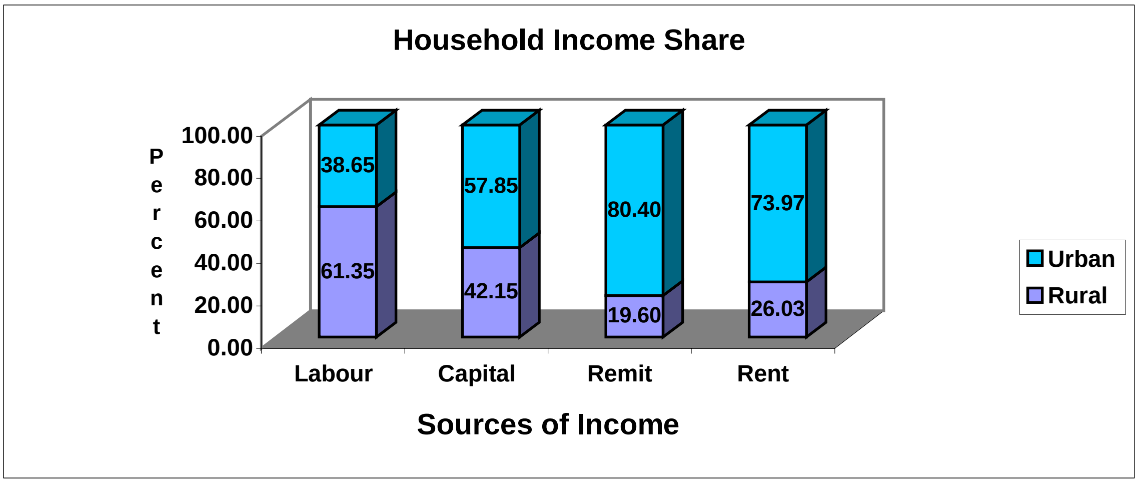
	Equation	Description
Price Block		
	$PM_i = \overline{PWM_i} \cdot ER \cdot (1+tm_i+tv_i)$	Import Price
	$PM_i = PWE_i \cdot ER$	Export Price
	$P_i \cdot Q_i = PD_i \cdot D_i + PM_i \cdot M_i$	Composite Price
	$PX_i \cdot X_i = PD_i \cdot (1-td_i-tr_i) \cdot D_i + PE_i \cdot E_i$	Activity Price
	$PN_i = \sum_j \tau_{ji} \cdot P_j$	Input price
	$PV_i \cdot V_i = PX_i \cdot X_i - PN_i \cdot INT_i$	Value added price
	$PK_i = \sum_j \kappa_{ij} \cdot P_j$	Capital Price
	$PINDEX = GDPVA / RGDP$	Numeraire Price
	Production and Supply Block	
	$V_i = AV_i \cdot [\sum_f \alpha_{if} \cdot FD_{if}^{-\mu_i}]^{-\frac{1}{\mu_i}}$	Value added function
	$FD_{if} = V_i \cdot \left[\frac{\alpha_{if} \cdot PV_i}{AV_i^{\mu_i} \cdot W_f \cdot \varpi_{if}}\right]^{\frac{1}{1+\mu_i}}$	Factor Demand
	$Q_i = AQ_i \cdot [\delta_i \cdot M_i^{-\rho_i} + (1-\delta_i) \cdot D_i^{-\rho_i}]^{-1/\rho_i}$	Composite Supply (Armington Function)
	$M_i = D_i \cdot [\frac{PD_i \cdot \delta_i}{PM_i \cdot (1-\delta_i)}]^{\sigma_i}$	Import-Domestic Demand Ratio
	$Q_i = M_i + D_i$	Composite commodity aggregation for perfect substitutes
	$Q_i = D_i$	Composite supply for Non-imported commodities
	$Q_i = M_i$	Composite supply for Non-produced imports
	$X_i = AT_i \cdot [\gamma_i \cdot E_i^{-\phi_i} + (1-\gamma_i) \cdot D_i^{-\phi_i}]^{1/\phi_i}$	Composite supply function
	$E_i = D_i \cdot [\frac{PE_i \cdot (1-\gamma_i)}{PD_i \cdot (1-td_i)}]^{\varphi_i}$	Export Supply
	$E_i = E_i^0 \cdot \left[\frac{PWE_i}{\overline{PWSE_i}}\right]^{\eta_i}$	Export Demand
Institutional Income		
	$Y_h = \left[YF_h + + PD_i \cdot D_i \cdot tr_i + \overline{RM_h}\right] \cdot (1-th_h-s_h)$	Household Income
	$YG = \sum_h th_h \cdot Y_h + \sum_i tm_i \cdot \overline{PWM_i} \cdot M_i \cdot ER + \sum_i td_i \cdot X_i \cdot PD_i$	Government Income
	$CD_{ih} \cdot P_i = \beta_{ih} \cdot Y_h$	Consumption Demand
	$\overline{GD_i} = \beta_i^g \cdot \overline{GTOT}$	Government Demand
	$PK_i \cdot DK_i = \xi_i \cdot I$	Investment by Destination

	Equation	Description
	$ID_i = \sum_j \kappa_{ij} \cdot DK_j$	Investment by Origin
	$INT_i = \sum_j \tau_{ij} \cdot N_j$	Intermediate Demand
Equilibrium Condition		
	$S = \sum_h SH_h + SG + SF$	Total Savings by Institutions
	$Q_i = INT_i + \sum_h CD_{ih} + GD_i + ID_i$	Product Market Balance: Supply equals Demand
	$\sum_i \overline{PWM_i} \cdot M_i - \sum_i PWE_i \cdot E_i - \sum_h \overline{RM_h} - SF = 0$	Current Account Balance: Receipts equal to Outlays
	$I = S = \sum_h SH_h + SG + SF$	Macro Balance: Investment equals Savings
	$GDPVA = \sum_i PV_i \cdot V_i + INDTAX + TARIFF$	GDP Value added
	$RGDP = \sum_i CD_i + ID_i + GD_i + E_i - (1 - \partial_i) * M_i$	Real GDP

APPENDIX B
DISTRIBUTION OF FACTORIAL INCOME AND OTHER INCOMES BY HOUSEHOLD GROUPS

It is mentioned earlier that changes in factorial income and other incomes may have different impacts of rural and urban household groups according to their initial endowment of factors and income distributions. Distributions of factorial income and other incomes are reported **Figure B-1**.

Figure B-1
Household Income Composition by Sources



It is observed that rural household receives 61 percent of their income from labour factor income and receives 42 percent of capital factor income. They also get 20 and 26 percents of remittance earnings and rent accrued from transport margins. Thus, changes in labour factor income will effect the income of rural household more compared to the changes in the other income sources (e.g. capital income, remittances and transport rents).

On the other hand, almost 58 percent of capital factor incomes accrue to them. They also receive 80 and 74 percent of remittance and transport sector rents. Urban household receive only 38 percent of labour factor income. It is therefore suggested that urban household group will be effected more than their rural counterpart if there were changes in capital income, remittance earnings and transport sector rents.

Composition of household's income by sources (presented in 6.10 in the text) suggests predominant source of their income is the factorial income rather than income from other sources. Factorial income accounts for about 97 percent of the total income of the rural household group. Contribution of rental income is small at around only 1.7 percent. For urban household, factorial income accounts for about of 88 percent of their income. Contribution of rental income is around 5 percent. The patterns of above income distribution envisage, ceteris paribus, that reduction of rental income due to the reduction of transport margin rates would effect the personal income of the urban household group more than their rural counter part.

Appendix C

DESCRIPTION OF THE SAM ACCOUNTS

The main sources of information for the SAM used in this study are (a) 1993/94 Input-output table prepared by Bangladesh Institute of Development Studies (BIDS 1998); (b) Household Expenditure and Income Survey 2000 by Bangladesh Bureau of Statistics; (c) Labor Force Survey of 2000 by Bangladesh Bureau of Statistics; (d) National Income Estimates by the Bangladesh Bureau of Statistics; and (e) several primary surveys undertaken by the Bangladesh Institute of Development Studies (BIDS).

1. Accounts

The SAM identifies the economic relations through *four types of accounts*: (i) production activity accounts for 50 sectors; (ii) 10 factors of productions with 8 different types of labor, one capital and one land; (iii) current account transactions between 3 main institutional agents; households and unincorporated capital, government and the rest of the world; and (iv) one consolidated capital accounts to capture the flows of savings and investment by institutions and sectors respectively.

2. Activity

The activity account is represented by 50 producing activities. These are derived from the 79 sectors of the 1993/94 Input-output table. Limited use of the more recent I-O with 86 commodities and 94 activities was also made.

3. Households

An important feature of the current SAM for 1999/2000 is the decomposition of the households into 20 groups. The household groups differ with respect to two dimensions of location – across northwest and rest of Bangladesh and across urban and rural origins. Within each group, the households are further classified in terms of occupation (farming and non-farming among rural households), income levels (proxied by land ownership in case of rural households) and skill levels (proxied by the level of education of household heads).

4. Labor Factor

The SAM for 1999/2000 also accounts for decomposition of the labor factor into 8 groups based on gender and skill level of the workers. The labor factor classification may be used to examine the consequences of policy measures on "factorial" income distribution. Information of level of education and gender, contained in the LFS 2000, has been used for labor factor classification.

The disaggregation of factors, households, activities and institutions in the SAM and model is given in Table C-1

Table C-1
Description of Factors, Institutions and Households in the SAM

Set	Description of Elements
Factors of Production (10)	
Labor (8)	**Female**: 4 categories according to skill levels (unskilled, low, medium and high). Unskilled: No education; Low: I-V class; Medium: VI-X class; and High: X Plus **Male**: 4 categories according to skill levels (unskilled, low, medium and high). Unskilled: No education; Low: I-V class; Medium: VI-X class; and High: X Plus
Capital (1)	• 1 type only
Land (1)	• 1 type only
Institutions (22)	
Households (20): Northwest (10) Rest of Bangladesh (10)	**Rural** *Agriculture*: 4 categories according to land ownership: Landless: no land; Marginal household: 1-49 dec; Small Farmers: 50-249, Large Farmers: >=250 dec. • **Rural** *Non-Farm*: 2 types: Poor: owning upto 49 dec land; Non-poor: owning >=50 dec. • **Urban**: 4 categories according to the level of education of the household's head: Unskilled: No education; Low Skilled: I-V class; Medium Skilled: VI-X class; and Professional: X +
Others (2)	• Government • Rest of the World
Activities (50)	
Agriculture (11)	• **Crops** : Paddy, Grains, Jute, Sugarcane, Other commercial crops, Other crops • **Non-crops : Livestock, Poultry, Shrimp, Other fish, Forest**
Industries (22)	• **Food Processing** : Rice Milling, Ata and Flour, Edible oil, Sugar, Other Food, Tobacco products • **Textiles** : Jute textile, Yarn, mill cloth, other clothing, Read Made Garments, Knitwear, Other textiles • **Others** : Leather, Wood products, Chemical, Fertilizer, Petroleum Products, Clay products, Steel, Machinery and Miscellaneous Industries
Services (17)	• Urban building, Rural building, Construction-electricity, Construction-road, Construction-others, Utility-electricity, Utility-gas, Trade service, Transport service, Housing, Health, Education, Public Administration, Financial Service, Hotel & restaurant, Communication and Other Services

APPENDIX D

STATISTICS ON NEWLY CLASSIFIED HOUSEHOLD GROUPS

Table D-1
Description of SAM Household Groups

Region/ Household Groups	**Number in HEIS 2000**	**% Share in total population**	**Per capita income (Taka)**	**Per capita expenditure (Taka)**	**% Share in total income**
Northwest					
Poor non-agriculture	219	0.57	612	493	0.29
NP Non-agriculture	2136	5.55	1022	684	4.73
Landless	1242	3.23	543	482	1.46
Marginal	542	1.41	508	546	0.60
Small	1140	2.96	718	651	1.77
Large	668	1.73	1350	892	1.96
Illiterate	844	2.19	1077	656	1.97
Low education	524	1.36	1677	1043	1.90
Medium education	387	1.00	2392	1532	2.01
High education	52	0.14	3434	2361	0.39
Sub-total -Northwest	*7754*	*20.13*	*1016*	*724*	*17.08*
Rest of Bangladesh					
Poor non-agriculture	871	2.26	658	580	1.24
NP Non-agriculture	9193	23.87	1109	888	22.10
Landless	3359	8.72	652	574	4.75
Marginal	1681	4.36	737	682	2.68
Small	3564	9.25	940	804	7.26
Large	1609	4.18	1429	990	4.98
Illiterate	4072	10.57	980	872	8.65
Low education	3599	9.35	1505	1300	11.74
Medium education	2338	6.07	2985	2066	15.13
High education	471	1.22	4288	3136	4.38
Sub-total-Rest of BD	*30757*	*79.87*	*1244*	*999*	*82.92*
All/Total	38511	100.00	1198	944	100.00

Note: NP=Non-poor, which includes households owning 50 decimals or more land.

APPENDIX E

ESTIMATION OF LOCATION QUOTIENT

Table E-1
Relative Sectoral Shares in GDP and GDP-based estimates on Location Quotient

Activity/Sector	Bangladesh	Northwest	Location Quotient
1. Agriculture	0.3726	0.4646	1.2468
a) Crops	0.2926	0.4082	1.3950
b) Forestry	0.0255	0.0033	0.1291
c) Livestock	0.0277	0.0393	1.4177
d) Fisheries	0.0269	0.0139	0.5175
2. Mining & Quarrying	0.0002	0.0000	0.0000
3. Industry	0.0998	0.0290	0.2903
a) Large scale	0.0586	0.0147	0.2502
b) Small scale	0.0412	0.0143	0.3474
4. Construction	0.0606	0.0695	1.1472
5. Power, gas, water & sanitary services	0.0131	0.0088	0.6721
6. Transport, storage & Comm.	0.1189	0.0727	0.6117
7. Trade services	0.0910	0.0951	1.0449
8. Housing services	0.0766	0.0878	1.1472
9. Public administration & defense	0.0434	0.0504	1.1615
10. Banking & insurance	0.0190	0.0207	1.0917
11. Professional & miscellaneous services	0.1049	0.1013	0.9662

Table E-2
Estimated Location Quotient based on Total Employment (Hours) by Activities

LFS code	Economic Activity	Bangladesh	Northwest	Location Quotient
1	Crop Production	0.2219	0.3427	1.5443
2	Home-based crop processing	0.0713	0.1221	1.7138
3	Vegetables & spices cultivation	0.0058	0.0095	1.6294
4	Livestock	0.0272	0.0378	1.3920
5	Poultry	0.0388	0.0403	1.0372
6	Forestry	0.0005	0.0007	1.4413
7	Other agriculture related	0.0028	0.0012	0.4449
8	Fishery	0.0114	0.0038	0.3307
9	Natural gas & other mining	0.0017	0.0050	2.8963
10	Processing & manufacturing, all size	0.0778	0.0502	0.6462
11	Cottage industry	0.0262	0.0310	1.1846
12	Utilities - electricity, water, gas	0.0044	0.0043	0.9785
13	Construction, road & building	0.0298	0.0236	0.7923
14	Trade services	0.1492	0.1243	0.8330
15	Hotel & restaurant	0.0169	0.0113	0.6714
16	Transport service/cold storage	0.0705	0.0561	0.7962
17	Financial services	0.0072	0.0064	0.8834
18	Tax, rent & business related work	0.0039	0.0043	1.0890
19	Public administration	0.0228	0.0070	0.3080
20	Education services	0.0207	0.0207	0.9975
21	Health services	0.0074	0.0055	0.7425
22	Social and other services	0.0340	0.0215	0.6317
23	Other services	0.0479	0.0406	0.8488

Table E-3
Estimated Location Quotient of Selected Manufacturing Activities, based on Value of Gross Output in CMI 1995-96

Manufacturing Industry	Bangladesh	Northwest	Location Quotient
Cigarette/Bidies	0.0172	0.0006	0.0339
Sugar Factories	0.0026	0.0127	4.8519
Leather Footwear		Negligible	
Jute Textile	0.0088	0.0031	0.3526
Cotton Textile	0.0046	0.0020	0.4432
Silk and Synthetic Textiles	0.0037	0.0010	0.2601
Knitwear	0.0019	0.0001	0.0794
RMG	0.0535	0.0001	0.0025
Fertilizer	Not estimated	0.0000	0.0000
Drug and Medicine	0.0065	0.0102	1.5698
Iron and Steel	0.0013	0.0001	0.0968

Table E-4
Estimates on Location Quotients for the Northwest Region in Bangladesh

Serial No.	SAM Activity Name	LQ	Serial No.	SAM Activity Name	LQ
1	Paddy	1.00000	26	Wood Products	0.6462
2	Grains	1.00000	27	Chemicals	0.7000
3	Jute	1.00000	28	Fertilizer	0.0000
4	Sugarcane	1.00000	29	Petroleum Products	0.0000
5	Other Commercial Crop	1.00000	30	Clay Products	0.6462
6	Other Crop	1.00000	31	Steel	0.0000
7	Livestock	1.00000	32	Machinery	0.0968
8	Poultry	1.00000	33	Misc. Industries	0.6462
9	Shrimp	0.00000	34	Urban Building	0.7923
10	Other Fish	0.75000	35	Rural Building	0.7923
11	Forest	0.12910	36	Construction Electricity	0.7923
12	Rice Mill	1.00000	37	Construction Road	0.7923
13	Ata / Flour mill	1.00000	38	Construction Other	0.7923
14	Edible Oil	0.64622	39	Utility, Electricity	0.6721
15	Sugar	1.00000	40	Utility, Gas + Mining	0.0500
16	Other Food	0.64622	41	Trade Services	1.0000
17	Leather	0.01000	42	Transport Services	0.6117
18	Jute Textile	0.35263	43	Housing	1.0000
19	Yarn	0.01000	44	Health	0.7425
20	Mill Cloth	0.44320	45	Education	0.9975
21	Other Cloth	0.44320	46	Public Administration	0.3080
22	Readymade Garments	0.00254	47	Financial Services	0.8834
23	Knitwear	0.07944	48	Hotel	0.6714
24	Other Textile	0.26008	49	Communication	1.0000
25	Tobacco Products	0.03391	50	Other Services	0.9662

Note: LQ means location quotient.