The Factor Content of Bilateral Trade between India & Sri Lanka

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Abstract

India and Sri Lanka account for the largest bilateral trade flow in the SAARC region. Following India's liberalization in early nineties this bilateral trade grew by 10% per annum during 1993-99. Thereafter following India-Sri Lanka FTA the trade flow grew by over 27% from 2000 to 2006. India is now Sri Lanka's largest importer and among the top five destinations for Sri Lankan exports. Given the growing importance of this bilateral trade, the present paper attempts to study the factor content of India-Sri Lanka bilateral trade.

The paper aims to examine whether the factor intensity of the bilateral trade have been in conformity with the pattern of comparative advantages of the respective countries, particularly India as is determined from their factor endowments. Using the input-output transaction tables for Sri Lanka (year 2000) and India (year 2003-2004) the paper tests empirically the Heckscher-Ohlin theory for India- Sri Lanka's bilateral trade and reports if Leontief paradox is witnessed or not. Results show that exports from India to Sri Lanka are capital intensive while imports from Sri Lanka are labour intensive. Thus, the results provide evidence to support Leontief paradox in case of India which the paper seeks to explain. The current paper also includes land as a third factor of production. Researchers across the world have shown interest on similar work involving developed and developing countries. But there has not been much work involving two developing countries. The paper seeks to contribute to this gap and comes up with results that have important implications both for academic and policy-making community.

JEL subject codes: F1, F14

Key Words: Factor content, Leontief paradox, Leamer, bilateral trade, India-Sri-Lanka

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The Factor Content of Bilateral Trade between India & Sri Lanka

India and Sri Lanka account for the largest bilateral trade flow in the SAARC (South Asian Association of Regional Cooperation) region. Bilateral trade between India and Sri Lanka and the idea to strengthen it has been discussed as early as 1990 in the writings of various researchers (Panchmukhi et al 1993; Jayawardena, Ali and Hulugalle, 1993). In 1993 the agreement on South Asian Preferential Trading Arrangement (SAPTA) was signed among the seven member countries of the SAARC with the aim to promote and sustain trade and economic cooperation in the region. This pushed behind the idea of strengthening just India-Sri Lanka bilateral trade for the time being. However, the negotiations under SAPTA progressed at a very slow pace and became a time consuming process. This failure of SAPTA brought back the interest in a free trade arrangement between India and Sri Lanka, initially from the Sri Lankan side as this was likely to provide the country with the much desired market access to its exporters in India. But soon India too started showing its keenness for such a bilateral trade arrangement with the aim to acquire the South Asian markets. Accordingly, the India-Sri Lanka Free Trade Agreement (ISFTA) was signed between the two countries on 28 December, 1998 in New Delhi, India and came into operation on 1 March, 2000.

1. India's trade with Sri Lanka

Sri Lanka embarked on a path of comprehensive economic policy reforms in 1977 and became the first country in South Asia to adopt the export-driven growth strategies. The Indian economy too moved towards liberalization since 1980 and following its macroeconomic crisis in 1991 the economy went in for long term structural reforms in the industrial, trade and financial sector of the economy. The trade policy too was reformed during this period with main focus on liberalization, openness, transparency and globalization.

Thus, the two economies of Indian and Sri Lanka gradually opened up and this gave a significant boost to bilateral trade between the countries (Table 1). India's exports increased from US $ 277 millions in 1992 to US $ 502 in 1999 while total trade went up from US $ 291 millions to US $ 546 millions. Thus, the total bilateral trade between the two economies nearly doubled during this period. Particularly, the export figures revealed that immediately in the post reform period when the Indian economy opened up, the exports of Indian goods to Sri Lanka increased at a rate of 13% per annum between 1992 to 1997. By 1995 India became the largest source of imports for Sri Lanka, accounting for 8%-9% of its total imports. Thus, Sri Lanka's trade with the SAARC region virtually amounted to trade with India.

Further, with the implementation of the FTA in March 2000, this bilateral trade has grown even more rapidly (figure 1). The total trade figures rose from US $ 706 million in 2001 to US $ 1.7 billion in 2004 and stood at US $ 3.4 billion in 2008. This, however, came down to US $ 2.1 billion in 2009. Thus, in the post FTA period, bilateral trade between the two economies increased at the rate of 47% per annum during 2001-2008. Exports from India to Sri Lanka increased from US $ 638 million in 2001 to US $ 2838 million in 2008, while exports from Sri Lanka to India during the same period increased from US $ 68 million to US $ 548 million.

Table 1

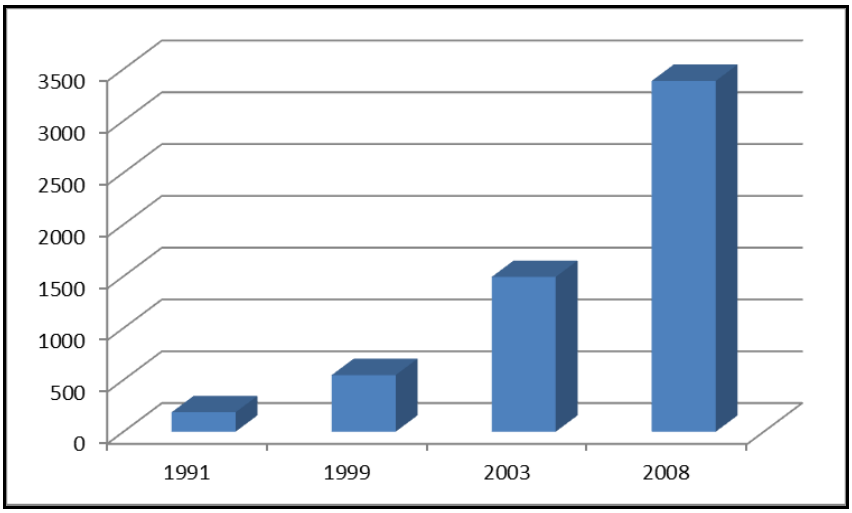
India's trade with Sri Lanka (1991-2009) (US $ million)

Year	Exports	Imports	Trade Balance	Total Trade
1991	175	12	163	187
1992	277	14	263	291
1993	288	39	249	327
1994	367	31	336	398
1995	400	39	361	439
1996	477	35	442	512
1997	489	42	447	531
1998	437	38	399	475
1999	502	44	458	546
2000	650	46	604	696
2001	638	68	570	706
2002	916	90	826	1006
2003	1302	192	1110	1494
2004	1400	333	1067	1733
2005	1939	568	1371	2507
2006	2105	505	1600	2610
2007	2594	441	2153	3035
2008	2838	548	2290	3386
2009	1724	328	1396	2052

Source: ITC Trademaps

Figure 1

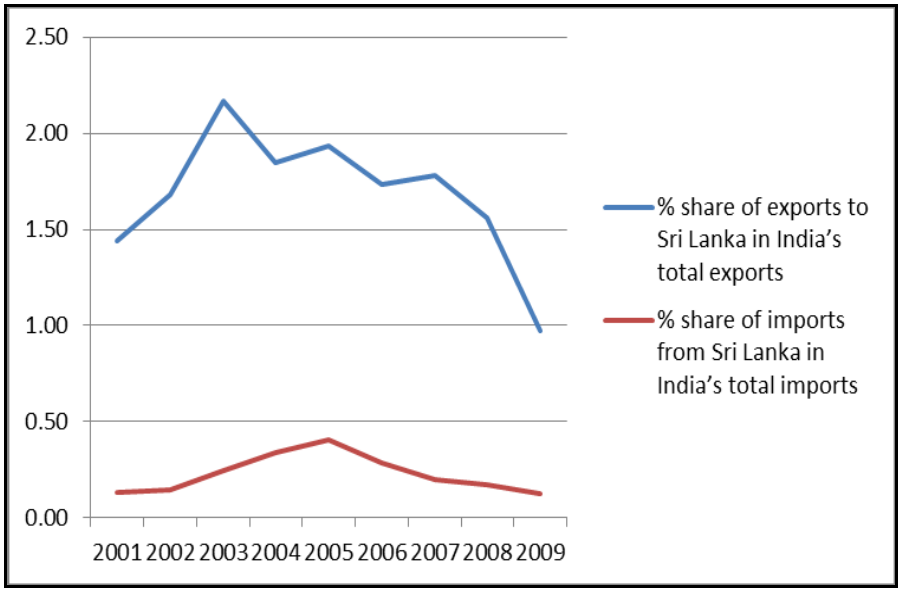
Total Bilateral Trade between India and Sri Lanka for select years prior to FTA and after FTA (US $ million)



Source: based on data from UN comtrade

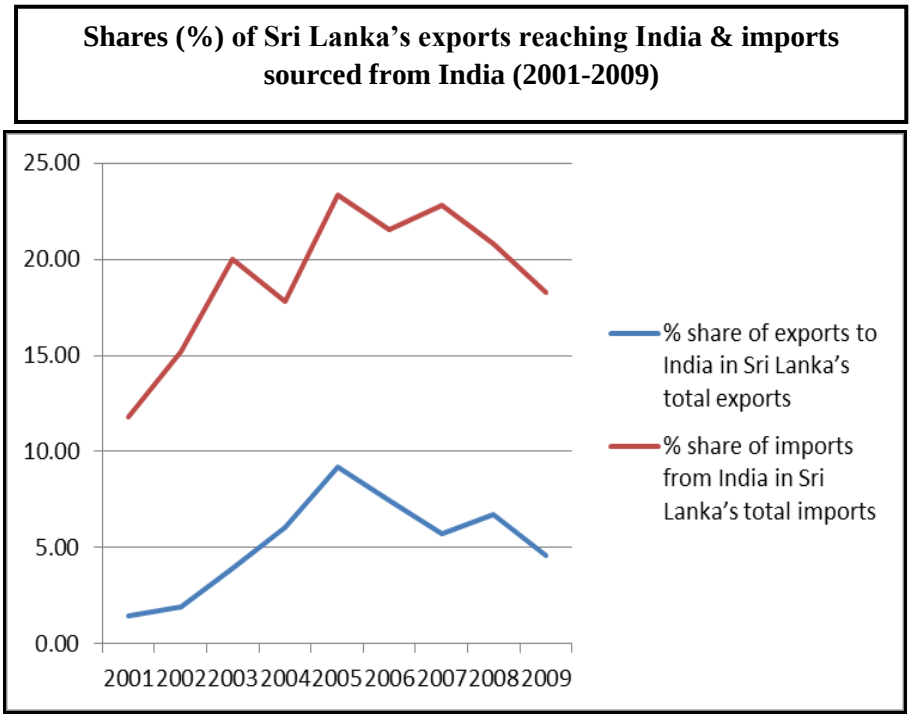
Figure 2a

Shares (%) of India's exports reaching Sri Lanka & imports sourced from Sri Lanka (2001-2009)



Source: based on data from UN Trademaps

Figure 2b



Source: based on data from UN Trademaps

The top Indian exports to Sri Lanka in the last couple of years are - mineral fuels, oils, distillations products, vehicles other than railway, tramway, iron & steel, cotton, pharmaceutical products, machinery, articles of iron & steel, paper and paper board, articles of pulp, paper & board, manmade filaments, apparels, salt, sulphur, earth, stone, plaster, lime & cement, sugars and sugar confectionary, cereals and inorganic chemicals. The largest share in India's total bilateral exports to Sri Lanka has throughout been Manufactured articles, Machinery and transport equipment, Food and live animals and Chemicals. Mineral fuels dominated a large share (19%) in initial years of the FTA, but over the period this share has come down to a minimal of 0.7%.

The top exports of Sri Lanka to India in the recent years have been apparel & accessories, coffee, tea, mate & spices, rubber & articles thereof, pearls, precious stones, metals and coins, fish, electrical and electronic equipment, nuclear reactors, boilers & machinery, copper and copper articles, plastics and plastic articles, edible fruits & nuts, ceramic products, other made textile articles, toys, games, sports requisites, vegetable textile fibres, paper yarn, woven fabric, tobacco and manufactured tobacco substitutes and animal, vegetable fats and oils, cleavage products etc. Food item has always occupied the largest share in SriLanka's total exports to India. In the initial years of the FTA, items like mineral fuels and inedible crude materials came next to food in terms of share in Sri Lanka's total export to

India. But nine years into the FTA, these goods have been replaced by manufactured articles and machinery & transport equipment.

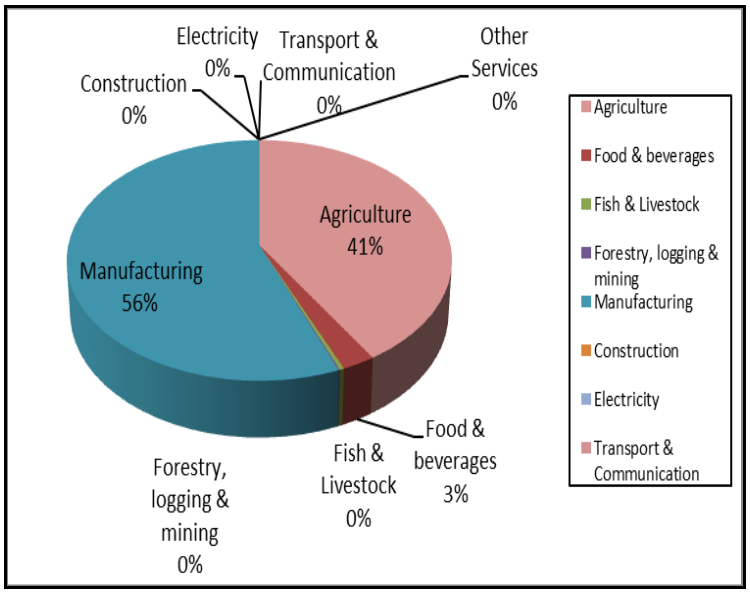
India mostly continues to export its traditionally important goods to Sri Lanka even after major tariff concession exchanges with the country under ISFTA. But for Sri Lanka the export basket has undergone major changes. However, food continues to be its main exports to India. It is to be noted that mineral fuels is a product which was earlier traded largely between the countries, is traded minimally between them at present.

Post the FTA implementation the India-Sri Lanka bilateral trade grew by more than 47% from 2001 to 2008 in contrast to the pre-FTA rate of 14% per annum during 1993-2000. India is now Sri Lanka's largest importer and among it's the top five export destinations. The bilateral trade basket has also seen some changes in its composition over the FTA period, particularly for Sri Lanka. The two countries have now moved towards negotiations on Comprehensive Economic Partnership Agreement (CEPA) with the aim of providing additional market access to each other. The CEPA negotiation was initiated in 2005 and was concluded in July 2008, after thirteen rounds of negotiations. CEPA aims at widening and deepening of the existing FTA, establishing an agreement on trade in services, including measures for promotion of investment in each other's countries and enhancing economic cooperation. Both the countries had taken a decision to sign the CEPA during the 15th SAARC Summit held in Colombo in 2008 but due to certain reservations expressed by the Government of Sri Lanka, the agreement has not yet been signed.

Against this backdrop, the present paper attempts to study the factor content of India-Sri Lanka bilateral trade based on India's input-output transaction table for 2003-2004. The composition of India's export to and imports from Sri Lanka during this year is presented in figures 3a & 3b.

Figure 3a

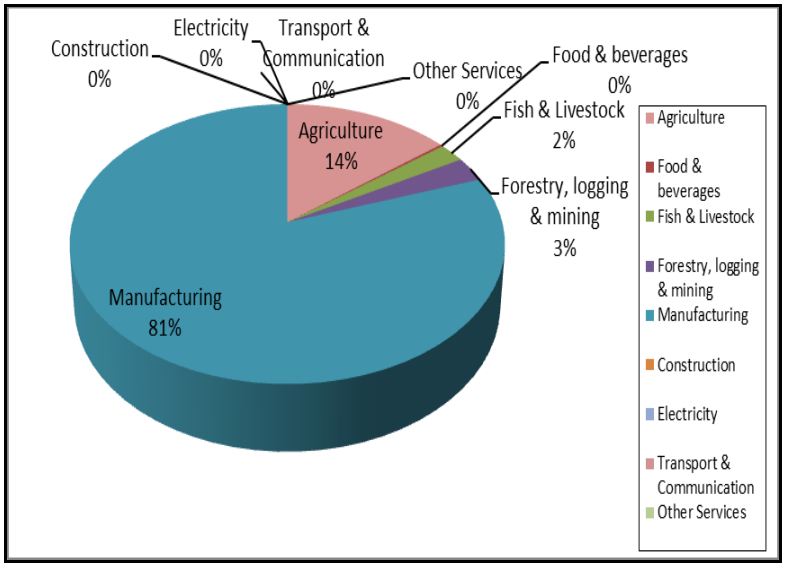
Share (%) of different product categories in India's total exports to Sri Lanka in 2003-2004



Source: based on data from UN comtrade

Figure 3b

Share (%) of different product categories in India's total imports from Sri Lanka in 2003-04



Source: based on data from UN comtrade

2. Objective of the Study

The paper aims to study the factor content of India's bilateral trade with Sri Lanka and examines whether the factor intensity of this growing bilateral trade have been in conformity with the pattern of comparative advantages of the respective countries as are determined from their factor endowments or whether there have been other factors which have affected the pattern of bilateral trade between the two countries. India and Sri Lanka are both labour abundant countries. Thus, according to the Hecksher-Ohlin hypothesis, India in its bilateral trade with Sri Lanka will tend to export relatively labour intensive commodities and also import goods from Sri Lanka which are labour intensive as well. Using the input-output transaction table for India (2003-2004) the paper tests empirically the Heckscher-Ohlin theory for India- Sri Lanka's bilateral trade and reports if Leontief paradox is witnessed or not.

3. Literature Review

India Sri Lanka bilateral trade has been a topic of discussion among contemporary researchers. They have shown much interest in analyzing the pattern of bilateral trade and analyzing the benefits and pitfalls as also the success and prospects of the FTA between these two South Asian economies. This interest gave rise to a substantial volume of literature on this topic in recent years. Some important contributions in this area have made by Jayawardena *et al* 1993; Kelegama 1999; Weerakoon 2001; Mukherjee *et al* 2002; Taneja *et al* 2004; Thenuwara 2005; Kelegama *et al* 2007. Most of these works discuss bilateral free trade between India and Sri Lanka with emphasis on the various aspects of trade like pattern of trade, time frame for tariff liberalization, negative list, rules of origin, the positive and the negative outcomes of the free trade agreement, yet none of these work have discussed the factor content of the bilateral trade between the countries.

Factor content of trade have been discussed extensively by researchers across the world. The earlier studies mostly examined this in the context of one country. Later on, there have been multi-country studies: Baldwin, 1979; Bowen *et al*., 1987; Clifton and Marxsen, 1983. Some important recent works which are worth mentioning are those by Duchin 2000 and Lee *et al* 2002. Duchin reviewed eight of Leontief's publications made between 1933 to 1977 and offered some of her observations about the evolution and significance of Leontief's body of work. As a part of this review she revisited Leontief's original work with US trade data for 1947 wherein the paradox of US being more labour rather than capital intensive was observed for the first time. Duchin noted that Leontief's work stimulated many empirical studies that examined the factor contents of imports and exports for different countries and time periods including the very influential article of Leamer (1980) which introduced a new line of refutation for the paradox observed by Leontief. This work by Duchin though a recent one and discusses Leontief's contribution in demonstrating the power of input-output

economies and in assessing the factor content of trade for countries, yet this is based on survey and hence theoretical. Lee *et al* earlier did an empirical work in this area wherein they studied the factor intensity of United States' agricultural trade in the context of Leontief's classic paradox using Leontief's method as well as methods developed by Leamer and others. Their findings indicate that factor endowments are important determinants of U.S. agriculture's comparative advantage in trade as suggested by the Heckscher-Ohlin theory. Torstensson (1995) too had done an empirical work involving the OECD countries. He examined the predictions of the Hecksher-Ohlin- Vanek theorem on each and every Organization for Economic Co-operation and Development (OECD) country's net trade in 1986. More recently, a similar work which studies India's factor content of trade has been done by Dasgupta *et al* (2009). This study measures the factor content of India's foreign trade during the nineties reform period with the objective to find out whether factor intensity of trade has been in tune with comparative advantage of the country as determined from its factor endowments. The study reports that India's exports to the rest of the world are more labour intensive than its import replacements and hence there is no paradox as such. But when it comes to India's trade with OECD, its exports are found to be more capital intensive than its imports during the later years of reforms, thereby producing an instance of Leontief paradox. The study also notes such paradox with respect to India's trade with EU, North America and Japan.

The present study attempts a similar work as that of Dasgupta *et al.* Here the factor content of India's bilateral trade with Sri Lanka is studied using Leontief's and Leamer's methods. This study differs from most of these earlier multi-country studies in three ways- First, it studies factor content of trade when the trading partners in question are both developing countries. Secondly, it studies factor content of India's bilateral trade with Sri Lanka using a very recent data (2003-2004) on trade flows. Moreover, the study first examines trade in a framework with two factors of production- labour and capital as was originally done by Leontief and Leamer. Then this framework is extended to include a third factor of production- land

The rest of the paper is organized as follows: Section 4 highlights the analytical framework. The data is discussed in section 5. Section 6 presents the results. The paper finally concludes with a summary of the finding and their policy implications.

4. Analytical framework

The estimation of the factor content of India-Sri Lanka bilateral trade in this study uses two alternative frameworks as developed by Leontief (1951) and Leamer (1980). At the outset we begin by discussing the two frameworks in detail.

4.1 Leontief framework

Heckscher (1919) and Ohlin (1933) made a major contribution to the theory of international trade by focusing on the relationships between the composition of a country's factor endowments and its

commodity trade patterns. The Heckscher–Ohlin theorem states that countries export those commodities which require, for their production, relatively intensive use of those productive factors which are found locally in relative abundance. The pioneering and elaborate effort of testing empirically the validity of this theorem was first attempted by Leontief in 1951. In his attempt to see if trade pattern of a country really corroborates the Hecksher-Ohlin conclusion, Leontief applied the tools of Input-Output technique and tested the factor intensities of the average export and competitive-import of the United States. By common consent the United States has more capital per worker than any of the countries with which it trades. Hence if Hecksher-Ohlin theorem holds, then USA should export commodities requiring more capital and import commodities which use, when domestically produced, relatively more labour. But this empirical research by Leontief led to the revolutionary finding that United States apparently exported labour-intensive goods and imported capital intensive commodities. This finding has been referred to in literature as Leontief Paradox.

In this pioneering research Leontief used an Input-Output table for United States based on 1947 data and considered two factors of production- labour and capital. He computed the direct and indirect requirement of labour and capital to produce a representative bundle of one million dollar worth of the U.S. exports and a representative bundle of one million dollar worth of domestic goods, directly competitive with the U.S. imports. Heckscher-Ohlin theory is applicable to the actual imports of a country and not to its import –replacements. But computation of input coefficients for actual imports of a country requires thorough knowledge of the production functions of each product in the country and all its trading partners. This is not only a herculean task; it is also difficult to get foreign data on factor requirements of actual imports of a country. Thus, Leontief considered the import competing industries in the USA and calculated their factor requirements by using USA's domestic technology coefficient matrix. While doing this exercise he omitted the non-competitive imports from USA's import basket. His argument was if the possible alternative pattern of trade is to have any meaning in respect of competitive imports then one must consider the stepped-up domestic production as an alternative to actual imports. By using the same technology matrix to compute the factor requirements both for exports and the import replacements, Leontief assumed production function for each commodity to be identical across the entire world and hence there was no factor intensity reversal. In this context the concept of competitive and non-competitive imports should be explained. The imported commodities which can also be produced domestically, either fully or partially are referred as competitive imports while those imports which are impossible or extremely difficult to produce domestically are referred to as non-competitive imports. The Leontief framework may be represented as follows:

Let

A = (n x n) be the technology matrix of an economy. Each element of this matrix represents the direct requirement of intermediate input per unit of output produced in the economy.

$x = (x_1, x_2 \ldots\ldots\ldots x_n)$, (1 x n) be the gross output vector of the economy

$C = (C_1, C_2 \ldots\ldots\ldots C_n)$, (1 x n) be the economy's domestic expenditure vector

$E = (E_1, E_2 \ldots\ldots\ldots\ldots E_n)$, (1 x n) be the export vector of the country. Each element of this vector represents the share of each commodity in one million dollar worth of exports done by the country.

$M = (M_1, M_2 \ldots\ldots\ldots M_n)$, (1 x n) be the import vector where each element represents the share of each commodity in one million dollar worth of imports of the country. As mentioned in the preceding paragraph this import includes only competitive imports and ignores non-competitive imports of the country.

$L = (L_1, L_2 \ldots\ldots\ldots\ldots L_n)$, (1 x n) be the economy's labour coefficient vector. Each element of this vector provides the direct requirement of labour per unit of output produced, measured in physical unit.

$K = (K_1, K_2 \ldots\ldots\ldots\ldots K_n)$, (1 x n) be capital coefficient matrix of the economy. Each element of the matrix shows the direct capital requirement per unit of output produced and is given in money unit.

Further, let us consider the equation

$x = Ax + C' + E' - M'$ (prime indicates transpose)

This is the balancing equation in an input-output model which shows that the output of each sector in the economy is just sufficient to meet the input requirements of all sectors including itself as well as the final demand. This can be rewritten as

$$x = (I - A)^{-1} (C' + E' - M') \quad (1)$$

We now define

$$G = L (I - A)^{-1}$$

This is a (1 x n) vector. An element of this gives the direct and indirect requirement of labour per unit of output.

Multiplying G with E′ and M′ we obtain the total labour embodied in one million dollar worth of export (l_E) and labour embodied one million dollar of import replacements (l_M) respectively.

$$l_E = L (I - A)^{-1} E' = G E' \quad (2)$$

and

$$l_M = L (I - A)^{-1} M' = G M' \quad (3)$$

Likewise we define

$$H = K (I - A)^{-1}$$

This is a (1 x n) vector. Each element of this gives the direct and indirect requirement of capital per unit of output.

And, then multiplying K by E′ and M′ respectively, the capital embodied in one million dollar worth of export (k_E) and one million dollar worth of import replacement (k_M) are obtained.

$$k_E = K (I - A)^{-1} E' = H E' \quad (4)$$

and

$k_M = K (I - A)^{-1} M' = H M'$ (5)

Finally, to verify the Heckscher-Ohlin predictions regarding the pattern of trade for the country in question a comparison between the capital-labour ratio for exports (k_E / l_E) and the capital-labour ratio for import replacements (k_M / l_M) is required to be done . One million dollar worth of export will be more or less capital intensive than one million dollar worth of import replacements according as

$(k_E / l_E) / (k_M / l_M) > 1 \rightarrow L1 > 1$ (6)

or $(k_E / l_E) / (k_M / l_M) < 1 \rightarrow L1 < 1$ (7)

In case there are more factors of production considered (as is in the present study where land is considered the third factor), the factor (say r) embodied in one million dollar worth of export and one million dollar worth of import replacement may be similarly obtained and then this may be compared with the other factors embodied in the same value of export and import-replacement to verify the Hecksher-Ohlin conclusion. That is, the set of ratios to be compared are: k_E / l_E; k_E / r_E; and r_E / l_E with k_M / l_M; k_M / r_M and r_M / l_M

4.2 Leamer framework

Leamer (1980) used an alternative theoretical framework and showed that Leontief applied a conceptually inappropriate test of the Heckscher-Ohlin hypothesis when he applied it on the US data for 1947. He proposed a new set of indices for factor abundance and re-examined the same data and the so called paradox arrived at by Leontief was found to vanish. According to him the same set of figures used by Leontief which led to the apparent paradoxical result in context of the US economy could also be used to show that U.S. net exports are more capital intensive than U.S. consumption. This, in fact, implies that capital is abundant relative to labour in the US. His argument was that the lower capital per worker as was found to be embodied in exports relative to imports in case of USA implied that a country was abundant in labour and scarce in capital (as proposed by Leontief) if and only if the country was found to be net exporter of labour services and net importer of capital services. Leamer used the same set of data for 1947 for the the U.S. economy as done by Leontief and found that US was a net exporter of both capital and labour services in that year. Based on this, he contended that Leontief's result was based on a false proposition. He further showed that under these circumstances, a country to be capital abundant must have its net exports more capital intensive than its consumption. The 1947 data on net export for the U.S. was found to be more capital intensive than the U.S. consumption and on the basis of this Leamer confirmed that the United States was relatively well endowed with capital than labour in that year. Thus, the so called Leontief Paradox ceased to exist.

Leamer argued against the usage of the Leontief's index (comparison of (k_E / l_E) and (k_M / l_M)) and held it to be conceptually incorrect and theoretically inappropriate when a country is net exporter or

importer of both capital and labour services. He proposed a new index for factor abundance using the Hecksher-Ohlin-Vanek (H-O-V) model. This is discussed below.

Let the number of countries in the world be 'c' with 'n' factors of production and 'm' commodities. The basic equation of the H-O-V model is,

$AT_i = F_{fi} = V_{fi} - \alpha_i V_{fw}$ (8)

(i = 1……c, f = 1,……,n and g = 1,……,m)

where for country i,

A = (n x n) the technology matrix.

T_i = (m x 1) vector of net export

V_{fi} = (n x 1) endowment vector

V_{fw} = (n x 1) endowment vector of world, $V_{fw} = \sum_{i=1}^{c} V_{fi}$

and α_i = i-th country's share in total world expenditure.

Let capital and labour be the two factors of production. The labour and capital content of trade are given respectively by

$K_T = K_i - \alpha_i K_w$ (9)

and

$L_T = L_i - \alpha_i L_w$ (10)

A country 'i' is capital abundant if and only if the share of the country's capital endowment in the world endowment of capital is greater than the share of its labour endowment in world's endowment of labour i.e.

$(K_i / K_w) > (L_i / L_w)$

or, $(K_i / L_i) > (K_w / L_w)$ (11)

Using equations (9), (10) and (11) it may be obtained that,

$(K_i / L_i) > [(K_i - K_T) / \alpha_i] / [(L_i - L_T) / \alpha_i]$

or, $- K_i L_T > - L_i K_T$ (12)

Given that there are two factors of production, if trade is balanced then K_T and L_T should be opposite in sign i.e if $K_T > 0$ then $L_T < 0$ if trade is balanced. If l_E and k_E are respectively the labour and capital content of export worth a million dollar, 'e' is the total value of export and likewise l_M and k_M are respectively the labour and capital embodied in imports worth one million dollar and 'm' be the import, then

$L_T = L_E - L_M = l_E e - l_M m$

If $L_T < 0 \Rightarrow l_E e - l_M m < 0 \Rightarrow (l_E / l_M) < (m / e) = 1$ (since trade is balanced)

Similarly, $K_T > 0 \Rightarrow (k_E / k_M) > (m / e) = 1$

Therefore, $(k_E / k_M) > (l_E / l_M)$ (13)

Thus, if trade is balanced, $K_T > 0$ and $L_T < 0$ implies that $(k_E / k_M) > (l_E / l_M)$ which is precisely the index Leontief applied.

Using 1947 US data Leamer found that both $K_T > 0$ and $L_T > 0$. Thus, $(k_E / k_M) < (l_E / l_M)$ was not the right proposition to conclude that the U.S. was not as well endowed with capital as it was with labour. $K_T > 0$ and $L_T > 0$ indicates the presence of either an additional factor or trade surplus or both. However, Deardorff (1984) pointed out that given the assumption of balanced trade, the presence of a third factor might not resolve the Paradox. Leamer adopted the second route to reconcile the paradox with the theory. He defined K_C and L_C as the capital and labour embodied in the domestic expenditure of the commodities respectively used in country i, where $K_i = K_C + K_T$ and $L_i = L_C + L_T$. Putting these relations in equation (12), we get the condition

$$(K_T / L_T) > (K_C / L_C), \quad (\text{if } K_T, L_T > 0) \tag{14}$$

This implies that a country is rich in capital relative to labour if production is endowed with more capital than domestic expenditure.

Moreover, given $K_T > 0$ and $L_T > 0$, equation (12) also implies

$$(K_T / L_T) > (K_i / L_i) \tag{15}$$

Leamer deduced the following conditions, either one of which had to be satisfied by a country whose trade figures revealed that it is more abundantly endowed with capital rather than labour.

$$K_T > 0 , L_T < 0 \tag{16}$$

$$K_T > 0 , L_T > 0 , (K_T / L_T) > (K_C / L_C) \rightarrow L2 > 1 \tag{17}$$

$$K_T < 0 , L_T < 0 , (K_T / L_T) < (K_C / L_C) \rightarrow L2 < 1 \tag{18}$$

Combining the calculations done by Leontief and Travis in their respective studies, Leamer checked these conditions for the U.S. economy and found that the U.S. was relatively more abundant in capital than labour.

In case there are three factors of production, these conditions can be extended to include the third factor (say r). The ratios to be compared to arrive at the relative factor abundance of a country are K_T / L_T; K_T / r_T and r_T / L_T with K_c / L_c; K_c / r_c and r_c / L_c respectively.

5. Data

The application of the theoretical frameworks developed in sections 4.1 and 4.2 require data on the following:

- Input-output coefficient matrix for India - A
- Sectoral capital, labour and land coefficients of India – k, l & r
- India's sectoral bilateral exports to and imports from Sri Lanka – E & M
- India's domestic expenditure corresponding to the sectors - C

The basis of the data for this study is the input-output transaction table for India for the year 2003-04 (Ministry of Statistics & Program Implementation, Government of India). This input output table has 130 sectors which have been aggregated into 33 sectors such that the sectors are comparable with the input output table for Sri Lanka for 2000 (Amarasinghe and Bandara 2005) which has 48 sectors. The aggregation of the sectors is based on the assumption that the aggregated sectors use inputs in identical proportion or are related to one another through strict complementarity or vertical integration so as to keep the input-output coefficients undisturbed. The aggregation scheme is given in Appendix table A1.1.

From this aggregated input-output table of the country, the input-output coefficient matrix (A) (table A1.2 in Appendix) has been computed. The sectoral labour coefficients (l) for the country, has been computed from the sectoral employment and sectoral output data of the economy. Given the employment data, wage rate and the value added for each sector, the sectoral capital coefficients (k) for India is worked out.

Data on usage of land for all the 33 sectors is difficult to get. However, it is necessary to treat land as an important factor for agricultural production. As such the sectoral land coefficients have been obtained for only the agricultural sectors, considered in the model. These are Paddy, Tea, Rubber, Coconut, Tobacco, Fruits, Vegetables and Miscellaneous Agricultural products. The data on land coefficients (r), like labour coefficients, has been worked out from the sectoral land usage and sectoral output data of the economy. Table A1.3 in the Appendix reports these sectoral labour, capital and land coefficients

The data on domestic expenditure corresponding to various sectors are obtained directly from the country's input output table.

Likewise data on India's bilateral import and export of commodities from and to Sri lanka are also directly obtained (UN Comtrade).

The detailed description of these data and their necessary adjustments are presented in the Appendix A1.

6. Results and discussions

The factor content of India's bilateral trade with Sri Lanka has been worked out in two stages. First two factors of production- land and labour are considered following Leontief's original and Leamer's subsequent work. Then the same frameworks are extended to incorporate a third factor of production-land. The results obtained in each case are discussed in the following two sub sections.

6.1 Factor content of India's bilateral trade with Sri Lanka considering two factors of production

Leontief Index

Considering labour and capital as the two factors of production, the Leontief's index is calculated for measuring the comparative capital-labour intensity with respect to India's bilateral trade with Sri Lanka. This is reported in table 2. It is observed that the capital required per unit of labour for India's exports to Sri Lanka is more than that required for domestic replacements of competitive imports (Appendix table A2.1). This implies that India's exports to Sri Lanka contain relatively more capital and less labour than the import replacements. Thus, India's trade structure with respect to Sri Lanka as revealed by Leontief index indicates India to be a capital abundant country.

Table 2

Relative Factor Abundance in India in case of two factors of production

Index	**Ratios Compared**	**Implications corresponding to sign of each ratio**	**Final factor content**
Leontief	$(k_e/l_e)/(k_m/l_m) = 1.21$	One million dollar worth of exports is more capital intensive	In one million worth of exports the factor content is of following order: $k > l$
Leamer	$k_T > 0$; $l_T > 0$ $(k_T/l_T)/(k_C/l_C) = 1.56$	Country is richly endowed with capital relative to labour	The relative factor abundance of the country as revealed by its bilateral trade is of the following order: $k > l$

Source: based on authors' calculation of the indices

Leamer's index

Applying, Leamer's methodology too yields the same results on India's relative factor abundance as revealed by its bilateral trade figures with respect to Sri Lanka. To determine the country's factor abundance as per Leamer's index we had to compare the capital per labour embodied in the country's domestic expenditure with that embodied in its net exports (table A2.2 in Appendix). It shows that India's net exports absorb more capital per unit of labour than its domestic expenditure. Thus, results for India's relative factor abundance as per the Leamer index (table 2) corroborate the results obtained by using the Leontief index. Either index yields that India is a relatively capital abundant country and thus provides evidence of Leontief paradox present with respect to India's bilateral trade with Sri Lanka.

6.2 Factor content of India's bilateral trade with Sri Lanka considering three factors of production

Leontief index

The exercise done in section 6.1 is repeated in this section with an additional factor of production, namely, land. The results of this are reported in table 3.

Table 3

Relative Factor Abundance in India in case of three factors of production

Index	**Ratios Compared**	**Implications corresponding to sign of each ratio**	**Final factor content**
Leontief	$(k_e/l_e)/(k_m/l_m) = 1.21$	One million dollar worth of exports is more capital intensive	In one million worth of exports the factor content is of following order: r > k > l
	$(k_e/r_e)/(k_m/r_m) = 0.85$	One million dollar worth of exports is more land intensive	
	$(r_e/l_e)/(r_m/l_m) = 1.41$	One million dollar worth of exports is more land intensive	
Leamer	$k_T > 0$; $l_T > 0$ & $r_T > 0$		The relative factor abundance of the country as revealed by its bilateral trade is of the following order: r > k > l
	$(k_T/l_T)/(k_C/l_C) = 1.56$	Country is richly endowed with capital relative to labour	
	$(k_T/r_T)/(k_C/r_C) = 0.4$	Country is richly endowed with land relative to capital	
	$(r_T/l_T)/(r_C/l_C) = 3.93$	Country is richly endowed with land relative to labour	

Source: based on authors' calculation of the indices

The results indicate that the land required per unit of labour for Indian exports to Sri Lanka relative to both labour requirement and capital requirement is more than that absorbed by the competitive imports (table A2.1 in Appendix). This implies that the exports from India contain more of land than any of capital and labour. Thus, based on Leontief's index worked out with respect to India's bilateral trade with Sri Lanka, India may be concluded to be more abundant in land and capital rather than labour.

Leamer's index

Likewise, we also had to compare capital per land and land per labour in the domestic expenditure with that in the country's net exports to obtain the Leamer's index. The results of this comparison (table 3) and the results with respect to labour and capital content of trade as reported in table 2, when combined, shows that India's net exports absorbs more capital per unit of labour than its domestic expenditure and further the net exports also absorb more land per unit of capital and labour than the domestic expenditure of the country (table A2.2 in Appendix). Thus, results for India's relative factor abundance as per the Leamer index in case of three factors of production also corroborate the results obtained by using the Leontief index.

Either of Leontief and Leamer index provides evidence to support that there is Leontief paradox present with respect to India's bilateral trade with Sri Lanka. This is true for both cases of two and three factors of production. India's growing trade with Sri Lanka has not been in line with the pattern of comparative advantage of India as suggested by Hecksher-Ohlin theory. India, in spite of being a labour abundant country has been exporting more land intensive and capital intensive goods to Sri Lanka rather than labour intensive goods.

7. Conclusion

There have been a number of studies in recent times which have tried to test the Hecksher-Ohlin theory for India's foreign trade. The present study attempts a similar exercise with respect to India's bilateral trade with Sri Lanka. India- Sri Lanka Free Trade Agreement (ISFTA) operational since 2000 has been a landmark in the economic as well as political ties between the two economies. It is now ten years since this FTA has been operational and both the countries have fully implemented the tariff concessions committed by each of them. As a result the bilateral trade between these economies during this period has reached new heights and dimensions. But in the post FTA period, the growth in exports from either side was noted in products, many of which were not major export earners for either country prior to the implementation of the ISFTA. So these products became commercially viable only following the implementation of the free trade agreement. But in order to sustain the growing trade between the two economies what is important is that goods with genuine comparative advantages (as determined by respective factor endowments) should be largely encouraged. Against this backdrop, the present paper examined whether the factor intensity of the bilateral trade have been in conformity with the pattern of comparative advantages of the respective countries as are determined from their factor endowments. Using the input-output transaction tables for India the paper tested empirically the Heckscher-Ohlin theory for India- Sri Lanka's bilateral trade.

By common knowledge both India and Sri Lanka are labour abundant countries. Thus, one would expect India to export to as well as import those goods from Sri Lanka which are rich in labour rather than any of capital and land. The factor content of this bilateral trade as worked out in this paper does not confirm this general expectation. Both the Leontief and Leamer's index that has been worked out both for two factors and three factors of production indicate that that exports from India to Sri Lanka are intensive in land and in capital rather than being labour intensive.

Thus, the results of the paper provide evidence to support Leontief paradox present with respect to India's bilateral trade with Sri Lanka. This growing trade has not been in line with the pattern of comparative advantage of India as suggested by Hecksher-Ohlin theory and as such the concern over the fact that goods without genuine advantage are dominating the bilateral export basket of India with respect to Sri Lanka seems to hold ground to some extent.

References:

1. Amarsinghe, D. & Bandara J.S. (2005), 'Input Output Tables for Sri Lanka-2000', *Research Studies: Macroeconomic Policy Series No. 16, June 2005*, Institute of Policy Studies, Colombo, Sri Lanka.
2. Baldwin, R.E. (1979), "Determinants of trade and foreign investment: further evidence", *Review of Economics and Statistics*, Vol. 61, pp. 40-8.
3. Bowen, H., Leamer, E.E. & Sveikauskas, L. (1987), 'Multicountry, multifactor tests of the factor abundance theory'. *American Economic Review*, 77, pp. 791-809.
4. Census of India (2001), 'Economic tables', *Office of the Registrar General and Census Commissioner, India*, available at website http://censusindia.gov.in/Tables_Published/B-Series/b_series_tables_2001.aspx
5. Clifton, D.S. and Marxsen, W.B. (1983), "An empirical investigation of the Heckscher-Ohlin theorem", *Canadian Journal of Economics*, Vol. 16, pp. 32-8.
6. Dasgupta, P., Dhar, A. and Chakraborty, D (2009) 'Some Further Evidence on the Factor Content of India's Foreign Trade', paper presented at the *17th International Input-output Conference in Sao Paulo, Brazil*, July 13-17, 2009
7. Deardorff, A.V. "Testing Trade Theories and Predicting Trade Flows", *In Handbook of International Economics*, Vol 1, ed. By R.W.Jones and P.B. Kenen. Amsterdam: North Holland.
8. Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, *Agricultural Statistics at a glance 2008*, available at http://agricoop.nic.in/Agristatistics.htm
9. Duchin, F. (2000) International Trade: Evolution in the Thought and Analysis of Wassily Leontief, *13th International Conference on Input-Output Techniques, Special Session in Memory of Wassily Leontief*, August 21-25, 2000, Macerata, Italy.
10. ITC trademap, *International Trade Centre Trade Map* available at http://www.trademap.org
11. Jayawardena, L., L. Ali and L. Hulugalle (1993), 'Indo-Sri Lanka Economic Cooperation: Facilitating Trade Expansion through a Reciprocal Preference Scheme', *Study Group Series No 9, UNU/WIDER.*
12. Kelegama, S. (1999), 'Indo-Sri Lanka Trade and the Bilateral Free Trade Agreement: A Sri Lankan Perspective', *Asia-Pacific Development Journal*, Vol.6, No.2, December 1999.
13. Kelegama, S. and I.N. Mukherjee (2007), 'India-Sri Lanka Bilateral Free Trade Agreement: Six Years Performance and Beyond', *Research and Information System for Developing Countries (RIS), Discussion Paper 119* available at *www.ris.org.in*.
14. Leamer E. E. (1980), 'The Leontief Pradox Reconsidered' *Journal of Political Economy*, Vol. 88, pp 495-503.
15. Lee, C, Will, D & Schluter, G 1988 'Examining the Leontief paradox in U.S. agricultural trade', *Agricultural Economics*, Vol 2, Issue 3, November 1988, pp 259-272

16. Leontief, W. (1953), 'Domestic Production and Foreign Trade: The American Position Reexamined', *Preceedings of the American Philosophical Society*, Vol. 97
17. Ministry of Labour, Government of India, *Report on Working of Minimum Wage Act, 2005*, available at http://labourbureau.nic.in/
18. Ministry of Statistics & Program Implementation, Government of India, *Input-output transaction table for India. 2003-04* available at http://mospi.nic.in/mospi_cso_rept_pubn.htm
19. Ministry of Statistics & Program Implementation, Government of India, *National Accounts Statistics, 2008, available at* http://mospi.nic.in/mospi_cso_rept_pubn.htm
20. Mukherjee, I.N., T. Jayawardena and S. Kelegama (2002), 'India-Sri Lanka Free Trade Agreement: An Assessment of Potential and Impact', *SANEI completed study* available at *www.saneinetwork.net*.
21. Panchamukhi, V. R., V. L Rao and N. Kumar (1993) 'Indo-Sri Lanka Economic Cooperation: An Operational Programme', *Research and Information System for the Non-Aligned and Other Developing Countries*, New Delhi.
22. Taneja, N., A. Mukherjee, S. Jayanetti, and T. Jayawardena (2004), 'Indo-Sri Lanka Trade in Services: FTA II and Beyond', *SANEI completed study* available at *www.saneinetwork.net*.
23. Thenuwara, H.N. (2005), 'Beyond Indo-Sri Lanka Free Trade: Comprehensive Economic Partnership Agreement with India*', 24th anniversary lecture of the Centre for Banking Studies, Central Bank of Sri Lanka*, December 2005.
24. Torstensson, J. (1995) 'The factor content of net trade for the OECD countries, *Journal of Economic Studies*, Vol. 22 No. 6, 1995, pp. 3-15.
25. Travis, W.P. (1972), 'Production, Trade and Protection When there are Many commodities and Two Factors', *American Economic Review*, Vol. LXII
26. UN Comtrade United Nations Commodity Trade Statistics Database available at http://comtrade.un.org/db/
27. Weerakoon, D. (2001), 'Indo-Sri Lanka FTA, How free is it?' *Economic and Political Weekly*, Vol. 36, No. 8 (Feb. 24 - Mar. 2, 2001), pp. 627-629.
28. World Bank (online), *World Development Indicators* available at http://ddp-ext.worldbank.org/ext/DDPQQ

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Appendix

1. Appendix A1

The application of the theoretical frameworks developed in sections 4.1 and 4.2 of the paper require data on the following:

- Input-output coefficient matrix for India - A
- Sectoral capital, labour and land coefficients of India – k, l & r
- India's sectoral bilateral exports to and imports from Sri Lanka – E & M
- India's domestic expenditure corresponding to the sectors - C

Data on first three categories have been compiled and constructed from various sources - official, semiofficial, and studies of other researchers while data on domestic expenditure of India is directly available from its input-output transaction table. This section describes the underlying data and their adjustments for obtaining each of the first three categories mentioned above.

A1.1 Input- Output Coefficient Matrix

The basis of the data for this study is the input-output transaction table for India for the year 2003-04 (Ministry of Statistics & Program Implementation, Government of India). This input output table has 130 sectors which have been aggregated into 33 sectors such that the sectors are comparable with the input output table for Sri Lanka for 2000 (Amarasinghe and Bandara 2005) which has 48 sectors. The sectors are: (1) Paddy, (2) Tea, (3) Rubber, (4) Coconut, (5) Tobacco, (6) Fruits, (7) Vegetables, (8) Miscellaneous agricultural products, (9) Food & beverages, (10) Tea & coffee processing, (11) Fish & livestock, (12) Forestry & logging, (13) Mining, (14) Textiles, footwear & leather products, (15) Readymade garments, (16) Wood & wood products, (17) Paper & paper products, (18) Chemicals & fertlizers, (19) Rubber & plastic products, (20) Petroleum, (21) Non-metallic & other mineral products, (22) Metal products, (23) Manufacturing, (24) Construction, (25) Electricity & water, (26) Transport (27) Communication, (28) Trade, (29) Hotels & restaurants, (30) Banking & insurance, (31) Ownership & dwellings, (32) Public administration and (33) Other services

The aggregation scheme followed to aggregate the input-output tables of the two economies is given in tables A1.1 and A1.2.

Table A1.1

Scheme for aggregating input-output table, India (2003-2004)

Sl. No.	Commodities	Constituent Subsector/s as per original input-output table
1	Paddy	Paddy (1)
2	Tea	Tea (14)
3	Rubber	Rubber (16)
4	Coconut	Coconut (10)
5	Tobacco	Tobacco (17)
6	Fruits	Fruits (18)
7	Vegetables	Vegetables (19)
8	Miscellaneous Agricultural products	Wheat (2); Jowar (3); Bajra (4); Maize (5); Gram (6); Pulses (7); Sugarcane (8); Groundnut (9); Other oilseeds (11); Jute (12); Cotton (13); Other crops (20)
9	Food & Beverages	Coffee (15); Milk and milk products (21); Sugar (38); Khandsari, boora (39); Hydrogenated oil(vanaspati) (40); Edible oils other than vanaspati (41); Miscellaneous food products (43); Beverages (44); Tobacco products (45)
10	Tea & coffee processing	Tea & coffee processing (42)
11	Fish & Livestock	Fishing (26); Animal services (agricultural) (22); Poultry & Eggs (23); Other liv.st. production & Gobar Gas (24)
12	Forestry & logging	Forestry and logging (25)
13	Mining	Coal and lignite (27); Natural gas (28); Crude petroleum (29); Iron ore (30); Manganese ore (31); Bauxite (32); Copper ore (33); Other metallic minerals (34); Lime stone (35); Mica (36); Other non- metallic minerals (37)
14	Textiles, Footwear & Leather Products	Khadi, cotton textiles(handlooms) (46); Cotton textiles (47); Woolen textiles (48); Silk textiles (49); Art silk, synthetic fiber textiles (50); Jute, hemp, mesta textiles (51); Carpet weaving (52); Miscellaneous textile products (54); Leather footwear (59); Leather and leather products (60)
15	Readymade garments	Readymade garments (53)
16	Wood & wood products	Furniture and fixtures-wooden (55); Wood and wood products (56)
17	Paper & paper products	Paper, paper prods. & newsprint (57); Printing and publishing (58)
18	Chemicals & Fertilizers	Coal tar products (64); Inorganic heavy chemicals (65); Organic heavy chemicals (66); Fertilizers (67); Pesticides (68); Paints, varnishes and lacquers (69); Drugs and medicines (70); Soaps, cosmetics & glycerine (71); Synthetic fibers, resin (72); Other chemicals (73)
19	Rubber & Plastic products	Rubber products (61); Plastic products (62)
20	Petroleum	Petroleum products (63)
21	Non metallic & other mineral products	Structural clay products(74); Cement (75); Other non-metallic mineral prods.(76)
22	Metal products	Iron, steel and ferro alloys (77); Iron and steel casting & forging(78); Iron and steel foundries (79); Non-ferrous basic metals (80); Hand tools, hardware (81); Miscellaneous metal products (82)
23	Manufacturing	Tractors and agri. Implements (83); Industrial machinery(F & T) (84); Industrial machinery(others) (85); Machine tools (86); Other non-electrical machinery (87); Electrical industrial Machinery (88); Electrical wires & cables (89); Batteries (90); Electrical appliances (91); Communication equipments (92); Other electrical Machinery (93); Electronic equipments(incl.TV) (94); Electronic equipments(incl.TV) (94); Ships and boats (95); Rail equipments (96); Motor vehicles (97); Motor cycles and scooters (98); Bicycles, cycle-rickshaw (99); Other transport equipments (100); Watches and clocks (101); Medical, precision& optical instru.s (102); Jems & jewelry (103); Aircraft & spacecraft (104); Miscellaneous manufacturing (105)
24	Construction	Construction (106)
25	Electricity & Water	Electricity (107); Water supply (108)
26	Transport	Railway transport services (109); Land tpt including via pipeline (110); Water transport (111); Air transport (112); Supporting and aux. tpt activities (113); Storage and warehousing (114)

27	Communication	Communication (115)
28	Trade	Trade (116)
29	Hotels & Restaurants	Hotels and restaurants (117)
30	Banking & Insurance	Banking (118); Insurance (119)
31	Ownership & Dwellings	Ownership of dwellings (120)
32	Public Administration	Public administration (130)
33	Other services	Education and research (121); Medical and health (122); Business services (123); Computer & related activities (124); Legal services (125); Real estate activities (126); Renting of machinery & equipment (127); Other commercial, social & personal services (128); Other services (129)

Table A1.2

Scheme for aggregating input-output table, Sri Lanka (2000)

Sl. No.	**Commodities**	**Constituent Subsector/s as per original input-output table**
1	Paddy	Paddy (6)
2	Tea	Tea Growing-High Elevation (1); Tea Growing- Medium Elevation (2); Tea Growing -Low, Elevation (3)
3	Rubber	Rubber Growing (4); Rubber Processing (22)
4	Coconut	Coconut and Toddy (5)
5	Tobacco	Tobacco (12)
6	Fruits	Fruits (8)
7	Vegetables	Vegetables (7)
8	Miscellaneous Agricultural products	Highland Crops (9); Potatoes (10); Minor Export Crops (11); Miscellaneous Agriculture Products (14)
9	Food & Beverages	Betel and Arecanuts (13), Coconut Processing (23); Rice Milling (24); Flour Milling (25); Food, Beverages and Other (26)
10	Tea & coffee processing	Tea Processing (21)
11	Fish & Livestock	Fisheries (19); Livestock (15)
12	Forestry & logging	Plantation Development (16); Firewood (17); Forestry (18)
13	Mining	Mining and Quarrying (20)
14	Textiles, Footwear & Leather Products	Textiles, Footwear and leather products (27)
15	Readymade garments	Garment Industry (28)
16	Wood & wood products	Wood and Wood Products (29)
17	Paper & paper products	Paper and Paper Products (30)
18	Chemicals & Fertilizers	Chemicals and Fertilizer (31)
19	Rubber & Plastic products	Plastic and Rubber Products (33)
20	Petroleum	Petroleum Industry (32)
21	Non metallic & other mineral products	Non Metallic & Other Mineral Products (34)
22	Metal products	Basic Metal Products (35); Fabricated Metal Products(36)
23	Manufacturing	Other Manufacturing (37)
24	Construction	Construction (39)
25	Electricity & Water	Electricity, Gas and water (38)
26	Transport	Transport (43)
27	Communication	Tourist Shops and Travel Agents (42); Post and Communication (44)
28	Trade	Wholesale and Retail Trade (40)
29	Hotels & Restaurants	Hotels and Restaurants (41)
30	Banking & Insurance	Banking, Insurance and Real Estate (45)
31	Ownership & Dwellings	Ownership of Dwellings (46)
32	Public Administration	Public Administration and Defence (47)
33	Other services	Other Personal Services (48)

From the aggregated input-output table of India, the input-output coefficient matrix (A) for the economy is computed using the standard input-output rule:

$$\mathbf{A = z\,x^{-1}}$$

Where z is the inter-industry transaction matrix of India (33x33) and x is the diagonal matrix representing its sectoral outputs. Table A1.3 represents the input-output coefficient matrix for India.

Table A1.3

Input-output coefficient matrix of India (A)

Commodities	1	2	3	4	5	6	7	8	9	10	11	12
Paddy	0.286	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.011	0.000	0.005	0.000
Tea	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.238	0.000	0.000
Rubber	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coconut	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000
Tobacco	0.000	0.000	0.000	0.000	0.051	0.000	0.000	0.000	0.003	0.000	0.000	0.000
Fruits	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048	0.000	0.000	0.000
Vegetables	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.002	0.000	0.000	0.000
Miscellaneous agricultural products	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.195	0.162	0.000	0.182	0.000
Food & Beverages	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.100	0.049	0.025	0.000
Tea & coffee processing	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.082	0.000	0.000
Fish & Livestock	0.054	0.063	0.031	0.037	0.019	0.010	0.011	0.054	0.018	0.000	0.005	0.000
Forestry & logging	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.002
Mining	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.000
Textiles, Footwear & Leather products	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.003	0.003	0.011	0.001
Readymade garments	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wood & wood products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.008	0.000	0.000
Paper & paper products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.011	0.000	0.002
Chemicals & Fertilizers	0.079	0.041	0.151	0.136	0.050	0.011	0.012	0.073	0.013	0.002	0.002	0.000
Rubber & Plastic products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.011	0.000	0.002
Petroleum	0.024	0.005	0.005	0.008	0.007	0.004	0.004	0.017	0.006	0.019	0.012	0.009
Non -metallic & other mineral products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Metal products	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.001
Manufacturing	0.005	0.000	0.003	0.000	0.001	0.000	0.000	0.004	0.006	0.010	0.007	0.010
Construction	0.012	0.000	0.005	0.000	0.003	0.001	0.001	0.008	0.006	0.003	0.000	0.010
Electricity & Water	0.029	0.000	0.000	0.000	0.006	0.003	0.003	0.016	0.009	0.023	0.000	0.001
Transport	0.033	0.016	0.020	0.013	0.011	0.003	0.003	0.023	0.030	0.273	0.038	0.032
Communication	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.003
Trade	0.038	0.012	0.025	0.033	0.003	0.001	0.006	0.027	0.105	0.053	0.120	0.003
Hotels & Restaurants	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
Banking & Insurance	0.006	0.010	0.010	0.010	0.007	0.009	0.010	0.007	0.018	0.027	0.002	0.002
Ownership & Dwellings	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Public Administration	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other services	0.004	0.003	0.002	0.000	0.001	0.001	0.000	0.001	0.006	0.025	0.000	0.015

Table A1.3 contd..
Input-output coefficient matrix of India (A)

Commodities	14	15	16	17	18	19	20	21	22	23	24	25
Paddy	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tea	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rubber	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coconut	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tobacco	0.004	0.000	0.000	0.000	0.000	0.041	0.000	0.000	0.000	0.000	0.000	0.000
Fruits	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Vegetables	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Miscellaneous agricultural products	0.104	0.006	0.000	0.001	0.022	0.000	0.000	0.000	0.000	0.000	0.008	0.002
Food & Beverages	0.001	0.000	0.001	0.006	0.020	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Tea & coffee processing	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fish & Livestock	0.002	0.002	0.190	0.046	0.002	0.003	0.000	0.000	0.000	0.000	0.001	0.000
Forestry & logging	0.014	0.000	0.004	0.000	0.001	0.006	0.000	0.001	0.000	0.000	0.004	0.000
Mining	0.003	0.002	0.004	0.012	0.041	0.007	0.619	0.127	0.116	0.012	0.041	0.118
Textiles, Footwear & Leather products	0.144	0.290	0.005	0.041	0.004	0.006	0.000	0.004	0.001	0.003	0.001	0.000
Readymade garments	0.004	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wood & wood products	0.002	0.005	0.004	0.002	0.003	0.006	0.000	0.006	0.001	0.004	0.013	0.000
Paper & paper products	0.006	0.006	0.028	0.241	0.013	0.011	0.001	0.010	0.002	0.004	0.001	0.004
Chemicals & Fertilizers	0.071	0.056	0.043	0.059	0.298	0.266	0.043	0.028	0.022	0.026	0.036	0.007
Rubber & Plastic products	0.029	0.012	0.005	0.000	0.003	0.022	0.000	0.021	0.004	0.018	0.000	0.000
Petroleum	0.017	0.009	0.015	0.011	0.015	0.083	0.001	0.057	0.017	0.008	0.012	0.082
Non -metallic & other mineral products	0.003	0.000	0.004	0.031	0.057	0.041	0.005	0.075	0.002	0.004	0.102	0.000
Metal products	0.001	0.002	0.024	0.004	0.007	0.024	0.000	0.011	0.273	0.190	0.117	0.002
Manufacturing	0.020	0.035	0.032	0.010	0.010	0.025	0.001	0.006	0.024	0.231	0.030	0.053
Construction	0.010	0.018	0.000	0.004	0.004	0.003	0.000	0.045	0.004	0.011	0.024	0.018
Electricity & Water	0.044	0.013	0.019	0.045	0.033	0.034	0.015	0.077	0.051	0.023	0.023	0.258
Transport	0.086	0.048	0.043	0.070	0.048	0.045	0.018	0.076	0.058	0.038	0.054	0.055
Communication	0.003	0.009	0.000	0.000	0.000	0.000	0.000	0.005	0.006	0.023	0.002	0.007
Trade	0.079	0.109	0.004	0.003	0.013	0.003	0.002	0.072	0.085	0.037	0.079	0.062
Hotels & Restaurants	0.011	0.000	0.064	0.051	0.053	0.057	0.007	0.000	0.000	0.000	0.000	0.001
Banking & Insurance	0.036	0.039	0.029	0.022	0.022	0.024	0.022	0.020	0.025	0.056	0.044	0.051
Ownership & Dwellings	0.001	0.000	0.004	0.004	0.005	0.005	0.002	0.000	0.000	0.000	0.000	0.000
Public Administration	0.001	0.000	0.007	0.003	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Other services	0.025	0.027	0.006	0.006	0.005	0.009	0.001	0.005	0.005	0.031	0.000	0.002

Table A1.3 contd..

Input-output coefficient matrix of India (A)

Commodities	26	27	28	29	30	31	32	33
Paddy	0.000	0.000	0.000	0.039	0.000	0.000	0.000	0.000
Tea	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rubber	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coconut	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tobacco	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fruits	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000
Vegetables	0.000	0.000	0.000	0.066	0.000	0.000	0.000	0.000
Miscellaneous agricultural products	0.012	0.000	0.001	0.089	0.000	0.000	0.000	0.002
Food & Beverages	0.000	0.000	0.000	0.154	0.000	0.000	0.000	0.000
Tea & coffee processing	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Fish & Livestock	0.000	0.000	0.000	0.053	0.000	0.000	0.000	0.000
Forestry & logging	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mining	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
Textiles, Footwear & Leather products	0.003	0.000	0.001	0.000	0.000	0.000	0.000	0.001
Readymade garments	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000
Wood & wood products	0.000	0.000	0.001	0.002	0.001	0.000	0.000	0.002
Paper & paper products	0.008	0.005	0.008	0.002	0.013	0.000	0.000	0.004
Chemicals & Fertilizers	0.006	0.000	0.003	0.001	0.000	0.000	0.000	0.040
Rubber & Plastic products	0.032	0.001	0.001	0.000	0.001	0.000	0.000	0.000
Petroleum	0.194	0.007	0.009	0.010	0.006	0.000	0.000	0.002
Non -metallic & other mineral products	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000
Metal products	0.004	0.001	0.010	0.000	0.002	0.000	0.000	0.001
Manufacturing	0.071	0.119	0.008	0.012	0.013	0.000	0.000	0.035
Construction	0.018	0.012	0.003	0.014	0.008	0.049	0.000	0.015
Electricity & Water	0.024	0.024	0.011	0.022	0.013	0.000	0.000	0.005
Transport	0.046	0.011	0.048	0.039	0.021	0.000	0.000	0.018
Communication	0.020	0.035	0.006	0.003	0.026	0.000	0.000	0.009
Trade	0.052	0.008	0.006	0.101	0.003	0.000	0.000	0.006
Hotels & Restaurants	0.021	0.003	0.003	0.005	0.016	0.000	0.000	0.019
Banking & Insurance	0.021	0.003	0.054	0.023	0.099	0.000	0.000	0.021
Ownership & Dwellings	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Public Administration	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other services	0.030	0.003	0.007	0.002	0.004	0.000	0.000	0.079

A1.2 Labour Coefficients

The sectoral labour coefficients 'l' for India have been computed from the sectoral employment and sectoral output data of the economy using the formula

$\mathbf{l = L.x^{-1}.}$

Where, 'l' is the row vector of the ratio of workers (in millions) to output. 'L' is the row vector of millions of workers employed in each sector and 'x' is the diagonal matrix representing the gross output of each sector.

The sectoral output data for the country is taken from the input-output table. The employment figures (in millions) for all the sectors have been obtained from the Economic Tables, Census of India (Census of India, 2001).

A1.3 Capital Coefficient*s*

The sectoral capital coefficients for India have been calculated in an indirect way using the formula

$$\mathbf{k = (v - wL)\, x^{-1}}$$

where 'k' is the row vector of ratio of capital (in US $ million) to output, 'v' denotes the row vector of value added at factor cost by sectors, 'w' is the wage rate of the sectors of the Indian economy, 'L' is the row vector of labour employed (in millions) in the Indian sectors.

The data on sectoral value added at factor cost is obtained from the country's input-output table and wage rates for the respective sectors of the economy are obtained from Ministry of Labour, Government of India.

A1.4 Land Coefficients

The sectoral land coefficients, calculated only for eight agricultural sectors, namely, Paddy, Tea, Rubber, Coconut, Tobacco, Fruits, Vegetables and Miscellaneous Agricultural products, is obtained using the formula

$$\mathbf{r_w = R_w\, x^{-1}}$$

Where, 'r_w' is the row vector of the ratio of land (in million hectares) to output. 'R_w' is the row vector of millions of workers employed in each sector and 'x' is the diagonal matrix representing the gross output of each sector.

The source of data on land for India is Agricultural Statistics at a glance 2008 (Department of Agriculture and Cooperation).

The sectoral labour, capital coefficients and land coefficients (l, k & r) thus obtained for India are presented in table A1.4

Table A1.4

Sectoral labour, capital and land coefficients for India

Commodity	Labour coefficients	Capital Coefficients	Land Coefficients
Paddy	0.000	0.000	0.000
Tea	0.000	0.000	0.000
Rubber	0.000	0.000	0.000
Coconut	0.000	0.000	0.000
Tobacco	0.000	0.000	0.000
Fruits	0.000	0.000	0.000
Vegetables	0.000	0.000	0.000
Miscellaneous agricultural products	0.012	0.000	0.001
Food & Beverages	0.000	0.000	0.000
Tea & coffee processing	0.000	0.000	0.000
Fish & Livestock	0.000	0.000	0.000
Forestry & logging	0.000	0.000	0.000
Mining	0.000	0.000	0.001
Textiles, Footwear & Leather products	0.003	0.000	0.001
Readymade garments	0.000	0.000	0.000
Wood & wood products	0.000	0.000	0.001
Paper & paper products	0.008	0.005	0.008
Chemicals & Fertilizers	0.006	0.000	0.003
Rubber & Plastic products	0.032	0.001	0.001
Petroleum	0.194	0.007	0.009
Non -metallic & other mineral products	0.001	0.000	0.000
Metal products	0.004	0.001	0.010
Manufacturing	0.071	0.119	0.008
Construction	0.018	0.012	0.003
Electricity & Water	0.024	0.024	0.011
Transport	0.046	0.011	0.048
Communication	0.020	0.035	0.006
Trade	0.052	0.008	0.006
Hotels & Restaurants	0.021	0.003	0.003
Banking & Insurance	0.021	0.003	0.054
Ownership & Dwellings	0.000	0.000	0.000
Public Administration	0.000	0.000	0.000
Other services	0.030	0.003	0.007

Source: based on authors' calculations

A2. Detailed figures related to calculation of Leontief and Leamer index

Table A2.1

Leontief index with respect to India's bilateral trade with Sri Lanka

Factors of production	Exports	Import replacements
Capital (US $ millions)	2343.4	295.7
Labour (millions)	9816.5	1534.9
Land (million hectares)	192.8	10.6
K/L	0.239	0.19
K/r	12.2	27.9
r/L	0.0196	0.007
Leontief Index: $(K/L)_E/(K/L)_M$ = **1.24**	$(K/r)_E/(K/r)_M$ = **0.44**	$(r/L)_E/(r/L)_M$ = **2.84**

Source: based on authors' calculations

Table A2.2

Leamer's index with respect to India's bilateral trade with Sri Lanka

Net Export of capital services (K_T) (US $ million)		2307700
Net Export of Labour services (L_T) (millions)		9621412
Net export of land (r_T) (million hectares		191927
Factor intensities of trade:		
Capital-Labour intensity of trade K_T/L_T (in US $ per millions of workers) **0.24**	Capital-Land intensity of trade K_T/r_T (in US $ per million hectare of land) **12.02**	Land-Labour intensity of trade r_T/L_T (in hectare per millions of worker) **0.02**
Capital embodied in Expenditure (K_C) (US $ million)		2095092.8
Labour embodied in Expenditure (L_C) (millions)		13333701.2
Land embodied in Expenditure (r_C) (million hectares)		71719.05
Factor intensities of expenditure:		
Capital-Labour intensity of expenditure K_C/L_C (in US $ per millions of workers) **0.16**	Capital-Land intensity of expenditure K_C/r_C (in US $ per million hectare of land) **29.2**	Land-Labour intensity of expenditure r_C/L_C (in hectare per millions of worker) **0.005**
Leamer Index: $(K_T/L_T)/(K_C/L_C)$ = **1.53**	$(K_T/r_T)/(K_C/r_C)$ = **0.41**	$(r_T/L_T)/(r_C/L_C)$ = **3.71**

Source: based on authors' calculation

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