Location of Comparative Advantages in India and Bangladesh

By

Chandrima Roy and Debesh Chakraborty*

Abstract

Trade has been accorded great importance in the SAARC agenda, leading much discussion. However, not much work has been done to study the comparative advantages in the member countries of the SAARC. The objective of the present paper is to locate the comparative advantage between the two economies of the SAARC – India and Bangladesh. Accordingly, we develop a model which is Hecksher - Ohlin as regards factor inputs, but Ricardian as regards technology. Three variants of the model are developed. In Model 1 the two economies maximize foreign earnings subject to their respective endowments and technologies. Secondly, a customs union model for India and Bangladesh is presented to assess their comparative advantages. Model 3 is constructed by restricting the bilateral trade to tradables only. Experiment with the three models is carried out and findings are discussed.

1. Introduction

Regional economic cooperation has been found to be an important engine of growth by developing countries all over the world. The objective of these cooperation arrangements is to maximize the people's welfare within the region, given the nature of the external environment faced by the countries of the region.

As far back as 1947, Jawaharlal Nehru (Parthasarathi, 1990) envisioned the great many advantages of political and economic cooperation among the countries of Asia. This spirit of Asian cooperation became manifest in the emergence in 1985 of the South Asian Association for Regional Cooperation (SAARC), comprised of seven countries: India, Bangladesh, Bhutan, the Maldives, Nepal, Pakistan and Sri-Lanka. Having begun with non-economic affairs, member countries of the SAARC gradually extended the scope of their cooperation to economic fields.

Member countries have initiated various measures for strengthening the process of regional cooperation within the framework of the SAARC, promoting steps for cooperation in core economic areas so as to facilitate the eventual transition of SAPTA (South Asian Preferential Trade Agreement) into SAFTA (South Asian Free Trade Area).

With the conscious political support offered by the member countries the

Received May 1999, final version received September 1999.

* Jadavpur University, Calcutta, 700032 India.

constitution of a viable trade agreement by lowering tariff barriers under SAPTA, will result in increased inflows and outflows of goods and services among the member countries. Thus, in the long run there will be movement away from the intra-restrictions mandated by SAPTA to a more free trade grouping without the restrictive trade barriers under the new SAFTA.

In this situation, trade models - both theoretical and empirical - need to be developed which will show increased inflows and outflows of goods and services among the member countries of the SAARC and will investigate the impact of such free trade on the regional economies. The purpose of this paper is to develop such a model and test it empirically. We shall concern ourselves with two countries of the SAARC region, namely, India and Bangladesh.

A good volume of literature has developed in recent years, assessing comparative advantage or bilateral trade gains between economies. Woodland (1982) developed a neoclassical model of international trade with fixed domestic endowments and commodities, which are tradable or non-tradable and intermediate or final. Ten Raa and Mohnen (1991) made this model operational by substituting Leontief production functions for technologies and foreign earnings for social welfare. They investigated the domestic efficiency and bilateral trade gains of the economies of Canada and Europe. Meanwhile, Ten Raa and Chakraborty (1991) likewise tried to locate the comparative advantage of India vis-a-vis Europe.

In this area, some work has been done for the SAARC region: Waqif (1987); Waqif (1991); Raghavan (1995); Prakash, Chowdhury, Singh and Sharma (1996); Mukherjee (1996), Raychowdhuri and Chatterjee (1996); Dubey (1996); Ten Raa (1996). There are also similar works relating to trade between India and Bangladesh: for example, Sen (1972).

But to the best of our knowledge there has been little theoretical or empirical work on Indo-Bangladesh trade. Specifically lacking is a trade model enabling one to analyze the relative trade positions of India and Bangladesh with a degree of specificity that will help to identify sectors where the economy of India has an advantage compared to that of Bangladesh. The present paper is expected to make a modest contribution to this area by developing a model that will enable us to locate the comparative advantage of Indian economy vis-a-vis Bangladesh. Comparative advantage within the two countries is located on the basis of only these fundamentals: the endowments, technologies and preferences of the two countries.

This paper is organized as follows. Section 1 introduces a model. Section 2 includes a brief analysis of the salient features of the economies of India and Bangladesh, followed by a review of the composition and trends in trade of the two countries. Section 3 presents the model that has been used for the analysis of the comparative advantage of the Indian economy vis-a-vis that of Bangladesh. Section 4 presents the results of the investigation. The paper, finally, concludes with a summary of possible explanations for the findings. The Appendix gives an idea of the kinds of data used, the sources from which they have been collected, and their adjustments to the required form.

2. Salient Features of The Economies of India and Bangladesh

To serve as a background for the ensuing analysis, this section attempts to provide a brief analysis of the salient features of the economies of India and Bangladesh.

2.1 Socio – Economic Indicators

India, with a population of 945 million (estimated in 1996), is the largest country among the SAARC members, comprising a land area of 2,973 thousands of square kilometers (estimated in 1995) and a population density of 320 persons per square kilometer (estimated in 1996). In the same year, the population of Bangladesh was estimated to be 122 million, inhabiting a land area of 130 thousands square kilometers and with a population density of 930 persons per square kilometer (both estimated in 1996).

2.2 Macro Economic Indicators

Distribution of GDP

Basically an agrarian economy, India has undergone significant structural changes in the last three decades. Agriculture, which contributed 38% of gross domestic product (GDP) in 1980, contributed only 29% of GDP in 1995. On the other hand, the shares of the industry and tertiary sectors have increased noticeably while that of manufacturing has increased only marginally. In the case of Bangladesh, too, the share of agriculture in GDP has diminished. Thus, the importance of agriculture has declined comparatively more in Bangladesh. The share of industry and services in the GDP of Bangladesh also increased over the years, but relatively less so than in the Indian economy. Finally while the share of manufacturing has increased slightly in India, in Bangladesh it has gone down drastically.

Agricultural Production

India is an agricultural economy, with agriculture still accounting for 31% of the total GDP of India. In 1991, around 60% of the working population had to depend on agriculture. Though agricultural production has shown improvement over the last decade, and the growth rate of agricultural production was 3.1% in the 1980's, agricultural production was seriously disturbed by the adverse weather conditions of the following few years, causing the average annual growth rate to decline to 2.9% in the first five years of the 1990's.

Agriculture is the single largest sector of the economy of Bangladesh, accounting for as much as 32% of the gross domestic product (GDP) in 1995-96 and 66% of the labor force. Its contribution to GDP was 38% in 1990-91. Although agriculture's contribution to the GDP has thus declined, its share in the economy is still high.

Thus, agriculture occupies more or less identical positions in the economies of India and Bangladesh. Though its share in the GDP of both the economies has declined

over the years, both economies are still primarily agricultural.

Industrial Production

Industrial production in India has undergone a major structural change from consumer goods to durable and capital goods. Today industries are widely dispersed geographically and there are both privately owned and managed and publicly run enterprises.

The industrial sector of Bangladesh includes small, medium, and large-scale manufacturing and cottage industries. The sector as a whole now contributes around 11.5% of GDP and employs around 12% of the employed labor force of the economy. Its contribution to GDP has been gradually increasing over the last few years from about 9.9% in 1984-85 to 11.5% in 1995-96.

The economies of both countries have experienced growth on the industrial front during the last few years, manufacturing, in particular, being the predominant activity in the industrial sector of both. But while India's industrial pattern is largely comparable to those of developed economies, Bangladesh is far below that standard.

Trade and Balance of Payments

The external sector has a strategic role to play in the economies of both India and Bangladesh. Over the years, this sector has undergone a significant transformation in India. Except for the periods 1972-73 and 1976-77, imports have always exceeded exports, and this gap widened considerably from 1977-78 onwards. As a result, India's balance of payments continued to be under pressure from a number of adverse medium term factors, including deceleration in the rate of growth of indigenous oil production, protectionist tendencies in international trade, and the unfavorable climate for concessional assistance. Following the second oil shock of 1979-80, the trade deficit had attained a peak of 4.4% of GDP in 1980-81. It declined steadily to 2.8% of GDP in 1983-84, more marginally in 1984-85, and sharply in 1985-86 to 3.7% of GDP.

During the same period in Bangladesh, exports in value terms declined to 909 million U.S. dollars from 971 million U.S. dollars in 1984-85. But by 1994-95, this figure rose significantly and stood at 3500 million U.S. dollars. On the other hand, India's exports in value terms increased from 13,325 million U.S. dollars in 1988 to 25,051 million U.S. dollars in 1994.

Thus, both economies experienced a rise in exports from the mid-eighties to the mid-nineties. Their imports also increased substantially during the same period. While for India the figure rose from 19,149 million U.S. dollars in 1988 to 26,762 million U.S. dollars in 1994, that of Bangladesh rose from -2643 million U.S. dollars in 1984-85 to -5700 million U.S. dollars in 1994-95. But Bangladesh faced an exceptional situation during 1985-86 when imports declined considerably and stood at a figure of 2364 million. So, while the Indian economy always showed a trade deficit over ten-year period, Bangladesh showed a trade surplus only once, with there being a trade deficit in all other years. During this ten-year period, both economies recorded a maximum trade deficit at almost the same time - Bangladesh during 1989-90, when it

faced a deficit of -2273 million U.S. dollars, and India during 1988, when it faced a deficit of -5824.

Thus, the trade scenario was almost identical in the two countries. Bangladesh could be taken to be slightly better off compared to India, managing to show a trade surplus at least once in a period of ten years.

Export Structure

A study of the trends reveals that the share of primary commodities in the total exports of both Bangladesh and India increased in the early eighties but has shown a tendency to decline since the mid-eighties. These trends appear to have been induced by variations in the share of fuel exports from these countries. The share of manufactured products in the total exports of either country increased over the period 1970-1992. The crucial factor contributing to this trend has been the increasing share of textiles and clothing in these countries' total exports.

Import Structure

According to UNCTAD classification, manufactured imports comprised, on average, around half or more than half the total imports of both Bangladesh and India.

Food imports constituted one of the most important product groups for India, with a total import share on average 11.85%. Ores and metals were another significant product group imported by both the countries. Fuel among primary products was more important an import product for India than for Bangladesh, being a little over 26% on average.

2.3 Trade Between India and Bangladesh

Details of intra-regional exports and imports of Bangladesh and India reveal that exports of India to Bangladesh have increased over the period 1988 to 1994, but in the case of Bangladesh this trend is not well marked.

The economies of both India and Bangladesh had a deficit with respect to world trade. With respect to each other, however, India had a trade surplus with Bangladesh which continued to increase during the period 1988-94, while Bangladesh had a trade deficit with India, which kept widening over the years 1988-94.

3. The Model

In this section we shall develop a model that can be used to determine the commodity flows between India and Bangladesh and hence help to locate the comparative advantage of the Indian economy vis-a-vis the Bangladesh economy.

The model is a linear program. It maximizes the foreign earnings of India and Bangladesh at given world prices, subject to material balance and factor endowments. From this maximization exercise, we identify the sectors with positive values as having

comparative advantages. According to the theory of linear programming, these sectors minimize production cost at shadow prices. Shadow prices are LaGrange multipliers associated with material balances and factor endowments. In our model, the shadow prices of material inputs are shown to match the world price, while those of the factor inputs, capital and labor, measure their relative scarcities in India and Bangladesh.

Foreign earnings are the value of net exports. In this model, we maximize the value of net output minus consumption. This includes not only net exports, but also investment and public spending. Thus, a resulting negative final demand component indicates an import commodity, but a positive component signals no more than exports potential, as investment or public spending may very well absorb it. We develop three models.

Model 1

In the first model, India and Bangladesh maximize foreign earnings subject to their respective endowments and technologies. Since we identify endowments and production structures as sources of comparative advantages, so all data in our model relate to endowments and production in the two economies.

For India, we have

K : Capital stock
L : Labor force
$\mathbf{k}$: sectoral capital coefficients row
$\mathbf{l}$: sectoral labor coefficient row
$\mathbf{A}$: material input coefficients matrix
$\mathbf{c}$: consumption coefficients vector.

The data on Bangladesh are the same, but denoted by K^1, L^1, $\mathbf{k}^1$, $\mathbf{l}^1$, $\mathbf{A}^1$, and $\mathbf{c}^1$

In addition to the above set of data, we need notations for the endogenous variables. For India, we use the following:

$\mathbf{x}$: vector of outputs
$\mathbf{y}$: vector of final demand (net of consumption);

and for Bangladesh,

$\mathbf{x}^1$: vector of outputs
$\mathbf{y}^1$: vector of final demand (net of consumption).

Formally, the objective function to be maximized is $\pi\ (\mathbf{y} + \mathbf{y}^1)$, where, π is a row vector of world prices.

The world prices used to value total surplus are unity, but in our model they will be parameterized as π, to uncover their role in the analysis.

The maximization of foreign earnings has to be performed under a certain set of inequality constraints. The production of each commodity has to be sufficient to meet

the industrial demand: i.e., the intermediate input requirements in the production of the other commodities, plus the consumption demand and the final demand (net of consumption). Thus, for India, the so-called material balance reads

$$\mathbf{Ax} + \mathbf{clx} + \mathbf{y} \leq \mathbf{x}. \tag{1}$$

In (1), **A**, being the material input coefficients matrix, when multiplied with output vector **x**, represents industrial or intermediate demand. **l**, being a row vector of sectoral labor coefficients, when multiplied with **x**, the column vector of outputs yield labor **lx**, which is a scalar. On multiplying **c**, the vector of per capita consumption with this labor employment figure, we obtain consumption. Alternatively, **cl** may be considered as augmenting **A** in acting on **x**. Since **c** is a column vector and **l**, a row vector, their multiplication yields a matrix whose typical element is $c_i l_j$, which represents the requirement of commodity i per unit of j, channeled through the household of the worker. Households are modeled as maintenance places for labor services. The third component on the left-hand side of (1) is **y** which is the vector of final demand (net of consumption), while **x** on the right hand side of (1) is the vector of outputs that represents supply. Thus, the left-hand side of (1) represents total demand while the right hand side represents the supply of the same. Hence, (1) is the demand - supply constraint for India.

Similarly, for Bangladesh the demand-supply constraint or the material balances reads

$$\mathbf{A}^1\mathbf{x}^1 + \mathbf{c}^1\mathbf{l}^1\mathbf{x}^1 + \mathbf{y}^1 \leq \mathbf{x}^1. \tag{2}$$

Again, output in each economy will be constrained by factor endowments. Thus, for India the factor supply-demand constraints are

$$\mathbf{kx} \leq K \tag{3}$$

$$\mathbf{lx} \leq L. \tag{4}$$

The counterparts for Bangladesh are

$$\mathbf{k}^1\mathbf{x}^1 \leq K^1 \tag{5}$$

$$\mathbf{l}^1\mathbf{x}^1 \leq L^1. \tag{6}$$

Finally, in the absence of inventories, the model is completed by the non-negativity constraints on production. Thus, for India,

$$\mathbf{x} \geq 0, \tag{7}$$

and for Bangladesh

$$\mathbf{x}^1 \geq 0 . \tag{8}$$

It is to be noted that non-negativity is imposed only on the activity levels, $\mathbf{x}$ and $\mathbf{x}^1$, but not on the domestic net outputs, $\mathbf{y}$ and $\mathbf{y}^1$ of the two countries. This freedom accommodates trade between the countries.

Maximization of π $(\mathbf{y}+\mathbf{y}^1)$, subject to (1)-(8), constitutes the basic model. Basically, each economy maximizes its own bill of final goods, $\mathbf{y}$ or $\mathbf{y}^1$, since the objective function is additive and constraints separate out in (1), (3), (4), and (7) for India and (2), (5), (6), and (8) for Bangladesh.

This model can be summarized as maximize $\mathbf{cz}$ subject to $\mathbf{Cz} \leq \mathbf{b}$ where the variables and objective function parameters are, respectively,

$$\mathbf{z} = \begin{bmatrix} \mathbf{x} \\ \mathbf{x}^1 \\ \mathbf{y} \\ \mathbf{y}^1 \end{bmatrix} \quad \text{and} \quad \mathbf{c} = \begin{bmatrix} \mathbf{0} \\ \mathbf{0} \\ \boldsymbol{\pi} \\ \boldsymbol{\pi} \end{bmatrix}.$$

The constraint coefficients and the constraint constants are, respectively,

$$\mathbf{C} = \begin{bmatrix} \mathbf{A}+\mathbf{cl}-\mathbf{I} & \mathbf{0} & \mathbf{I} & \mathbf{0} \\ \mathbf{0} & \mathbf{A}^1+\mathbf{c}^1\mathbf{l}^1-\mathbf{I} & \mathbf{0} & \mathbf{I} \\ \mathbf{k} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{l} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{k}^1 & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{l}^1 & \mathbf{0} & \mathbf{0} \\ -\mathbf{I} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & -\mathbf{I} & \mathbf{0} & \mathbf{0} \end{bmatrix} \quad \text{and} \quad \mathbf{b} = \begin{bmatrix} 0 \\ 0 \\ K \\ L \\ K^1 \\ L^1 \\ 0 \\ 0 \end{bmatrix}.$$

The first order, or Kuhn-Tucker, conditions of this maximization problem involve LaGrange multipliers, one for each constraint. A LaGrange multiplier measures the sensitivity of the value of the objective function with respect to the constraint. In fact, it is the amount by which the value would increase, when the constraint is relaxed by one unit. In other words, the LaGrange multiplier is the marginal productivity of the entity underlying a constraint. It is also called shadow price. The LaGrange multipliers associated with the material balance (1) and (2) are the shadow prices of the commodities in either economy and will be denoted by row vectors $\mathbf{p}$ and $\mathbf{p}^1$ respectively. The LaGrange multipliers associated with factor endowments, (3-6), are the shadow prices of labor and capital in either economy and will be denoted by $\mathbf{w}$, $\mathbf{r}$ and $\mathbf{w}^1$, $\mathbf{r}^1$, respectively. Also, the LaGrange multipliers associated with the

non-negativity constraints on output levels, $\mathbf{x}$ and $\mathbf{x}^1$, are slack variables, denoted by $\mathbf{s}$ and $\mathbf{s}^1$ respectively. These shadow prices or LaGrange multipliers can be determined directly by the so-called dual program, which has the LaGrange multipliers as variables and yields the same solution value.

Schrijver (1986) shows that the dual to the above primal program is

$$\text{Minimize } \lambda\mathbf{b} \text{ subject to } \lambda\mathbf{C} = \mathbf{c} \text{ and } \lambda \geq 0,$$

where λ is a row vector with dimension equal to the number of constraints in the primal problem, the number of rows of b or C. It lists the LaGrange multiplier associated with the constraints. Thus,

$$\lambda = (\mathbf{p}, \mathbf{p}^1, \mathbf{r}, \mathbf{w}, \mathbf{r}^1, \mathbf{w}, \mathbf{s}, \mathbf{s}^1).$$

The objective function of the dual problem is

$$\lambda\mathbf{b} = rK + wL + r^1 K^1 + w^1 L^1.$$

Taking into account the constraints, $\lambda\mathbf{C} = \mathbf{c}$, it consists of four components,

$$\mathbf{p}(\mathbf{A} + \mathbf{cl} - \mathbf{I}) + \mathbf{rk} + \mathbf{wl} - \mathbf{s} = \mathbf{0},$$

$$\mathbf{p}^1(\mathbf{A}^1 + \mathbf{c}^1\mathbf{l}^1 - \mathbf{I}) + \mathbf{r}^1\mathbf{k}^1 + \mathbf{w}^1\mathbf{l}^1 - \mathbf{s}^1 = \mathbf{0},$$

$$\mathbf{p} = \boldsymbol{\pi}, \quad \text{and,} \quad \mathbf{p}^1 = \boldsymbol{\pi}.$$

Elimination of slacks $\mathbf{s}$ and $\mathbf{s}^1 \geq 0$ and domestic prices $\mathbf{p}$ and $\mathbf{p}^1$ makes the dual problem separate out into

$$\min_{r,w} \quad rK + wL \text{ subject to } \quad \boldsymbol{\pi}(\mathbf{I} - \mathbf{A} - \mathbf{cl}) \leq \mathbf{rk} + \mathbf{wl}, \text{ and}$$

$$\min_{r^1,w^1} \quad r^1K^1 + w^1L^1 \quad \text{subject to} \quad \boldsymbol{\pi}(\mathbf{I} - \mathbf{A}^1 - \mathbf{c}^1\mathbf{l}^1) \leq \mathbf{r}^1\mathbf{k}^1 + \mathbf{w}^1\mathbf{l}^1.$$

Thus, capital and labor are priced as low as possible subject to the condition that in each sector unit factor costs cover the value of net output at world prices. If the constraint is binding, that is if revenue equals cost, then profit is zero; and if the constraint is not binding, that is, if revenue falls short of cost, then profit will be negative. According to the phenomenon of complementary slackness, if profit is negative then output is zero. So, only the sectors having zero profit will operate. This behavior will be mimicked by entrepreneurs in a pure competitive economy. Since there are only two variables, $\mathbf{r}$ and $\mathbf{w}$, only two sectors can break even. They are the sectors that use least factor input per net material output. Here lies the comparative advantage which is signaled by the break-even condition in prices and by positivity of output.

Model 2

In this model we consider a scenario in which India and Bangladesh have formed a customs union, with commodities freely exchanged between the two countries. Each country has its own technology, but can benefit from the superior technology of its partner by importing its production. This bilateral structure emerges only when non-negativity is imposed on joint net output of the two countries. Thus, to obtain the Customs Union Model we have to add one more constraint to the set of inequality constraints in Model 1.

In a customs union model, the objective function is the same as in Model 1, but now the constraint in addition to the eight constraints of Model 1 is

$$\mathbf{y} + \mathbf{y}^1 \geq 0 . \tag{9}$$

This inequality insulates India and Bangladesh from the rest of the world and the consequent division of activity will indicate their comparative advantages vis-à-vis each other.

In a customs union, bilateral trade is cheap relative to trade with the rest of the world. The purest case of a customs union is one which involves free bilateral trade and prohibitively expensive imports from the rest of the world. Constraints (1-8) of Model 1 along with constraint (9) reflect this condition.

In this Model also, as in the case of Model 1, the LaGrange multipliers of the linear program, that is, the shadow prices, can be determined directly by the dual problem

Minimize $\boldsymbol{\lambda}\mathbf{b}$ subject to $\boldsymbol{\lambda}\mathbf{C} = \mathbf{c}$ and $\boldsymbol{\lambda} \geq 0$.

But here, $\boldsymbol{\lambda}$ lists one additional LaGrange multiplier which is associated with the additional constraint incorporated in this model. It is the price of joint autarky and may be denoted by $\mathbf{T}$. Thus, in this model

$$\boldsymbol{\lambda} = (\mathbf{p}, \mathbf{p}^1, \mathbf{r}, \mathbf{w}, \mathbf{r}^1, \mathbf{w}^1, \mathbf{s}, \mathbf{s}^1, \mathbf{T}) .$$

$\mathbf{T}$ is a self-sufficiency price vector common to India and Bangladesh. This self-sufficiency requires that the number of active sectors in each economy be equal to the number of commodities. For each commodity there must be one sector (in India or in Bangladesh) which breaks even. This in turn requires mark-ups for these commodities, which constitute the minimum tariffs needed to sustain a customs union. $\mathbf{T}$ is a row vector of these tariffs, which are the LaGrange multipliers, associated with the pooled non-negativity constraints on $\mathbf{y}$.

Model 3

Given the model of a customs union of India and Bangladesh, Model 3 is obtained by restricting bilateral trade to tradable only. Let the subscript N select the non-tradable commodities. For these non-tradable commodities, the inequality has to be strengthened

to

$$\mathbf{y}_N \geq 0 \qquad \text{and} \qquad \mathbf{y}_N^1 \geq 0 .$$

Each country has to meet its own domestic demand for non-tradables; that is, it must be self-sufficient with respect to non-tradables. Thus, in Model – 3 the objective function is the same as in Models 1 and 2, but the set of inequality constraints now includes two constraints in addition to the set of inequality constraints in Model 2:

$$\mathbf{y}_N \geq 0 \tag{10}$$

$$\mathbf{y}_N^1 \geq 0 . \tag{11}$$

The LaGrange multiplies of this model are

$$\boldsymbol{\lambda} = (\mathbf{p}, \mathbf{p}^1, \mathbf{r}, \mathbf{w}, \mathbf{r}^1, \mathbf{w}^1, \mathbf{s}, \mathbf{s}^1, \mathbf{T}, \mathbf{t}, \mathbf{t}^1) .$$

The inclusion of the non-tradability constraints (10) and (11) leads to divergence of price. **t** and **t′** are costs of the local production of the non-tradable in excess of what they would have been were they freely available from the counterpart economy. It is easily seen that the material balance constraints imply that any tradable commodity must be produced somewhere and any non-tradable must be produced everywhere. Consequently, prices of tradables become equal across the two countries while those of non-tradables are determined by the value added coefficients **wl** + **rk** and $\mathbf{w}^1 \mathbf{l}^1 + \mathbf{r}^1 \mathbf{k}^1$.

A further application of the complementary slackness is that if the price of a tradable commodity exceeds world price, then its total surplus is zero. Consequently, any positive total surplus is signaled by the condition that price is at minimum world levels. These commodities constitute the joint Indo-Bangladesh comparative advantage vis-à-vis the rest of the world.

4. Results

This section presents the results of the models that we have developed in Section-II. We have three models. In model 1, total surplus is maximized subject to technology and endowment constraints (1-8). Model 2, the customs union model, makes the two economies of India and Bangladesh jointly autarkic with respect to the rest of the world, by constraint (9). Furthermore, Model 3 makes two commodities non-tradable through constraints (10-11). Tables 1 to 6 present the results.

Table 1 presents the results of model 1. The endogenous variables are the gross outputs and final demand (net of consumption), that is, net outputs of the various commodities in India and Bangladesh. Moreover, domestic prices of the commodities and factor prices can be determined. The latter is shown in Table 2.

The gross output figures, (Table 1) show that both India and Bangladesh produce all the commodities. There are no specific commodities in which the countries

specialize. But inspection of the signs and magnitudes of net output (Table 1) reveals that India exports electricity and gas and services to the rest of the world, while Bangladesh exports chemicals. Moreover, inspection of price figures yields that production prices exceed world levels, except for electricity and gas and services in India and chemicals for Bangladesh. Thus, electricity and gas and services are the most competitive products of the Indian economy while for Bangladesh chemicals are the most competitive of all the products produced.

Table 1. Results of Model 1

	Gross Output (Rs. Million)		Net Output (Rs. Million)		Price	
	India	Bangla-desh	India	Bangla-desh	India	Bangla-desh
1. Agriculture	765347	95364	0	-	2.22530	1.48284
2. Livestock, fishing and forestry	328668	180288	0	-	2.39834	1.41408
3. Other food	264937	33137	0	-	1.75635	1.24096
4. Textiles	288812	29058	-	0	1.18991	1.44005
5. Manufacturing	2881221	278057	0	-	1.65178	1.15678
6. Chemicals	367557	1159628	0	731008	1.20291	1
7. Machinery	836463	44290	0	0	1.22030	1.09981
8. Construction	244929	20882	0	0	1.99420	1.21462
9. Electricity and gas	8543341	48898	5471480	0	1	1.14905
10. Services	7946745	169226	4835126	0	1	1.07415

Table 2. Shadow Price of factors in India and Bangladesh in Model 1

	Capital	Labor
India	0.55931	0.02498
Bangladesh	1.40212	0

According to the phenomenon of complementary slackness (Ten Raa, 1995) of the theory of linear programming, a positive shadow price indicates the scarcity of the corresponding factor while a zero shadow price signals the abundance of that factor. Thus, as seen from Table 2, Bangladesh is labor abundant, but capital scarce. India, on the other hand, is both capital and labor scarce but relatively more scarce in capital.

Thus, given their respective factor endowments, the comparative advantages of India are in electricity, gas and services, and those of Bangladesh are in chemicals in a perfectly competitive world market. But change in world prices may shift the comparative advantage to other sectors and hence may jeopardize the development programs of the economies. So, we now turn to the problem of making the two economies of India and Bangladesh jointly self-sufficient. We consider this in subsequent customs union model by assuming a cut-off in trade connections to India and Bangladesh from the rest of the world.

Table 3. Results of Model 2

	Gross Output (Rs. Million)		Net Output (Rs. Million)		Price	
	India	Bangla-desh	India	Bangla-desh	India	Bangla-desh
1. Agriculture	765347	95364	0	0	2.22530	1.48284
2. Livestock, fishing and forestry	328668	180288	0	0	2.39834	1.41408
3. Other food	264937	33137	0	0	1.75635	1.24096
4. Textiles	288812	29058	0	0	1.18991	1.44005
5. Manufacturing	2881221	278057	0	0	1.65178	1.15678
6. Chemicals	367557	1159628	0	731008	1.20291	1
7. Machinery	836463	44290	0	0	1.22030	1.09981
8. Construction	244929	20882	0	0	1.99420	1.21462
9. Electricity and gas	8543341	48898	5471480	0	1	1.14905
10. Services	7946745	169226	4835126	0	1	1.07415

Note: (-) negligible figures

Table 4. Shadow Price of factors in India and Bangladesh in Model 2

	Capital	Labor
India	0.65931	0.02498
Bangladesh	0.18991	0

The customs union results are shown in Table 3. We find that the competitive sectors in India are still the electricity and gas and service sectors. But now India is competitive in textiles also, while Bangladesh continues to be competitive in chemicals. It now also enjoys comparative advantage in agriculture, livestock, fishing and forestry, other food and machinery products. However, as seen from Table 3, the net output figures in these additional competitive sectors are negligible both for India and Bangladesh, indicating neither enjoys much advantage in the production of these commodities. Inspection of the net output figures further shows that there are practically no bilateral trade relations between India and Bangladesh. The gross figures, as before, show that there are no specific sectors in which each economy specializes. Both economies produce all commodities themselves instead of producing some and exchanging them for others from the other economy. Moreover, the gross output figures of the two economies are the same as in Model 1.

The shadow prices of labor and capital also continue to be the same as in Model 1. Thus, the results of Model 2 show practically no improvement over the results of Model 1. The few changes that we have are so negligible that they can be easily ignored. We fail to trace any comparative advantage of India vis-a-vis the economy of Bangladesh with model 2, indicating that neither India nor Bangladesh is jointly self-sufficient, but is so dependent on the rest of the world that the idea of one closed economy comprised of these two economies does not seem to be a viable proposition.

We will now discuss the results of Model 3 where we brought in the non-tradables. Some commodities may not be tradable for physical reasons. On the basis of zeros in

actual trades, we have identified construction and electricity and gas as non-tradables. The imposition of non-tradability of construction and electricity and gas in Model 2 yields Model 3. Inspection of the signs and magnitudes of net output (Table 5) yields the following patterns.

Table 5. Results of Model 3

	Gross Output (Rs. Million)		Final Demand (Rs. Million)		Price	
	India	Bangla-Desh	India	Bangla-desh	India	Bangla-desh
1. Agriculture	760686	95157	0	-	2.13676	1.48370
2. Livestock, fishing and forestry	349487	180303	0	-	2.38199	1.41499
3. Other food	254490	32614	0	-	1.68442	1.24168
4. Textiles	309226	29044	-	0	1.12586	1.44082
5. Manufacturing	4190599	278140	0	0	1.35043	1.15733
6. Chemicals	487699	1160316	0	731527	1.03260	1
7. Machinery	8554224	44290	6736441	-	1	1.10044
8. Construction	158725	20881	0	0	1.94910	1.21525
9. Electricity and gas	2072196	48911	0	0	0.72989	1.14913
10. Services	5313264	169168	2073643	0	1	1.07480

Note: (-) negligible figures

Table 6. Shadow Price of factors in India and Bangladesh in Model 3

	Capital	Labor
India	0.16814	0.02780
Bangladesh	1.40311	0

There is, as before, no indication of bilateral trade relations between India and Bangladesh. But with the imposition of the non-tradability restriction, India's competitiveness has shifted from electricity and gas to machinery, making it competitive in the world with its machinery and services. Bangladesh, as before, enjoys competitiveness in chemicals and to a very small extent in agriculture, livestock, fishing and forestry and other food. But now it imports a very negligible quantity of manufactured goods, as shown by the net output figure.

The shadow prices of the factors are now slightly changed (Table 6). In Bangladesh, though the wage rates are the same as before, reflecting labor abundance, the rental rates of capital are higher, showing that the supply of capital is now short.

On the other hand, in India, the rental rates of capital have gone down, showing capital is now less scarce while wage rates are slightly higher, showing the greater scarcity of labor.

With the inclusion of the non-tradability restriction on electricity and gas and construction, India now exports services and machinery to the rest of the world and becomes relatively more capital abundant and more labor scarce. Thus, India, being endowed with skilled labor, uses more labor to produce machinery, in which it enjoys a

comparative advantage. The shift in competitiveness from electricity and gas to machinery releases capital and absorbs more labor, resulting in the greater labor scarcity and capital abundance in the economy of India. On the other hand, capital stock in Bangladesh is small, and non-tradibility of some goods changes the production patterns in such a way that capital becomes even shorter. As a result, the shadow rate of return on capital in the economy becomes considerably high.

5. Summary and Conclusion

Low intra-SAARC trade resulted in a concrete step being taken when a study on SAARC Trade, Manufactures and Services was commissioned at the Islamabad Summit in 1988.

Member countries have initiated various measures for strengthening the process of regional cooperation within the framework of SAARC. They are now promoting steps for cooperation in core economic areas so as facilitate the transition of SAPTA (South Asian Preferential Trade Agreement) into SAFTA (South Asian Free Trade Area). With this kind of effort on the part of the member countries, it is expected that in the long run there will be a movement away from intra restrictions mandated under the arrangement of SAPTA to a more free trade grouping without restrictive trade barriers under the arrangement of SAFTA.

In this paper, we have concerned ourselves with two SAARC members, India and Bangladesh, trying to locate the comparative advantage of the former vis-a-vis the latter. We have developed three models for the analysis of the comparative advantage of the Indian economy vis-a-vis that of Bangladesh.

The first model shows that while India's comparative advantage in a perfectly competitive world market rests in electricity and gas and services, that of Bangladesh is in chemicals. The shadow prices of factor inputs show that India has a scarcity of both labor and capital, being relatively more lacking in capital, while Bangladesh is deficient only in capital.

The results of Model 2 also show that India is competitive in electricity and gas and services as in model 1. However, with the inclusion of the joint autarky constraint India now enjoys, though to a very small extent, it now has a comparative advantage in textiles also. Likewise, given the joint autarky constraint Bangladesh continues to enjoy a comparative advantage in chemicals, with some recently gained advantage, though negligible, in operating the sector - agriculture, livestock, fishing and forestry, other food, and machinery.

The shadow prices as obtained in model 2 are the same as in Model 1. Model 2 ultimately shows that there exist no bilateral trade relation as such between the economies of India and Bangladesh.

Finally, in the third model, with the inclusion of the non-tradability constraints on electricity and gas and construction, India's comparative advantage shifts to machinery while services continue to be a competitive sector. Bangladesh still continues to enjoy its competitiveness in chemicals and to a negligible extent in agriculture, livestock, fishing and forestry and other food. Bangladesh, now, also imports a small quantity of

manufactured goods.

This change is accompanied by an increase in capital scarcity in Bangladesh and labor scarcity in India. Moreover, capital has now become relatively less scarce in India. This may be due to increase in India's competitiveness and hence in production of machinery, which releases more capital but absorbs more of its abundant factor, labor. On the other hand, non-tradability of some goods changes production patterns in Bangladesh in such a way that renders capital more scarce than before.

To conclude, the present study shows that with given world prices, India's comparative advantage vis-a-vis the rest of the world is in two sectors - electricity and gas and services, and that of Bangladesh is in chemicals. Thus, export of these commodities to the rest of the world by India and Bangladesh will enhance the earning capacity of these economies.

However, our attempt to make India and Bangladesh jointly autarkic does not yield the desirable results. It shows that the two economies cannot be jointly self-sufficient. They are too dependent on the rest of the world and as such the idea of a closed economy comprised of India and Bangladesh does not seem to be a viable proposition.

The findings of this work should be treated as tentative. Our data base has some limitations, being of a highly aggregative nature. The economies of both India and Bangladesh consist of 10 sectors only. Moreover, all the data required are not available in the desired form, causing us to adopt roundabout methods to prepare the data set. Nevertheless, the findings, though tentative, encourage us to believe the work should be pursued in detail.

Appendix

Data

The data required for our empirical work was not available in the desired form and as such we had to adopt roundabout methods to obtain the statistics necessary for the model. We have used various sources – official and semiofficial sources, as well as studies of other researchers - to build a data base for the empirical implementation of the model.

The application of the model developed in Section 3 requires data on the following

* Input-output coefficient matrices for India and Bangladesh ($\mathbf{A}$, $\mathbf{A}^1$)
* Sectoral capital and labor coefficients ($\mathbf{k}$, $\mathbf{k}^1$, $\mathbf{l}$, $\mathbf{l}^1$)
* Sectoral consumption coefficients ($\mathbf{c}$, $\mathbf{c}^1$)
* Stock of capital and labor for the two economies (K, L, K^1, L^1).

Since the data are not always available in these forms, we will now describe the data and their manipulation in the following section.

A.1 Input - Output Coefficient Matrices

The basis of the data for this study are the two Input-Output Tables of the Indian Economy for the year 1991-92 [Government of India, Planning Commission, 1995], and of the economy of Bangladesh for the year 1992-93 [Center on Integrated Rural Development for Asia and Pacific, (CIRDAP), Bangladesh, June 1996].

The Input-Output Table for the Indian economy consists of 60 sectors, while that of the economy of Bangladesh consists of 53 sectors. These two input-output tables have been aggregated into 10 sectors only, in a way such that there are common sectors for India and Bangladesh. From the aggregated input-output table of each country, the input-output coefficient matrices - ($\mathbf{A}$) for India and ($\mathbf{A}^1$) for Bangladesh - have been computed.

A.2 Labor and Capital Coefficients

Labor Coefficients

In this study, sectoral labor coefficients for each sector have been computed from the sectoral employment and sectoral output data of the respective economies. While for the economy of Bangladesh the employment figures for the desired sectors were available for the year 1992-93 [Center on Integrated Rural Development for Asia and the Pacific (CIRDAP), Bangladesh, June 1996], for the economy of India the employment figures for all the sectors desired were not available for the year 1991-92. We computed them using the employment figures of the year 1979-80 (Ten Raa and Chakraborty, 1991) and employment growth rate for the period 1977-78 to 1987-88 (Government of India, Planning Commission, 1995).

Capital Coefficients

To obtain the sectoral capital coefficients for the economies of India and Bangladesh, we made use of their sectoral values added at factor cost and their wage rates. For both the economies these figures for sectoral capital coefficients were available from their respective input-output tables.

For the Indian economy, the wage rate was available from the Indian Labor Year Book 1995. For the economy of Bangladesh we had the data on wage rates for all the sectors,

[Center on Integrated Rural development for Asia and Pacific (CIRDAP), June 1996]

A.3 Consumption Coefficients

From the input-output table of India and Bangladesh we take the consumption vector, and allocate to the workers by the wage share of value added. Finally, we divide this by total employment to get consumption per unit of labor, i.e, the consumption coefficients.

Table A.1 Sectoral Labor, Capital and Consumption Coefficients in India and Bangladesh

	India			Bangladesh		
	Labor Coefficient	Capital coefficient	Con-sumption coefficient	Labor Coefficient	Capital coefficient	Con-sumption coefficient
1. Agriculture	42.37672	0.392793	0.001540	53.82907	0.299198	0.003919
2. Livestock, fishing and forestry	42.37672	0.229301	0.000650	28.68416	0.574995	0.001197
3. Other food	8.832467	0.075254	0.000626	11.20844	0.162946	0.000942
4. Textile	8.832468	0.409036	0.000578	30.29417	0.002132	0.000506
5. Manufacturing	8.832467	0.294772	0.000274	6.156246	0.136486	0.000260
6. Chemicals	8.832468	0.264908	0.000089	1.355685	0.209854	0.000355
7. Machinery	8.832467	0.333914	0.000155	4.202512	0.259145	0.000138
8. Construction	32.86428	0.018992	0	9.094539	0.035194	0
9. Electricity and gas	4.602278	0.443211	0.000034	2.759021	0.461916	0.000037
10. Services	18.59349	0.487776	0.002054	21.16043	0.388550	0.002187

A.4 Capital Stock and Labor Stock

In order to estimate the total capital stock of an economy, we require data on the degree of capacity utilization of that economy. For India, we obtained it to be roughly around 60% from Ten Raa and Chakraborty (1991). Given this rough estimate of capacity utilization, the total capital stock for the Indian economy is obtained.

The capacity utilization in Bangladesh is also assumed to be around 60% and the capital stock for the economy of Bangladesh is also obtained.

The figures for the total labor force for both economies are the total economically active population which includes persons employed as well as those who are willing to supply labor. For India this figure is available from the Government of India, Planning Commission 1995, and for Bangladesh it is available from the World Development Report, 1995.

Table A.2 Capital Stock and Labor Stock of India and Bangladesh

	Capital Stock (Rs millions)	Labor (million)
India	5876701.0	282.42000
Bangladesh	521360.4	36.23898

References

[1] Center on Integrated Rural Development for Asia and Pacific, Bangladesh (1996), *Database for the General Equilibrium Model: Input-Output and Related Tables for the Bangladesh Economy* 1992-93, MAP Working Paper Series No.2.

[2] Duby, M. (1996), "South Asia Free Trade and India," Paper presented in a conference on SAARC: Conflict and cooperation held 22-23 March, 1996, DSA center for Regional Economies. Department of Economics, Jadavpur University, Calcutta.

[3] Gupta, I. (1997), *A Spatial Equilibrium Model for SAARC countries*, (unpublished) M. Phil dissertation, Jadavpur University, Calcutta.

[4] Mukherjee, I. N. (1996), "South Asian Preferential Trading Arrangement: Assessing Trade flows in Negotiated Products," Paper presented in a conference on SAARC: conflict and cooperation, held 22-23 March, 1996. DSA Center for Regional Economics, Department of Economics, Jadavpur University, Calcutta.

[5] Niyogi, T. (1996), *Factor Content of India Foreign Trade*, (unpublished) M. Phil dissertation, Jadavpur University, Calcutta.

[6] Parthasarathi, G. (1990), *Economic Cooperation in the SAARC Region. Potentials, Constraints and Policies*, Interest Publications, New Delhi.

[7] Planning Commission Government of India, *A Technical Note to the Eight plan of India* (1992-97).

[8] Shri, P., Chowdhury, S., Singh, S., Sharma, A. (1995), "Structure of Trade and Cooperation Among Members of SAARC," paper presented in a conference on SAARC: Conflict and Cooperation held 22-23 March, 1996. DSA center for Regional Economics, Department of Economics, Jadavpur University, Calcutta.

[9] Raghavan, S. N. (1995), *Regional Economic Cooperation Among SAARC Countries*, Allied Publishers Limited.

[10] Raychowdhuri, A. and Chatterjee, B. (1996), "Trade patterns between India and other SAARC countries: Some observations and Suggestions," paper presented in a conference on SAARC Conflict and Cooperation held in 22-23 March, 1996. DSA center for Regional Economics, Department of Economics, Jadavpur University, Calcutta.

[11] Schrijver, A (1986), *Theory of Linear and Integer Programming*, John Wiley and Sons.

[12] Sen, S. (1972), "Indo-Bangladesh trade: problems and prospects," Foreign Trade / Bangladesh. Volume 7, No.15.

[13] Ten Raa, T. (1995), *Linear Analysis of Competitive Economies*, Harvester Wheat Sheaf.

[14] Ten Raa, T. (1996), "The Location of Comparative Advantages within SAARC," paper presented in a conference on SAARC: Conflict and Cooperation held 22-23 March, 1996. DSA Center for Regional Economics, Dept. of Economics, Jadavpur University Calcutta.

[15] Ten Raa, T. and Chakraborty, D. (1991), "Indian Comparative Advantage vis-a-vis Europe as Revealed by Linear Programming of the two Economies," *Economic Systems Research*, Volume 3, No.2.

[16] Ten Raa, T. and Mohnen, P. (1991), *Domestic Efficiency and bilateral trade gains with an application to Canada and Europe* (unpublished).

[17] The Bangladesh Development Studies (1995), *The Quarterly Journal of the Bangladesh Institute of Development Studies*. Volume 23, Nos. 3 &4.

[18] Waqif, A. A. (1987), *South Asian Cooperation in Industry, Energy and Technology*. Sage Publications.

[19] Waqif, A. A. (1991), *Regional Cooperation in Industry and Energy Prospects for South Asia*. Sage Publications.

[20] Woodland, A. D. (1982), *International Trade and Resource Allocation*. North Holland, Amsterdam.