Bilateral trade between India and Sri Lanka – does factor content matter?

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Abstract

With increasing integration of countries across the world there has been stupendous rise in intermediate trade flows across boundaries and production networks in trade patterns have assumed a pivotal role. These have often led to the idea that concept of comparative advantage are possibly not relevant for trade policy anymore. Trade patterns are argued to be no longer determined by resource endowment and factor content of trade of respective countries. Rather they are dictated by trade policies and pattern of technology transfer. This paper addresses this question: to what extent is factor content still reflected in trade patterns. To do this it considers bilateral trade between the two countries of India and Sri Lanka. These two South Asian countries had very strong economic ties between them and there are in place a number of cooperation arrangements between them. Though trade flow has increased between them over the years, but there have been concerns from both researchers as also policy makers that many of these arrangements have not been as successful as they should have been. Thus, the paper attempts to study if the trade pattern between these two economies could be explained by their resource endowment and their factor content or is it the trade policies of the countries towards one another which explain it.

JEL subject codes: F1, F14

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

Introduction

India is Sri Lanka's closest neighbor. The relationship between these two South Asian economies dates back to several hundred years in history as both the countries have built extensively upon a legacy of intellectual, cultural, religious and linguistic intercourse. With the passage of time this relationship has matured and diversified into all areas of contemporary relevance. Currently, this relationship has been more oriented towards developing closer political and economic contacts, growing trade and investment cooperation and cooperation in other fields of development, education, culture and defense.

Bilateral trade between India and Sri Lanka and the idea to strengthen it has been discussed in the early writings of various researchers (Panchmukhi et al 1993; Jayawardena, Ali and Hulugalle, 1993). Sri Lanka was 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 a trade policy reform that focused on liberalization, openness, transparency and globalization. This gradual opening up of the two economies gave a 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.

This bilateral trade grew even rapidly after the entry into force of the India-Sri Lanka Free Trade Agreement in March 2000. 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 was the year when the FTA between the two countries got fully implemented. 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.

The two economies now enjoy a robust trade and investment relationship, with bilateral trade growing rapidly and a number of leading Indian private sector companies investing in Sri Lanka and establishing a presence in the country. Sri Lanka is India's largest trade partner in South Asia. India in turn is Sri Lanka's largest trade partner globally. India has also emerged as the main source of Foreign

Direct Investment in Sri Lanka. Post the global recession in 2009 the bilateral trade between the countries rebounded in 2010. Bilateral trade in first eleven months of 2011 amounted to US $ 4.46 billion, which is about 72 % higher than the corresponding period last year (Jan- Nov of 2010 - US $ 2.59 billion). India's exports to Sri Lanka amounted to US $ 3.97 billion. This too is an increase of about 83 % compared to corresponding period last year. Sri Lanka's exports to India amounted to US $ 481.85 million and represented an increase of about 14 % compared to corresponding period last year (Ministry of External Affairs, India, 2012). Following these positive turn of things the countries in recent months, have resumed the discussions on Comprehensive Economic Partnership Agreement (CEPA). The CEPA negotiations which 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, was initiated in 2005 and was concluded in July 2008, after thirteen rounds of negotiations. 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 was not signed.

Table 1

India's trade with Sri Lanka (1991-2011) (US $ million)

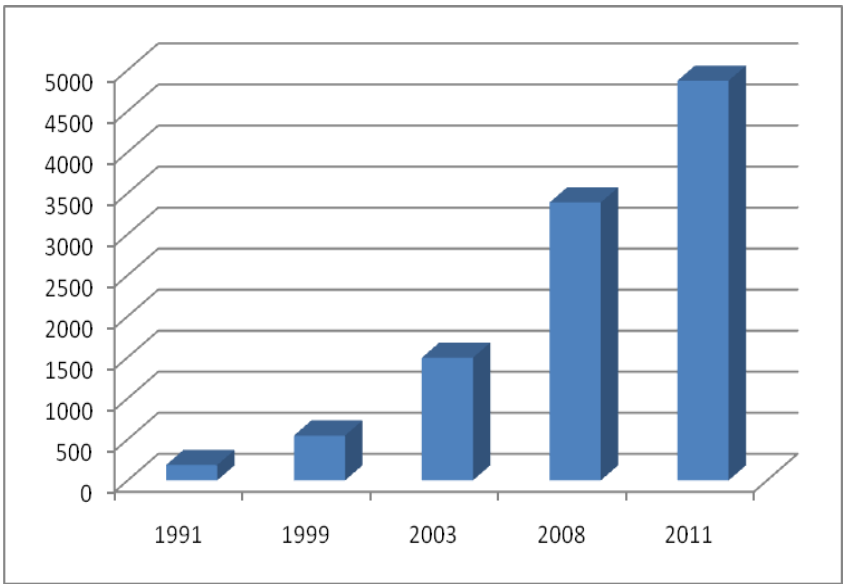
Year	Exports	Imports	Trade Balance	Total Trade
1991	175	12	163	187
1992	277	14	263	291
1993	288	39	249	327
1994	367	31	336	398
1995	400	39	361	439
1996	477	35	442	512
1997	489	42	447	531
1998	437	38	399	475
1999	502	44	458	546
2000	650	46	604	696
2001	638	68	570	706
2002	916	90	826	1006
2003	1302	192	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
2010	3305	368	2937	3673
2011*	4349	521	3828	4870

Source: ITC Trademaps
*Uncomtrade

The top Indian exports to Sri Lanka in recent 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%.

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

Note: in 2003 India completed the FTA implementation & in 2008 Sri Lanka completed the implementation

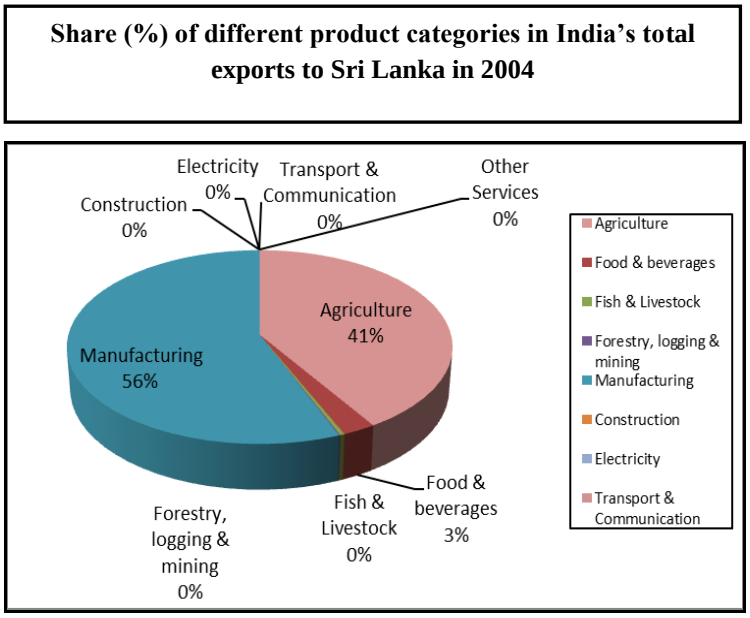
The top exports of Sri Lanka to India during these years have been apparel & accessories, coffee, tea, mate & spices, rubber & articles thereof, pearls, precious stones, metals and coins, fish, electrical and electronic equipment, nuclear reactors, boilers & machinery, copper and copper articles, plastics 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 twelve years into the FTA, these goods have been replaced by manufactured articles and machinery & transport equipment.

India exports its traditionally important goods to Sri Lanka even after major tariff concession exchanges under the scope of the 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.

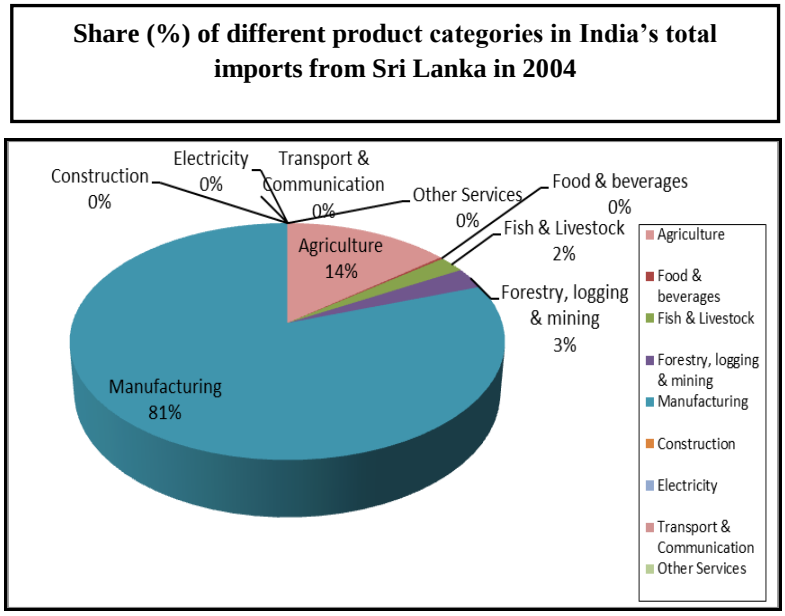
Against this backdrop, the present paper attempts an analysis of comparative advantage of the two economies from the perspective of factor services embodied in traded outputs between the countries. The study is based on the GTAP 7 database which uses 2004 as the base year. The composition of India's export to and imports from Sri Lanka during this year is presented in figures 3a & 3b.

Figure 3a



Source: based on data from UN comtrade

Figure 3b



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 could be explained by the resource endowment and factor content of the respective countries or is it the trade policies of the countries towards one another which explain it. 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 GTAP 7 database the paper tests empirically the Heckscher-Ohlin theory for India- Sri Lanka's bilateral trade and reports if factor content is reflected in the bilateral trade pattern between the countries.

3. Literature Review

Contemporary researchers have shown considerable interest in India Sri Lanka bilateral trade. 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 has led to 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 on the basis of Leontief and Leamer index of factor content of trade 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. Sikdar & Chakraborty (2011) attempts a similar exercise in the context of India-Sri Lanka

bilateral trade and finds that Leontief paradox exists with respect to India's net exports to Sri Lanka which are found to be capital intensive.

The present study attempts an extension of the work by Sikdar & Chakraborty (2011). The factor content of India's bilateral trade with Sri Lanka is studied not only using Leontief's and Leamer's methods but also Trefler & Zhu (2010) method. The latter method unlike Lontief and Leamer accounts for the technology differences across countries and factors in trade in intermediate inputs while defining the factor content of trade of a country. 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 (2004) on trade flows. Moreover, the study examines factor content of trade in a framework with two factors of production- labour and capital as done by Leontief and Leamer. Then this framework is extended to include technology differences existing between the two countries and incorporates the trade in intermediate inputs between them.

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 three alternative frameworks as developed by

- Leontief (1951)
- Leamer (1980) and
- Trefler & Zhu (2010)

At the outset we begin by discussing the three 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.

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

$C = (C_1, C_2 \ldots\ldots\ldots\ldots C_n)$, (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.

$M = (M_1, M_2 \ldots\ldots\ldots\ldots M_n)$, (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.

$L = (L_1, L_2 \ldots\ldots\ldots\ldots\ldots L_n)$, (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

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

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

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

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 c

V_{fw} = (n x 1) endowment vector of world, $V_{fw} = \Sigma V_{fi}$

i =1

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

Equation (8) holds when one works with a country's trade with the rest of the world. In standard theory, there is typically no prediction made about factor content of bilateral trade because the pattern of bilateral goods trade may not be uniquely defined. However, given the assumptions of specialization and identical homothetic preferences one can make predictions about factor content of bilateral trade. Given assumption of specialization, there is little harm in thinking of each country as producing a single composite good using all of its factors and then using it both for domestic consumption as well as exports. Thus the net factor content of trade in factor 'f' between countries 'i' & 'j' is given as follows

$$F_{fij} = \alpha_j V_{fi} - \alpha_i V_{fj} \quad (9)$$

Equation (9) implies that the factor content of trade in factor 'f' between country i and j is given as the difference between the exports of 'f' from i and the imports of 'f' by i

It follows from equation (9) that a country 'i' will be a net exporter of factor 'f' bilaterally to any country 'j' such that:

$$V_{fi}/\alpha_i > V_{fj}/\alpha_j$$

In the reverse case it will be a bilateral net importer.

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

$$K_{Tij} = \alpha_j K_i - \alpha_i K_j$$

And (10)

$$L_{Tij} = \alpha_j L_i - \alpha_i L_j$$

Thus, a country 'i' is a net exporter of capital to country 'j' and hence capital abundant if

$$K_i/\alpha_i > K_j/\alpha_j \quad (11)$$

Likewise, a country 'j' is a net exporter of labour to country 'j' and hence labour abundant if

$$L_i/\alpha_i > L_j/\alpha_j \quad (12)$$

Given that there are two factors of production, if trade is bilateral trade is balanced then K_{Tij} and L_{Tij} should be opposite in sign i.e if $K_{Tij} > 0$ then $L_{Tij} < 0$ if trade is balanced. If l_E and k_E are respectively the labour and capital content of bilateral export worth a million dollar, 'e' is the total value of

bilateral export and likewise l_M and k_M are respectively the labour and capital embodied in bilateral imports worth one million dollar and 'm' be the bilateral import, then

$L_{Tij} = L_E - L_M = l_E\, e - l_M\, m$

If $L_{Tij} < 0 \Rightarrow l_E\, e - l_M\, m < 0 \Rightarrow (l_E / l_M) < (m / e) = 1$ (since bilateral trade is balanced)

Similarly, $K_{Tij} > 0 \Rightarrow (k_E / k_M) > (m / e) = 1$

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

Thus, if bilateral trade is balanced, $K_{Tij} > 0$ and $L_{Tij} < 0$ implies that $(k_E / k_M) > (l_E / l_M)$ which is precisely the index Leontief applied.

Leamer worked with data on US's total trade with the Rest of the World. Hence he worked with data on US's K_T and L_T and not on K_{Tij} and $L_{Tij.}$ Using 1947 US data Leamer found that both $K_T > 0$ and $L_T > 0$. Thus, $(k_E / k_M) < (l_E / l_M)$ with respect to US's total trade was not the right proposition to conclude that the U.S. was not as well endowed with capital as it was with labour. The same holds in the case of any country's bilateral trade with another country.

$K_T > 0$ (or $K_{Tij} > 0$) and $L_T > 0$ (or $L_{Tij} > 0$) indicate 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 $L_i = L_C + L_T$. he found out that if K_T and $L_T > 0$, then a country is rich in capital relative to labour if production is endowed with more capital than domestic expenditure i.e.,

$(K_T / L_T) > (K_C / L_C)$, (if $K_T, L_T > 0$) (14)

Moreover, given $K_T > 0$ and $L_T > 0$, it also implies that

$(K_T / L_T) > (K_i / L_i)$ (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.

$K_T > 0 , L_T < 0$ (16)

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

$K_T < 0 , L_T < 0 , (K_T / L_T) < (K_C / L_C) \rightarrow L2 < 1$ (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 of bilateral trade also if both $K_{Tij} > 0$ and $L_{Tij} > 0$, then a country is rich in capital relative to labour if production for bilateral trade is endowed with more capital than domestic expenditure i.e.,

$(K_{Tij} / L_{Tij}) > (K_C / L_C)$ (19)

Thus, following Leamer, a country's trade figures would reveal that it is more abundantly endowed with capital rather than labour if any one of the following conditions are satisfied by

$K_{Tij} > 0$, $L_{Tij} < 0$ (20)

$K_{Tij} > 0$, $L_{Tij} > 0$, $(K_{Tij} / L_{Tij}) > (K_C / L_C) \rightarrow L2 > 1$ (21)

$K_{Tij} < 0$, $L_{Tij} < 0$, $(K_{Tij} / L_{Tij}) < (K_C / L_C) \rightarrow L2 < 1$ (22)

4.3 Trefler & Zhu framework

Researchers in recent years have dealt extensively with the impact of international technology differences on the factor content of trade. Yet the literature has not dealt much with a very important issue related to international trade in today's globalized world - With international technology differences and traded intermediate inputs there is no existing definition of the factor content of trade that is compatible with Vanek's factor content prediction. Trefler & Zhu (2010) contribute to this gap. Earlier Reimer (2006) too has done a similar work whereby he develops an approach to measure the factor content of trade when intermediate inputs are traded and techniques differ across countries. Trefler & Zhu (2010) further builds upon this framework.

Let g =1,...,G represent goods. Let i and j=1,...,N index countries and let f=1,...,K represent 'K' factors. Let Vi be the K×1 vector of country I endowments and let $V_w \equiv \Sigma_i V_i$ be the world endowment vector, and let F_i be the K×1 vector giving the factor content of trade for country i . Let α_i be country i's share of world consumption, where $\alpha_i > 0$ for all i and $\Sigma_i \alpha_i = 1$.

As mentioned earlier in equation (8) in section 4.2, the Vanek factor content of trade prediction is given by

$F_i = V_i - \alpha_i V_w$

Every good produced by a country is consumed as a final product and/or used as an intermediate input. Let C_{ij} be the G×1 vector denoting country i's consumption of goods produced in country j. Let Y_{ij} be a G×1 vector denoting i's usage of intermediate inputs produced in country j. Thus, country j's output denoted by Q_j is the summation of the amount of the good used for final consumption and that used as intermediate inputs ie.,

$Q_j \equiv \Sigma_i (C_{ij} + Y_{ij})$ (23)

World consumption of goods produced in country j is given by

$C_{wj} \equiv \Sigma_i C_{ij}$ (24)

Let B_{ij} (g, h) be the amount of intermediate input g used to produce a unit of good h, where h is produced in country 'j' with intermediate input 'g' sourced from country i. Now, Q_j (h) is a typical element of Q_j. Thus, B_{ij} (g,h) Q_j (h) is the amount of input g used to produce Q_j(h) and $\Sigma_h B_{ij}$(g,h) Q_j(h) is the amount of input g used by country j. In matrix notation,

$Y_{ji} = B_{ij} Q_j$ (25)

where B_{ij} is the G×G matrix whose typical element is of the form Bij (g, h).

Let Di be a K×G matrix whose (f,g) element gives the amount of factor 'f' used directly to produce one unit of good 'g' in country i. Given full employment, we assume that

$$D_iQ_i = V_i \quad (26)$$

Country i's vector of imports from country j is given by

$$M_{ij} \equiv Y_{ij} + C_{ij} \qquad \text{for } j \neq i$$

$$\text{Or, } M_{ij} = B_{ij}Q_j + C_{ij} \qquad \text{for } j \neq i \quad (27)$$

Country i's vector of exports to the world is $X_i \equiv \Sigma_{j\neq i}M_{ji} = \Sigma_{j\neq i}(Y_{ji} + C_{ji}) = \Sigma_j (Y_{ji} + C_{ji}) - Y_{ii} - C_{ii}$

Using equations (23) and (25), 'X_i' can be rewritten

$$X_i \equiv Q_i - B_{ii}Q_i - C_{ii} \quad (28)$$

Given the complete list of variables as defined in equations (23) to (28), the factor content of trade will now be defined such that equation (8) ($F_i = V_i - \alpha_i V_w$) is satisfied. 'Fi' is the factors employed worldwide to produce the net trade flow of country i. A regional input –output model of the world economy is constructed such that each region is a country. This allows one to track the movement of intermediate inputs across countries. The regional input–output model comprises mainly of an NG×NG matrix as follows:

$$B \equiv \begin{Bmatrix} B_{11} & B_{12}\ldots\ldots\ldots\ldots\ldots\ldots.. & B_{1N} \\ B_{21} & B_{22}\ldots\ldots\ldots\ldots\ldots\ldots... & B_{2N} \\ . & . & . \\ . & . & . \\ B_{N1} & B_{N2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & B_{NN} \end{Bmatrix}$$

The off diagonal sub-matrices of the 'B' matrix track the requirements of foreign intermediate inputs across the world.

The 'Q', 'C' & 'T' matrices are defined as

$$Q \equiv \begin{Bmatrix} Q_1 & 0\ldots\ldots\ldots\ldots\ldots\ldots & 0 \\ 0 & Q2\ldots\ldots\ldots\ldots\ldots\ldots & 0 \\ . & . & . \\ . & . & . \\ 0 & 0 \ldots\ldots\ldots\ldots\ldots\ldots & Q_N \end{Bmatrix} \qquad C \equiv \begin{Bmatrix} C_{11} & C_{21}\ldots\ldots\ldots\ldots\ldots\ldots & C_{N1} \\ C_{12} & C_{22}\ldots\ldots\ldots\ldots\ldots\ldots & C_{N1} \\ & . \quad . & \\ . & . & . \\ C_{1N} & C_{2N} \ldots\ldots\ldots\ldots\ldots\ldots & C_{NN} \end{Bmatrix} .$$

$$T = \begin{Bmatrix} X_1 & -M_{21} \ldots\ldots\ldots\ldots\ldots -M_{N1} \\ -M_{12} & X_2 \ldots\ldots\ldots\ldots\ldots -M_{N2} \\ . & . \quad\quad . \\ . & . \quad\quad . \\ -M_{1N} & -M_{2N} \ldots\ldots\ldots\ldots\ldots X_N \end{Bmatrix}$$

Using matrix notation, equation (27) can be written as

$$T = Q - BQ - C \qquad (29)$$

Or, $Q = (I-B)^{-1}(C+T)$

The above represents the fundamental input-output identity where 'Q' denotes gross output and 'C+T' denotes net output (or final demand). Let 'Z_i' be an arbitrary net output vector for country i. Then, Zi is NG× 1, reflecting the fact that one must track not only what intermediate inputs were used to produce Zi, but also track the sources of these inputs. BZ_i is the vector of intermediate inputs directly needed to produce Z_i. Further, $B(BZi)= B^2Zi$ is the intermediate inputs directly needed to produce BZ_i. Thus, $\Sigma_{n=1}^{\infty} B^nZ_i$ is the matrix of intermediate inputs directly and indirectly needed to produce Z_i. Turning from intermediate requirements to total requirements, delivering net output Z_i requires gross output of $Z_i+\Sigma_{n=1}^{\infty} B^nZ_i=\Sigma_{n=0}^{\infty} B^nZ_i=(I-B)^{-1}Z_i$. This is Leontief's famous contribution.

Let us further define,

$D \equiv \{D_1 \quad D_2 \quad \cdots \quad D_N\}$

which is a K×NG matrix of direct factor requirements and

$A \equiv D(I-B)^{-1}$ where I is the NG× NG identify matrix.

Then AZ_i is the factor content of Z_i i.e., the amount of factors employed worldwide to produce any net output vector Z_i. Finally, let Ti be the ith column of matrix T. Then $F_i \equiv AT_i$ is the factor content of trade of country i.

5. Data

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

- Input-output coefficient matrix for India
- Sectoral capital and labour coefficients of India
- India's sectoral bilateral exports to and imports from Sri Lanka
- India's domestic expenditure corresponding to the sectors

The application of the theoretical framework of Trefler and Zhu developed in section 4.3 needs additionally to distinguish the origin of inputs used by each productive sector of an economy. Likewise, the pattern of import sourcing concerning goods for final use (C +I +G) must be known. Data on factor endowments and direct factor inputs for Sri Lanka and India is also required. One data source that provides most of the above data in the desired form is the Global Trade Analysis Project (GTAP) as compiled by the Centre for Global Trade Analysis, Purdue University, United States. The database used is version 7. The reference year for the database corresponds to the global economy in 2004. The database is compiled for bilateral exports and imports, and tariffs inclusive of other flows for 113 regions across the world and for 57 tradeable commodities of the world. Of the 113 regions, 94 are primary regions that are developed from contributed I-O tables of the respective countries; the remaining 19 are composite regions. All the trade flows across the 57 commodities are distinguished by their regions of origin and destination, and are based on agents such as intermediate demand, final demand by private households, government and investment. It provides a method for allowing for varying import intensities by different economic agents within a region.

However, GTAP factor measurements are made in value terms instead of physical units. For example, labor usage is measured in 2004 U.S. dollars, as opposed to 'hours worked' or 'number engaged'. But for the purpose of this paper labour needs to be measured in terms of physical units. Thus, the present paper uses the GTAP data on labour employment for both India and Sri Lanka but divides this data by wage rates for the respective sectors in the two economies. The data for the wage rates are obtained from the Annual survey of industries for both the countries for the manufacturing sectors. For agricultural wages, the data is taken from Agricultural Statistics for both India and Sri Lanka. For services, the data is obtained from the UNIDO database. Data on sectoral capital usage as used in the application is as obtained from the GTAP database.

For the empirical application of the theoretical frameworks, the present paper aggregates the GTAP database so as to have

- 3 regions – India, Sri Lanka and Rest of the World
- 6 sectors – Primary, Food, Extraction, Manufacturing, Utility and Services

6. Results and discussions

Factor content of India's bilateral trade with Sri Lanka considering 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 labour required per unit of capital for India's exports to Sri Lanka is more than that required for domestic replacements of competitive imports

(Appendix table A1). This implies that India's exports to Sri Lanka contain relatively more labour and less capital than the import replacements. Thus, India's bilateral trade structure with respect to Sri Lanka as revealed by Leontief index indicates that India is a labour abundant country.

Table 2

Relative Factor Abundance in India as per Leontief & Leamer index

Index	**Ratios Compared**	**Implications corresponding to sign of each ratio**	**Final factor content**
Leontief	$(k_e/l_e)/(k_m/l_m) = 0.92$	One million dollar worth of exports is more labour intensive	In one million worth of exports the factor content is of following order: $l > k$
Leamer	$k_{Tij} > 0$; $l_{Tij} > 0$ $(k_{Tij}/l_{Tij})/(k_C/l_C) = 0.903$	Country is richly endowed with labour relative to capital	The relative factor abundance of the country as revealed by its bilateral trade is of the following order: $l > k$

Source: based on authors' calculation of the indices

Factor content of India's bilateral trade with Sri Lanka considering Leamer's index

Applying, Leamer's methodology too yields the same results (as that when Leontief is applied) 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 bilateral exports (table A2 in Appendix). It shows that India's net exports absorb more labour per unit of capital 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 labour abundant country. This result is as expected given the fact that India is a labour abundant country and thus there is no evidence of Leontief paradox present with respect to India's bilateral trade with Sri Lanka.

Factor content of India's bilateral trade with Sri Lanka considering Trefler & Zhu framework

Trefler & Zhu is different from the earlier framework in that their framework measures factor content of trade when intermediate inputs are traded and techniques differ across the two countries. Here there are three regions considered in the database- India, Sri Lanka & Rest of the World. But to keep the expression for F_i manageable we assume that intermediate inputs flow from India to Sri Lanka and from Sri Lanka to India. There is no flow of intermediate inputs from Rest of the world to any of these

two countries. The factor content of India's net exports of both final goods and intermediate inputs to Sri Lanka are reported in table 3. The factor content of India's total exports of final goods and intermediate inputs to Sri Lanka and factor content of India's total imports of final goods and intermediate inputs from Sri Lanka are also reported in the table. The table finally reports the net factor content of India's bilateral trade (summation of final and intermediate goods) with Sri Lanka.

As is noted from the table, India's net exports to Sri Lanka, considering both goods for final use as also intermediate use, is relatively more labour intensive. India's net exports as also imports are both labour intensive. But exports happen to be more labour intensive than the imports. Looking at exports and imports of final goods and intermediate inputs separately gives the result that the exports of both the final goods and intermediate inputs are labour intensive. However, the net exports of intermediate inputs are relatively less labour intensive than the net export of final goods. This is because India's exports of intermediate inputs to Sri Lanka are not as much labour intensive as the export of final goods. Thus, when intermediate inputs and technology differences are incorporated in measuring factor content of trade, India's bilateral trade structure with respect to Sri Lanka points to the fact that India is endowed with relatively more labour than capital. Thus, like the case of Leontief and Leamer, Trefler and Zhu (2010) framework too indicates that India is a labour abundant country. Thus, there is no evidence of Leontief paradox in this case too.

Table 3

Relative Factor Abundance in India in case of Trefler & Zhu

Factor Content of India's net export to Sri Lanka	**Ratios Compared**	**Implications corresponding to sign of each ratio**	**Final factor content**
Factor content of India's net exports in final goods	$D_1 (1-B_{11})^{-1}*X_{12} - D_2 (1-B_{22})^{-1}*M_{12}$		
Labour	199054.17	One million worth of exports of final goods is more labour intensive	-
Capital	264.72		
Factor content of India's net exports in intermediate inputs	$D_2(1-B_{22})^{-1}*B_{21}(1-B_{11})^{-1}*X_{12} - D_1(1-b_{11})^{-1}*B_{12}(1-B_{22})^{-1}*M_{12}$		
Labour	578.4	One million worth of exports of intermediate inputs is more labour intensive	
Capital	3.4		

Factor content of export to Sri Lanka (incl final & intermediate goods)	$D_1 (1-B_{11})^{-1}*X_{12} + D_2(1-B_{22})^{-1}*B_{21}(1-B_{11})^{-1}*X_{12}$		
Labour Capital	265559.14 439.07	One million dollar worth of exports is more labour intensive	
Factor content of import to Sri Lanka (incl final & intermediate goods)	$D_2 (1-B_{22})^{-1}*M_{12} + D_1(1-B_{11})^{-1}*B_{12}(1-B_{22})^{-1}*M_{12}$		
Labour Capital	65926.1 170.93	One million dollar worth of imports is more labour intensive	
Factor content of India's net exports to Sri Lanka (incl final & intermediate goods)			
Labour Capital	199633 268.1	One dollar worth of net exports is more labour intensive	The relative factor abundance of the country as revealed by its bilateral trade is of the following order: $l > k$

Source: based on authors' calculation of the indices

Thus, based on the results obtained from the empirical implementation of the theoretical frameworks developed in section 4 of the present paper, it is observed that there is no 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 trade only in final goods (as in Leontief & Leamer) as also when trade in intermediate inputs and differences in technology are considered (as in Trefler & Zhu). India's growing trade with Sri Lanka has been in line with the pattern of comparative advantage of India as suggested by Hecksher-Ohlin theory. India, being a labour abundant country has been exporting more labour intensive goods to Sri Lanka.

7. Conclusion

Large number of studies in recent times has 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 twelve 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.

With increasing integration of countries across the world there has been stupendous rise in intermediate trade flows across boundaries and production networks in trade patterns have assumed a pivotal role. India- Sri Lanka too has been no exception to this. Such increase in intermediate trade flows and production networks have often led to the idea that concept of comparative advantage is possibly not relevant for trade policy anymore. Trade patterns are argued to be no longer determined by resource endowment and factor content of trade of respective countries.

In fact, in the post FTA period, the growth in exports from either side of these South Asian countries 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.

Against this backdrop, the present paper examined whether the factor intensity of the bilateral trade has been in conformity with the pattern of comparative advantages of India as are determined from India's factor endowments. Using the GTAP 7 database 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 capital. The factor content of this bilateral trade as worked out in this paper does confirm this general expectation. All of the Leontief index, Leamer's index and Trefler's framework (including trade in intermediates) indicate that exports from India to Sri Lanka are intensive in labour and not in capital.

Thus, the results of the paper provide no evidence to support Leontief paradox present with respect to India's bilateral trade with Sri Lanka. This growing trade has 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 factor content is not reflected in trade patterns and are dictated by trade policies and pattern of technology transfer does not hold good with respect to the bilateral export basket of India to Sri Lanka.

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Appendix

Detailed figures related to calculation of Leontief and Leamer index

Table A1

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

Factors of production	**Exports**	**Import replacements**
Capital (US $ millions)	0.312	0.328
Labour (millions)	191.09	184.55
K/L	0.0016	0.002
Leontief Index: $(K/L)_E/(K/L)_M$ = **0.917**		

Source: based on authors' calculations

Table A2

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

Net bilateral export of capital services (K_{Tij}) (US $ million)	282.94
Net bilateral export of Labour services (L_{Tij}) (millions)	181064.13
Factor intensities of trade: Capital-Labour intensity of trade K_{Tij}/L_{Tij} (in US $ per millions of workers)	0.0016
Capital embodied in Expenditure (K_C) (US $ million)	141368.8
Labour embodied in Expenditure (L_C) (millions)	81777124
Factor intensities of expenditure: Capital-Labour intensity of expenditure K_C/L_C (in US $ per millions of workers)	**0.0017**
Leamer Index: $(K_{Tij}/L_{Tij})/(K_C/L_C)$ = **0.903**	

Source: based on authors' calculation

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